

010260W07 Interconnect Access to the Telstra InfraCo Underground Network

Author's name Rose, Darren	Business unit Exchanges and Infrastructure	Sub-business unit Pit & Duct Asset Management
Issue number 1	Document ID 010260W07	Approver Name Leader, Warren
Issue Date 20/03/2023	Last Review Date 15/03/2023	Approval Date 15/03/2023

Summary

This Specification was formerly published as TM00042A01 and has been re-published as 010260W07 to align with Telstra InfraCo's document library, This Specification is to provide the Contractor with detailed Technical Requirements which must, unless otherwise directed by Telstra InfraCo, be complied with in performing WUC (as defined in the General Conditions of Contract).

© Telstra Corporation Limited (ABN 33 051 775 556) 2012. All rights reserved.

This work is copyright. Apart from any use as permitted under the Copyright Act 1968, information contained within this manual cannot be used for any other purpose other than the purpose for which it was released. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the written permission of Telstra Corporation Limited.

Words mentioned in this book that are known to be trademarks, whether registered or unregistered, have been capitalised or use initial capitals. Terms identified as trademarks include Cisco®, Microsoft®, Microsoft Windows®, Apple®, AirPort®, Mac®, Linksys®.

General

Contents

01	Purpose	5
02	Scope	5
03	Technical Requirements	5
3.1.	Business Rules for ADR Online tool	5
3.2.	Preliminary Design	5
3.3.	OHS in Congested Manholes and Pits (damage to plant and person)	5
3.3.1.	Data Requirements	5
3.3.2.	ACIF C524:2013	6
3.3.3.	Scope	6
3.3.4.	Use of Telstra InfraCo Logo	6
3.4.	Design	6
3.4.1.	Subduct	6
3.4.2.	Bare Optic Fibre Cable	7
3.4.3.	Subduct Sizes	7
3.4.4.	Interconnection to Telstra InfraCo Manholes and Pits – Breakouts	7
3.4.5.	Installing Pits for Other Carriers	8
3.4.6.	Separation between Telstra InfraCo and Other Carriers Pits/Manholes	8
3.4.7.	Material Management Process	9
3.4.8.	Subduct and Conduit	9
3.4.9.	Plugs - Conduit and Pipe	10
3.4.10.	Cable and Joint Closure Housing – Fittings	10
3.4.11.	Cable hauling Lubricant	10
3.4.12.	Labelling of Plant	11
3.4.13.	Recording of Plant	11
3.4.14.	Plant Location	11
3.4.15.	Manhole Preparation	12
3.4.16.	Duct Breakout Installation	12
3.4.17.	Subduct installation	13
3.4.18.	Hauling Subduct and cables	15
3.4.19.	Cable and Splice Closure Installation	18
3.4.20.	Sealing Conduits, Breakouts and Subducts	19
3.4.21.	Recording of Subduct and Other Carriers Plant within the Telstra InfraCo Network	21
3.5.	Commissioning/Acceptance	21
3.5.1.	Quality Control System	21
3.5.2.	Inspection	21
3.6.	Recovery	21
3.6.1.	Requirements after Cancellation of Subduct or Bare Fibre Lease	21

04	Material list	22
05	References	23
06	Definitions	23
07	Attachments	26
08	Document control sheet	26
09	Record of Issue	27
A1	- Current Practice for Breakout in Coffin Shaped Manholes	28
A1.1	- Current Practice for Breakout in Standard type Manholes (No Turret)	29
A1.2	- Manholes with a Turret	30
A2	- T-Dux Solutions	31

01 Purpose

The purpose of this Specification is to provide the Contractor with detailed Technical Requirements which must, unless otherwise directed by Telstra InfraCo, be complied with in performing Work Under the Contract (**WUC**) as defined in the General Conditions of the Contract.

02 Scope

This Specification applies to the Design Elements and Deliverable Items (DI's)

(Conduit)

This specification specifically refers to.

Interconnect Access to The Telstra InfraCo Underground Network by Other Carriers

and refers to Contractors installing plant as part of the delivery of a wholesale product e.g., duct access for other telecommunications Carriers and Carriage Service Providers in the Telstra InfraCo Underground Network.

Under the Facilities Access Agreement (**FAA**), the Carrier or Carriage Service Provider and Telstra InfraCo jointly agree that an Approved Contractor perform the construction activity in a professional manner in accordance with Telstra InfraCo Technical Specifications and Procedures whilst exercising due care, skill, and judgement.

The order in which the Technical Requirements are set out in this Specification is listed below and corresponds with the order in which Deliverable Items (DI's) are listed in the Schedules:

- Preliminary Design
- Design
- Material
- Installation Work
- Commissioning/Acceptance
- Cutover
- Recovery

03 Technical Requirements

3.1. Business Rules for ADR Online tool

- All routes shall, unless agreed with InfraCo, be designed using 32mm PE subduct media type.
- If any “confirmed” path section comes back as unavailable for 32mm PE subduct media type, Customer can then redesign the unavailable section to check for bare fibre availability, Customer must specify the correct cable media type.

3.2. Preliminary Design

3.3. OHS in Congested Manholes and Pits (damage to plant and person)

In the Design submission all manholes and pits that are Congested or unsafe to enter shall be recorded and Telstra InfraCo advised, (The manhole/pit is not to be entered until Telstra InfraCo have provided guidance).

3.3.1. Data Requirements

For all Ground-breaking activities Refer to Telstra InfraCo's “Working on or Adjacent to Underground Assets Procedure” & Contractors requiring access to data stored within Telstra InfraCo systems shall request such access through the Telstra InfraCo Business Unit SQ&ND.

3.3.2. ACIF C524:2013

Provides guidance on the basic principles of installation, maintenance, and safety of external telecommunications networks; describes the minimum requirements for electrical, structural and network reliability and employee/public safety under specified conditions.

3.3.3. Scope

This Industry Code applies to persons who are:

- (a) Owners of an external Communication Network covered by the Scope of the Code.
- (b) Lessees of an external Communication Network covered by the Scope of the Code.
- (c) Employees of the owners or lessees; and
- (d) Contractors to the owners or lessees and persons employed by or subcontracted by such contractors.

The construction, maintenance, and safety provisions of this Industry Code apply to all external Communication Network systems whether the system is:

- (a) In service or out of service.
- (b) Being constructed and has never been energised or operated in some form; or
- (c) Being constructed on or near other Utility infrastructure.

This Industry Code is intended to provide guidance on the basic principles of installation, maintenance, and safety of external Communication Networks with the purpose of achieving the minimum requirements for electrical, structural and network reliability, as well as setting out the minimum provisions that are considered necessary for the safety of employees and the public under the specified conditions.

3.3.4. Use of Telstra InfraCo Logo

The Telstra InfraCo logo must not be used on any item of another Carrier's plant.

3.4. Design

Subduct is the preferred method for carrier's cable installations and should always be the first choice for cable installations as a direct point to point reservation.

Bare Optic fibre cable in a street network can be installed where integrity and serviceability of existing network is not jeopardized.

3.4.1. Subduct

Subducting allows maximum protection for other Carrier's cables during and after installation, and during recovery of cables.

Accordingly, polyethylene (PE) subducts are to be installed to house other telecommunications Carriers' cables installed in the Telstra InfraCo underground network, with the following exceptions:

- CBD tunnel systems in Melbourne and Sydney.
- Exchange cable chambers.
- To allow splice or loop installation in manholes that are deemed suitable locations by Telstra InfraCo and approved in a Design & Construction Proposal or in a Construction Finalization Document (CFD),
- When a subduct cannot be made continuous from Telstra InfraCo's conduit network into a carrier P50mm breakout conduit,
- Building lead-ins,

A subduct shall have a tensile strength and crush resistance, complying with AS/NZS 4130:2009 "Polyethylene (PE) pipes for pressure applications".

Subducts installed in the Telstra InfraCo network for the housing of other Carriers cables, remain the property of Telstra InfraCo, and are leased by the Carrier.

3.4.2. Bare Optic Fibre Cable

OC Bare Optic fibre cable in a street network shall only be installed when integrity and serviceability of existing network is not jeopardized.

All Bare Optic fibre cables must be clearly labelled as per Telstra InfraCo standards.

Note: Carrier waives any liability towards Telstra InfraCo if Bare Fibre is damaged. No other criteria are required, or approval sought, Bare fibre or micro ducts can be installed in a conduit that contains any existing copper cables, preferably in a conduit that has small copper cables, subduct, or bare fibre cables.

3.4.3. Subduct Sizes

The standard subduct is PE 32 (28mm ID) subduct to AS/NZS 4130:2009 "Polyethylene (PE) pipes for pressure applications".

3.4.3.1. Number of Subducts per Duct Unoccupied Ducts

3.4.3.1.1. Unoccupied Ducts

More than one subduct may be installed in unoccupied duct. The space required for the multiple subducts should be proven by passing through the duct, a mandrel 95% of the internal diameter of the duct.

3.4.3.1.2. Occupied Ducts

More than one subduct may be installed in an occupied duct. The duct space required for the subduct(s) must be proven by passing a mandrel through the duct equivalent to 1.5 times the diameter of the proposed subduct(s).

Note: Number of sub-ducts in vacant ducts: 4 – P100/A100; 3 – P80/E85, additional bare fibre cables can be installed in conduits containing maximum number of subducts.

3.4.3.2. Length of subduct

Lengths of subduct may be joined to provide a continuous length limited only by the capacity to haul and handle the subduct, and the maximum hauling length of the cable to be installed within it.

3.4.3.3. Selection of conduit for Subducting and bare fibre

The selection of a conduit for subducting or bare fibre must take the following considerations:

The cable and/or subduct flow will not block off other ducts, or interlace, obstruct, or interfere with other cables or plant in the manhole.

The duct installed by NBN Co and tagged in a manhole or pit must not be selected,

3rd party asset transferred lead in conduits shall not be utilized,

Preferably the allocation of a duct in a nest of ducts for subduct installation, should generally follow by commencing with the bottom row of a nest, choosing the duct closest to the wall of the manhole where the cable or subduct is to be housed, and then occupying the remaining ducts in sequence in the row, before then selecting a duct from the next row following the same sequence.

If no other alternatives exist, duct containing copper cable (200pr and above) can be allocated for a new subduct or bare fibre allocation, if capacity can be proven with the appropriate size mandrel. Maintenance requirements and existing reservations must not be jeopardized.

3.4.4. Interconnection to Telstra InfraCo Manholes and Pits – Breakouts

3.4.4.1. Overview

A breakout is installed in a Telstra InfraCo manhole or pit where another Carrier's conduit network is to be connected to Telstra InfraCo's underground network. Simply stated, it consists of a hole through a manhole/pit wall through which another Carrier's conduit enters the manhole. As some breakouts are done in advance of a Carrier's conduit construction a short length of starter conduit may be installed.

As a rule, Telstra InfraCo exchange entry manholes (No breakouts in exchange cable chamber manholes), underground electronics manholes, small sized pits 5 pits and above, tunnel entrance or shaft manholes and tunnels, are not suitable for breakouts.

The minimum size pit for a breakout conduit is a 5 pit.

3.4.4.2. Breakout Conduit Type

While 100/4 white PVC telecommunications conduit shall be used for most breakouts from Telstra InfraCo manholes, 50mm PVC may also be requested by the access seeker and approved by Telstra InfraCo at manholes. 50mm PVC may also be used where the situation renders it impractical or where Telstra InfraCo pits are encountered that are not suitable for 100mm conduit installation. Only three sizes of breakout conduit are permitted – 100mm, 50mm & 20mm white PVC.

3.4.4.3. Conduit Bushes

Conduit/Pipe bushes shall be fitted to all conduits entering pits or manholes.

- All conduits shall be fitted with a bush of the appropriate size (Refer to Table 1). The conduit is to be fully inserted into the bush and glued in place.
- All bushes shall be flush with the inside wall of the pit (Carrier breakouts are not to be installed on ribbed section of pits).

Size	Material Number
Bush, Pipe PVC 20 mm	07300100
Bush, Pipe PVC 50 mm	07300070
Bush, Pipe PVC 100 mm	07300102

Table 1 - Conduit Bushes

Refer to Work Instruction 010254W02 for further detail.

3.4.4.4. Other Carrier (OC) Lead-Ins

Where a Telstra InfraCo manhole is located directly adjacent to a building's foundations and the Carrier requires a new lead-in to the building, the breakout shall enter the Carriers or Developers pit before entry into any premises,

Note: Any variation to this shall be agreed to by the Customer Facilities Access team prior to any non-standard works, if approved the lead in shall become a Telstra InfraCo asset.

3.4.5. Installing Pits for Other Carriers

Under no circumstances should another Carrier's pit be installed over Telstra InfraCo conduits.

Should another Carrier, for their own use, source pits from the same supplier as Telstra InfraCo it is mandatory that any reference to Telstra InfraCo does not appear internally or externally on the pit or on the pit cover. This includes, for example, contract number, Telstra InfraCo's internal serial and item number, company name or logo. If, as an expediency or temporary measure and with the agreement of Telstra InfraCo on a case-by-case basis, a Telstra InfraCo pit cover is to be used on another Carrier's pit, all references to Telstra InfraCo, as above, must be completely removed before it is placed in service. When this occurs, the temporary cover must be replaced expediently with the Carrier's correct cover.

3.4.6. Separation between Telstra InfraCo and Other Carriers Pits/Manholes

A minimum separation of 3 metres shall be maintained between the openings (covers) of Telstra InfraCo underground chambers and another Carrier's pits and manholes. Wherever possible manholes and pits should be placed to allow both Carriers to work in their respective underground plant at the same time. A minimum separation of 1m must be maintained between the adjacent walls of the manholes/pits. See Figure 1 - Typical installation of another carrier's pit adjacent to a Telstra InfraCo manhole. Carrier's breakout pit should not be placed more than 10m from Telstra InfraCo manhole or pit and cannot be interconnected to another Telstra InfraCo manhole or pit, under no circumstances should another Carrier's pit be installed over Telstra InfraCo conduits.

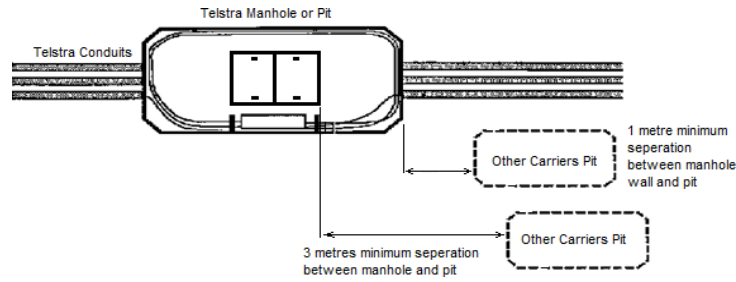


Figure 1 - Typical Installation of Another Carrier's Pit Adjacent to a Telstra InfraCo Manhole

3.4.7. Material Management Process

Details for ordering PSA materials referred to in this specification can be obtained from your Telstra InfraCo lead.

3.4.8. Subduct and Conduit

Description	Material Number
Pipe, PE Sub-Duct 28mm Id/32mm OD	07300107
Conduit, PVC 4.5m L 100mm NB 4mm thick	07300207
Bush, Pipe PVC 100mm	07300102

Table 2 - Subduct, Conduit and Fittings

Description	Material Number
Joiner, Sub-Duct 32mm Dia comp 145mm Lg	07300283

Table 3 - Subduct Joiners

3.4.9. Plugs - Conduit and Pipe

Description	Material Number
Plug, Conduit PE 100mm	07300044
Conduit Plug -Pressure Type	438/00024
Plug, Pipe EPDM 20mm nom	07300216
Plug, Pipe EPDM 35mm nom	07300217
Plug, Pipe EPDM 50mm nom	07300218
Installation Tool, TDUX sealing system	07300160
Duct Sealing System, wraparound TDUX45	07300193
Duct Sealing System, wraparound TDUX60	07300194
Duct Sealing System, wraparound TDUX100	07300196
Clip, Duct TDUX-CL-20 box of 5	07300199
Clip, Duct TDUX-CL-60 box of 5	07300227
Gas Cylinder, CO2 TDUX inflation	07300229

Table 4 - Conduit and Pipe Sealing Plugs

3.4.10. Cable and Joint Closure Housing – Fittings

Description	Material Number
Bearer, Cable Movable 75MM	42600005
Bearer, Cable Movable 125MM	42600006
Bearer, Cable Movable 255MM	42600007
Bearer, Cable Movable 370MM	42600008
Bearer, Cable Movable 480MM	42600009
Expansion Anchor ½"	089/00011

Table 5 - Cable and Joint Housing Fitting

3.4.11. Cable hauling Lubricant

Description	Material Number
Lubricant, Cable Type A Polywater	09100030

Table 6 - Cable Hauling Lubricant

3.4.12. Labelling of Plant

All other Carrier's plant installed in the Telstra InfraCo network (e.g., subduct, bare fibre, breakout, loop, etc.) shall be labelled to identify the Carrier, the Study Reference Number approved for construction and install date, e.g.

Identification tapes, markers and tags are to be provided by the Acquiring Carrier.

3.4.13. Recording of Plant

Plant installed for interconnect access shall be recorded in Telstra InfraCo Physical Network Inventory database (TPNI).

It includes:

- Cables occupying trays in CBD tunnels or Exchange cable chambers.
- Subducts and/or bare fibre housed in conduits.
- Breakouts i.e., manholes or pits where breakout ducts connect to another carrier's networks.
- Equipment manholes i.e., Telstra InfraCo manholes used to accommodate items of other carriers' equipment e.g., joints/splices, cable loops, multi-subduct joiners etc.
- Duct configuration and used duct for each conduit run used by other carrier.

It is the responsibility of a Carrier or Carrier's authorised Contractor to provide the appropriate data for these systems at the end of construction.

Within a timeframe specified in a Commercial Agreement an As-built plan, manhole layouts and other required documents (e.g., photos, approval for augmentation or scope variation or one-off exemption to standards or specifications etc. as applicable) must be submitted to Telstra InfraCo.

Telstra InfraCo will verify this data and arrange the necessary systems input.

All additions or alterations to Telstra InfraCo network plant shall be recorded in the appropriate Telstra InfraCo Systems. It is the responsibility of the SQ & ND to input the appropriate data to these systems prior to commissioning and handover. Recording of Subduct and Other Carriers Plant within the Telstra InfraCo Network

Plant installed for interconnect access e.g., joints/loops, subducts, subduct joiners and breakouts, and other carriers' plant is to be recorded in the Cadlink and TPNI databases.

- Plant to be recorded includes:
- Cables occupying trays in CBD tunnels or Exchange cable chambers.
- Subducts and subduct joiners.
- Breakout manholes i.e., manholes where breakout ducts connect to another carrier's networks.
- Equipment manholes i.e., Telstra InfraCo manholes used to accommodate items of other carriers' equipment e.g., joints, repeaters, cable loops etc.
- Duct reservations shall be recorded in TPNI/ADR (valid for 180 Calendar days).

3.4.14. Plant Location

3.4.14.1. Locating underground assets

Before any excavation works are to be carried out all constructors shall comply with.

[Working on or Adjacent to Underground Assets Procedure](#)

And complete

[Working on or Adjacent to Underground Assets Permit](#)

3.4.14.2. Clearing Impediments to Physical Access to Telstra InfraCo Plant

Telstra InfraCo is not responsible for locating buried manholes but will help with information from plans, if necessary. Similarly, removal of water or dirt covering the manhole lids, removal of grass or weeds growing over manhole lids, moving vehicles parked over manholes or gaining access to manholes having their entrances impeded by temporary structures is the responsibility of the other Carrier or its contractor.

3.4.15. Manhole Preparation

To ensure safe and successful installations, the following manhole preparation and procedures must be carried out before and during installation work:

- Apply all relevant safety precautions including gas detection and manhole rescue procedures, before opening, entering, and working in the manhole.
- Examine winching entry and exit points and flow for winch ropes, subduct and cable, and position to avoid any damage to the manhole, cable, subduct and other plant or equipment contained within the manhole.
- Ensure secure attachment and placement of cable blowing equipment to avoid any damage to cables or equipment.
- It is acceptable to temporarily shift cables, closures, ladders, or other plant which may be in the way of the hauling path, if no other option exists and providing that there is no possible risk to Telstra InfraCo plant. Any item of plant temporarily shift must be relocated and secured back in its original position.
- If there is any possible risk of damage to Telstra InfraCo plant, the contractor must arrange for Telstra InfraCo to temporarily shift and then relocate the plant, at the Contractors expense.
- Subduct or cable or subduct joiner must not be left unsupported or lying on the floor of the manhole.

3.4.16. Duct Breakout Installation

3.4.16.1. Installation in Manholes

Breakout points shall generally be in the end walls of manholes. Where connection is required to a point adjacent to a manhole, and end entry is not practical i.e., due to the position of the other Carriers facility e.g., pit /manhole, or the end wall of the Telstra InfraCo manhole is heavily congested, then side wall entry shall be agreed with Telstra InfraCo on a case-by-case basis.

The breakout point shall preferably be located a minimum of 300mm from the manhole roof and nearest wall unless prior agreement with Telstra InfraCo.

The breakout hole in a manhole should be provided by core boring, at the outside diameter of the interconnect conduit, to provide a neat fit for the conduit.

Where core boring is not possible, the breakout should be provided in a manner so to restrict damage, cracking and breakage of the manhole wall to the absolute minimum to allow the conduit installation. The manhole wall must be reinstated to restore it to a durable, smooth, and neat finish.

Conduit bushes must be fitted to all Telstra InfraCo Manhole entries. Any gap between the conduit and manhole wall must be sealed with cement grout.

3.4.16.2. Installation in Pits

Breakouts should always be done in the ends of Telstra InfraCo pits to minimize bending radii. Where a Carrier wishes to install conduits at right angles from the pit, a suitable PVC bend must be used at the breakout point.

Breakout entries into cement or plastic pits must be sealed to prevent silt etc. entering the pit. Conduit bushes must be fitted at all Telstra InfraCo pit entries.

Breakouts are not permitted if the pit already has the maximum allowable number of conduit entries at each end. Refer 010254W01.

3.4.17. Subduct installation

3.4.17.1. Installing Sub-ducts

A subduct shall be installed in a conduit, without any deformation, necking or stretching.

To enable maximum hauling distance for cables, subduct must be installed to avoid excessive bends, and abrupt changes of direction.

Where a subduct passes through a manhole, it shall be neatly racked and housed against the wall with smooth gradual curves and provide as close as possible a straight through appearance, that will least affect the cable hauling tension.

The tensile strength shall be such that it can meet all potential cable installation requirements, including cable/hauling line blowing techniques to a blowing pressure of 700 kPa. (100 psi).

Once installed a subduct shall allow passage of a mandrel equal to 95% of the internal diameter of the subduct.

At Exchange entry manholes or Exchange cable chambers, ducts in which subducts are installed must be sealed with an appropriate duct sealing system.

Subducts terminating in the Telstra InfraCo underground network, including in exchange cable chambers and tunnels must be sealed to prevent gases, liquids or other substances entering the Telstra InfraCo network, or passing to other Carriers networks.

For details of conduit and subduct sealing refer 3.4.20.

3.4.17.2. Blocked ducts

The Carrier's contractors should install subducts/bare fibre only as indicated on an approved Design & Construction Proposal. During construction, where ducts are found to be blocked or damaged, the Carrier's contractor shall contact the Customer Facilities Access Team for appropriate direction. Refer 010260W02.

Works performed under DCAF/ADR allows the Carrier/contractor to choose an alternative Duct without consulting Customer Facilities Access Team. Carrier /Contractor must ensure all technical standards, maintenance standards & reservations have been accounted for. Carrier /Contractor must mark on the As-built plan and TM sheets the blocked Duct and the distance to the blockage from adjacent manholes or pits from both ends.

3.4.17.3. Labelling of Subduct and other Approved Carrier Infrastructure

Subducts are to be labelled in such a manner as to clearly indicate the lessee i.e., identified and clearly marked at ends and in all through manhole/pits with the Approved Duct study number and Carriers identification (usually Company logo or name).

Adhesive backed identification tape, or other Telstra InfraCo approved methods (e.g., tags) must be secured to the subduct, plastic cable ties are suitable for this purpose, where they appear in manholes, pits, and tunnels.

Subduct labelling: shall include approved for construction Study Reference Number and a date of installation, also applicable to Bare Optic fibre in manholes and pits,

The identification shall be applied close to each duct entry (Not to obstruct duct face) and in the centre of the span where subducts are continuous through a manhole, See Figure 2.

Note: Approved bare fibre cables and any other Approved Carrier Infrastructure shall be labelled using the same specification as above.

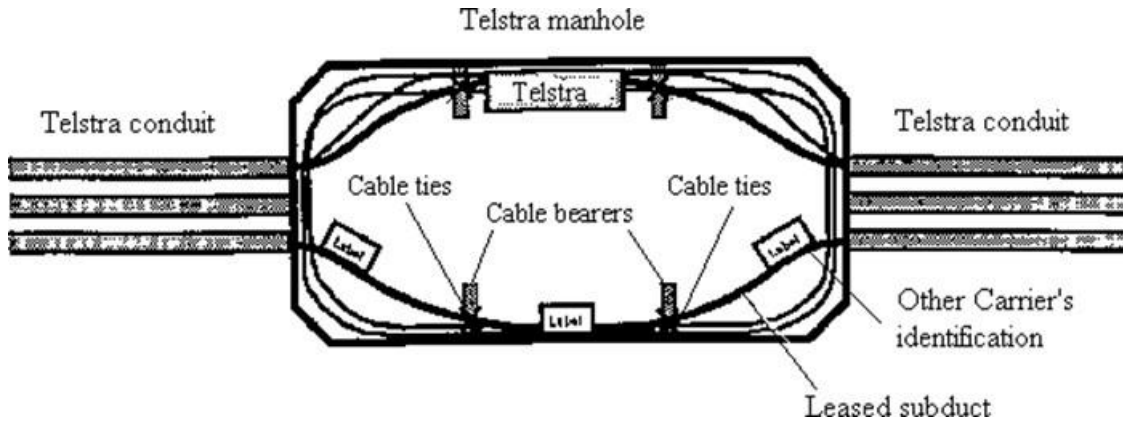


Figure 2 - Labelling Subduct in a Telstra InfraCo Manhole

3.4.17.4. 32mm Subduct Joiners

Several types of subduct joiners are recommended for use within the Telstra InfraCo duct network. These are mentioned below. No other joiners are recommended for use within the Telstra InfraCo network. Other joiners will only be permitted for installation after the Telstra InfraCo Technical team has approved and specifications updated.

3.4.17.5. In Line Subduct Joiners

Where subducts are to be joined, a Telstra InfraCo approved joining method must be used.

Mechanical couplers such as Plasson KIWA-A or Comfit (Comfit catalogue ref. # 40032M0032), for 32mm x 32mm are recommended. See Figure 3 and Figure 4.



Figure 3 - Typical Subduct Joiners

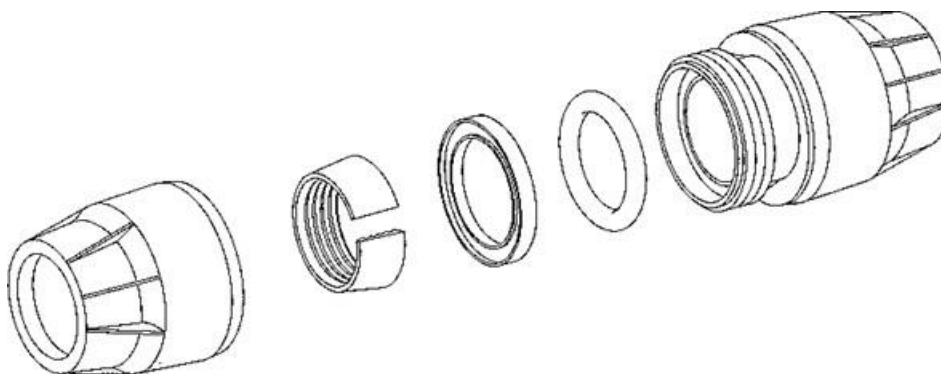


Figure 4 - Expanded View of Comfit 32mm Subduct Joiner

Welding methods such as butt fusion are also acceptable. The method used should result in a join that has no internal lip and, consequently, maintains the original internal dimensions of the subduct. Heat shrink sleeve technologies must not be used to join subducts in the Telstra InfraCo underground network. Joins in subduct are to be capable of withstanding a maximum cable blowing installation

pressure of 700 kPa. All joiners are to be placed in manholes, pits, or chambers. Joiners shall not be placed in ducts between manhole, pits, or chambers.

3.4.17.6. Multiple Subduct Interchange

The Interchange shall only be installed in manholes, subducts shall be sealed using the approved methods and secured to cable bearers,

Refer to **A2 T-Dux Solutions**.

3.4.17.7. Housing Subduct and Bare Fibre cables in Manholes

Subduct and Bare fibre cables passing through intermediate manholes shall be splayed towards the nearest side wall of the manhole and secured in that position.

They shall be housed with smooth bends, avoiding excessive bending or curvature or abrupt changes in direction, to provide as close as possible a straight through appearance that will least affect the cable installation tension.

They shall be securely fastened to cable bearers with plastic cable ties.

Note: Where no cable bearers are installed the Contractor shall install them as required in each location for their installation and report to Telstra InfraCo any existing non-conformance.

Refer to 010254W06 Installation of Jointing Pits and Manholes for installation of Cable Bearers.

Subduct and Bare Fibre cables shall not obstruct access to cables, joint closures, other conduit entrances or other equipment in the manhole. To avoid confusion any cable, joint, sub duct or subduct joiner must not block off other ducts, or interlace, obstruct, or interfere with other cables or plant in the manhole.

3.4.17.8. Breaks in Subduct Continuity

Where subduct continuity is broken (not made continuous through manhole/pit) then it shall:

- Extend approximately 300mm past the duct entry point in manholes unless otherwise agreed with Telstra InfraCo.
- The subduct can be extended into the pit no more than 100mm from pit end wall.
- Be sealed using Telstra InfraCo approved sealing methods.

3.4.18. Hauling Subduct and cables

3.4.18.1. Hauling Subduct

Subduct shall be hauled using appropriate hauling ropes (see below), avoiding any damage, stretching, or elongation to the subduct, or damage to the ducts, manhole or any other cable or plant.

Attention must be taken to the rope/subduct and conduit interface, and steps should be taken e.g., use of cable guides, to reduce friction and prevent damage.

The rope/subduct attachment point should present a smooth profile.

Lubricants e.g., Polywater®, should be used when hauling subduct. Lubricants must have long term compatibility with cable, rope, and conduit material.

Kevlar/Spectra braided rope e.g., Superbraid® / Spectra™ is to be used for hauling subduct into occupied conduits. This rope must be manufactured with a braided core of Kevlar/Spectra fibre cordage, and braided polyester cover, and have an outside diameter of not less than 8mm.

For hauling subduct into unoccupied conduit, Steel Wire Rope (SWR) or Wire Rope Core (WRC) hauling ropes may be used.

Blue/yellow polypropylene rope (Material; 67500294) SHALL NOT be used for mechanically hauling. It may be used for manual hauling, e.g., over short sections.

3.4.18.2. Hauling Subduct over Existing Cables/Plant

When hauling subduct into occupied duct, sufficient space must be available within the duct to satisfactorily overhaul the introduced subduct without causing any damage or movement of existing cable or plant in the duct.

The duct or pipe must be proved with a suitable mandrel 1.5 times the subduct diameter prior to attempting the overhaul.

Pressure roping of occupied ducts must be used in preference to hand rodding.

If at any stage the proving of the duct becomes difficult or it cannot be proven, then proving work should cease and Telstra InfraCo consulted to arrange alternative action e.g., select another or upgrade the duct.

Action must be taken to ensure a clear path for the subduct and hauling rope through all manholes and pits, so that existing cables or other plant in the manhole or pit are not obstructed or rubbed against.

Existing cables or subduct should be constantly observed for movement (through dragging). If there are any significant signs of cable gathering, or of cable or subduct movement at any location along the route, the haul should be ceased immediately, and action taken e.g., reapply lubricants, restrain the cable(s), to prevent further movement /dragging of the cable(s) or subduct, before recommencing the haul. If necessary, arrange a new duct allocation with Telstra InfraCo.

The maximum hauling tension for overhauling must not be exceeded. Refer to Section 3.4.18.3 to determine the maximum allowable hauling tension when overhauling subduct into an occupied duct.

3.4.18.3. Overhauling – Maximum Allowable Hauling Tension

When installing subduct or cable in occupied duct, the maximum allowable hauling tension must be determined prior to any overhauling, by:

Determining the maximum hauling tensions of all the existing cables in the conduit or pipe (Refer to Table 7 and Table 8]

100/0.40	2.4Kn
200/0.40	4.8Kn
400/0.40	9.6Kn
800/0.40	19.2Kn
1200/0.40	28.8Kn
2400/0.40	40.0Kn
200/0.64	12.3Kn
400/0.64	24.6Kn

Table 8

- And, of all the hauling tensions, haul to the lowest maximum tension, or where small sized twisted pair cables exist (<100/0.40) haul to a maximum of 2 Kn.
- To limit the hauling tension, a mechanical hauling fuse rated at the lowest hauling tension, or an equivalent tension limiting device must be used.

If during a haul the tension begins to exceed the maximum hauling tension previously determined, the haul must stop immediately. Do not continue, until appropriate action has been taken to reduce the hauling tension.

Table 7 provides the maximum hauling tensions for optical fibre cables.

Cable Type	Fibre Count	Maximum Hauling Tension	
Standard Cable	6 -60	2Kn (2,000 Newtons)	
	120 & 288	4Kn (4,000 Newtons)	
High Strength	6 -60	4Kn	5Kn
	120		
Aerial	6 -36	5Kn	
Underwater	6 – 120	30Kn	
Rodent Proof Dielectric	6 –60	4Kn	5Kn
	120		
Internal Tie	6 – 120	2Kn	

Table 7 - Maximum Hauling Tensions

Cable Size/Type	Maximum Hauling Tension
100/0.40	2.4Kn
200/0.40	4.8Kn
400/0.40	9.6Kn
800/0.40	19.2Kn
1200/0.40	28.8Kn
2400/0.40	40.0Kn
200/0.64	12.3Kn
400/0.64	24.6Kn

Table 8 - Copper Cable Hauling Tensions

For standard copper cables not included in Table 7 above, maximum hauling tensions can be calculated using the formula:

Tension = 150 Pd² Newtons (where P = no. of pairs, d = conductor diam. In mm)

3.4.18.4. Overhauling – Care of existing plant

- The existing network must be always cared for and not interfered with during installation of either rod, rope, subduct, or cables.
- If existing cables and/or joints need to be moved during work, they must be handled carefully and replaced correctly in the pit on completion of the task.
- Lead cables are fragile and can be easily damaged. They should not be moved, and extreme care must be taken when working around them.
- Avoid lacing the rope through existing cables, as this will cause undue pressure to be inserted upon them.

3.4.19. Cable and Splice Closure Installation

3.4.19.1. Movement Of Subduct to Install Cables

Where subduct is released and moved from a manhole wall or cable bearers, to provide a more straight-through appearance to assist reducing the hauling tension of cable being installed within the subduct, the subduct must be rehoused correctly and secured back into its original position.

3.4.19.2. Cable Loops (Coils)

Suitability of individual manholes for housing cable loops will be assessed by Telstra InfraCo or Accredited Carrier contractor.

Cable loops (coils of cable) are not permitted in pits, tunnels, Exchange cable chambers, riser shafts, regenerator or repeater manholes, or congested manholes.

Cable loops left in manholes are to be installed vertically and housed neatly against manhole walls and secured to manhole walls so as not to obstruct access to existing cable closures and cable loops, cable bearers and other fittings provided for future cables and closures.

Where splice closures are installed, sufficient looped cable should be left to enable the splice closure to be removed from the manhole for splicing etc. operations.

Under no circumstances will loops exceed 40m.

Access to conduit entrances must not be obstructed so as not to inhibit subsequent cable installation.

Cable loops shall not be left unsupported or lying on the floor of a manhole, to avoid being damaged by installation staff, manhole ladders, lids, and other accessories.

3.4.19.3. Housing Cables and Joint/Splice Closures

Suitability of individual manholes for housing cable joint closures will be assessed by Telstra InfraCo or Accredited Carrier contractor.

Joint closures will not be permitted in pits and congested manholes.

Locating closures in manholes specifically for containment of Telstra InfraCo repeater or regenerator housings is not permitted.

Where in-line splice closures are used they are to be housed horizontally on bearers at the appropriate level in the manhole.

Where single-ended splice closures are used, they shall be mounted in a suitable position on the manhole wall using an appropriate bracket.

The cables entering the splice closure must not be intertwined with existing cables or housed in such a way as to risk intertwining with future cables.

Closures and their associated cables must not obstruct access to existing closures and cable loops or interfere with the installation of subsequent cables and closures.

All closures must be mounted and secured to support brackets or cable bearers.

3.4.19.4. Securing Cable Loops and Splice Closures in Manholes

Splice closures and their associated cables must be fully supported and secured to the cable bearers or manhole walls, so that there is no likelihood of them being dislodged or becoming loose.

Cable bearers including the making of any masonry anchorage points will be installed as required to provide the support and securing of cables and joint/splice closures.

Bearers may be attached directly to the manhole wall or be secured to Unistrut members. Bearer length will depend on the number and size of cable to be housed.

Anchors and bearers must be installed to not interfere with or obstruct the housing or access to existing cables or other plant in the manhole.

In manholes where Unistrut or similar support members are provided, splice closures may be supported on these members.

3.4.19.5. Labelling of Other Carrier's Cables

Cable loops and cable joint/splice closures must be clearly labelled. And include approved for construction Study Reference Number and a date of installation e.g., Carrier000M01 05/2017 or Carrier000TP01 11/2019 or Carrier000ADR 02/2022

Carrier = customer abbreviation

XXXX = order number

M01/TP01/ADR=order type

Also applicable to Bare Optic fibre in cable chambers, manholes and pits.

At locations where the other Carrier's fibre cable is not subducted it must be clearly identified. This includes CBD tunnels, Exchange cable chambers, POI (Point of Interconnect) and TEBA (Telstra InfraCo Equipment Building Access) space.

Adhesive backed tape or tags bearing the owning Carrier's identification (usually Company logo or name) and attached by plastic cable ties are suitable for this purpose.

3.4.19.6. Installations in Tunnels and Exchange Cable Chambers

All practices and procedures for access and for working in tunnels, and Exchange cable chambers (special work locations) must be complied with.

Installation of other Carriers cable or other plant must not obstruct or interfere with existing Telstra InfraCo plant.

3.4.19.7. Housing Cables and Closures in Tunnels, Exchange Entry Manholes and Cable chambers, POI and TEBA

Cables installed in Exchange chambers, tunnels and into POI or TEBA space are not to be subducted. Cables are to follow existing riser shafts and fibre trays and are to be installed in a professional manner. Where tray work internal to the Exchange is inadequate to house a new cable, the Carrier is responsible for supplying any additional requirements.

Telstra InfraCo will provide any tray work, bearers or ironwork in CBD tunnels and Exchange chambers.

Fixing by other Carriers or contractors will be limited to securing cable or closures to racking or trays using approved cable ties.

Unless otherwise agreed with Telstra InfraCo, cable joint or splice closures will not be permitted in Exchange entry manholes, cable chambers or tunnels.

Cable sheaths must be clearly identified at, locations where the cable changes direction or elevation, duct entry/exit points, cable loops and all other locations were deemed necessary by Telstra InfraCo.

3.4.20. Sealing Conduits, Breakouts and Subducts

Any re-entry into existing breakouts and subducts shall be resealed using approved methods,

3.4.20.1. Sealing Conduits and Breakouts

As specified in this document, conduits and breakout conduits containing subducts are to be sealed with an appropriate sealing system. E.g., TDUX Inflatable Sealing System, or Filoform FILOseal + Duct Sealant.

Expandable foam type blockers shall not be used.

Vacant breakout conduits are to be sealed using appropriate plugs e.g., Tapered PE or pressure type plug Figure 10, or TDUX, Filoform FILOseal + Duct Sealant.

Where a breakout is installed in a Telstra InfraCo manhole/pit and the subduct is to be made continuous into the other Carrier's conduit network, the breakout and the subduct should be sealed to prevent gas or liquids escaping between networks via either the subduct or the conduit. The conduit is sealed at the breakout point, whilst the subduct should be sealed in the next pit in the other Carrier's network, as shown in Figure 5 - Sealing conduits and subducts to prevent passage of gas or liquids between Telstra InfraCo's and another Carrier's conduit networks,

When a subduct cannot be made continuous from Telstra InfraCo's conduit network into a carrier P50mm breakout conduit the use of TDUX and Filoform Duct Sealant is acceptable to use to seal the Bare Fibre Optic cable.

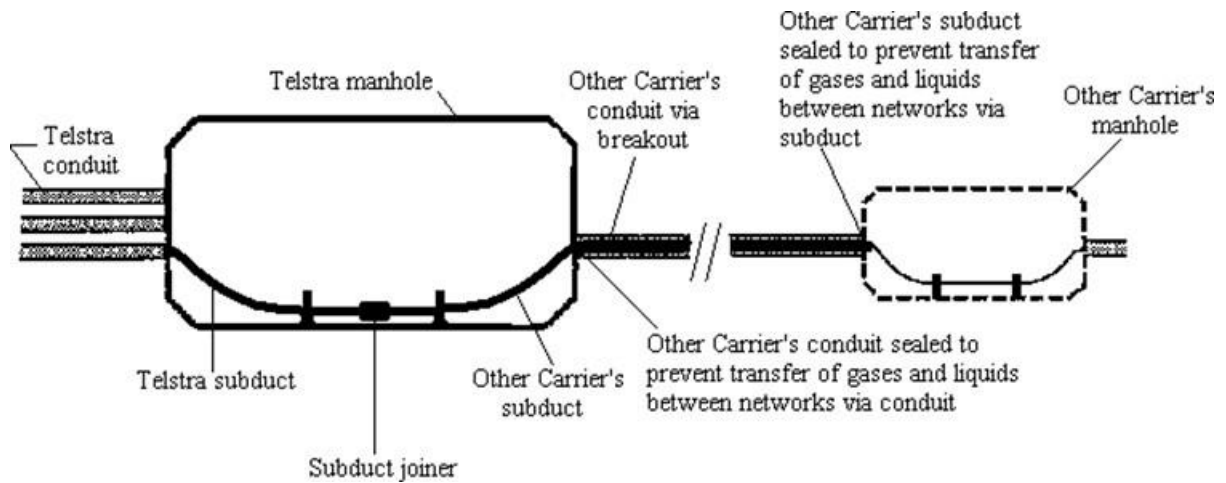


Figure 5 - Sealing Conduits and Subducts to Prevent Passage of Gas or Liquids Between Telstra InfraCo's and another Carrier's Conduit Networks

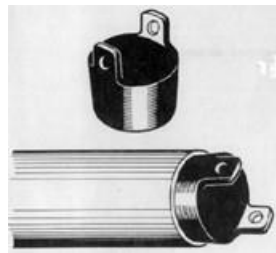


Figure 6 – 7300044 Tapered PE Type Conduit Plug

3.4.20.2. Sealing Vacant Subducts

After installation of another Carrier's subduct into a breakout as shown in Figure 9 - Sealing conduits and subducts to prevent passage of gas or liquids between Telstra InfraCo's and another Carrier's conduit networks the subduct should be temporarily sealed prior to cable installation. A Comfit plug Figure 11 - Comfit plug (Catalogue #40032P0100) used for temporarily sealing a subduct, Filoform FILOSeal + Duct Sealant or TDUX should be used for this purpose.

When a multi sub duct joiner is installed all unused subduct ports must also be appropriately sealed.



Figure 7 - Comfit Plug (Catalogue #40032P0100) Used for Temporarily Sealing a Subduct

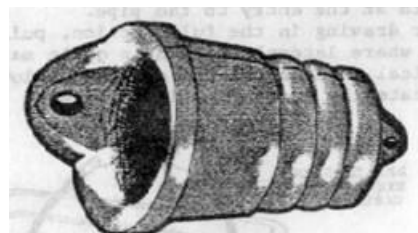


Figure 8 - EPDM Rubber Plug (Material; 07300216 & 07300218, Available from Vinidex P/L)

3.4.20.3. Sealing Subducts after Cable Installation

After cable installation, subducts are to be sealed with an appropriate sealing system e.g., T-DUX 35, Tyco Simplex Plug or a Telstra InfraCo approved heat shrink or Filoform FILOseal + Duct Sealant technique.

Expandable foam type blockers shall not be used.

Note: Jackmoon type sealing plugs are approved for use on both Occupied and Unoccupied subducts and shall not be used for breakout conduits.

3.4.21. Recording of Subduct and Other Carriers Plant within the Telstra InfraCo Network

Plant installed for interconnect access e.g., subducts and breakouts, and other carriers' plant is to be recorded in the PNI database.

Plant to be recorded includes:

- Cables occupying trays in CBD tunnels or Exchange cable chambers.
- Subducts.
- Breakout manholes i.e., manholes where breakout ducts connect to another carrier's networks.
- Equipment manholes i.e., Telstra InfraCo manholes used to accommodate items of other carriers' equipment e.g., joints, repeaters, cable loops etc. including any multi sub duct joiners in manholes and pits.

3.5. Commissioning/Acceptance

3.5.1. Quality Control System

The handover procedure should be supported by the installers project-based quality control system. The installer must be able to provide the documented evidence of the quality processes applied to all phases of the project including the design, planning, installation, testing and suggested maintenance. This will provide the necessary confidence to the customer that it should not be necessary for the complete cable route to be inspected as part of the final handover procedure.

3.5.2. Inspection

The network owner or his representative shall request or conduct a Telstra InfraCo completion or self-assessment completion inspection/audit,

A completion inspection advice will be required at submission of the construction finalization documentation, all relevant project design documentation, updated plans, photos and manhole layout sheets, equipment spares, test records and maintenance requirements or plan as appropriate.

3.6. Recovery

3.6.1. Requirements after Cancellation of Subduct or Bare Fibre Lease

Should a Carrier terminate a lease on Telstra InfraCo subducts or Bare fibre cables it will be required to, at the appropriate time.

- Remove all subducted cable or bare fibre cable from the sections of leased Telstra InfraCo conduit.
- Removal all multi sub duct joiners.
- Remove all splices and identification tags from the cancelled sections.
- Remove all identification tapes from the leased subduct.
- Remove all sections of subduct entering the other Carrier's conduits. Telstra InfraCo's subducts are left in situ.
- Reseal all redundant breakout points once cable and/or subducts have been removed to prevent gases or liquids transferring between conduit networks. The conduit should be re-labelled to indicate that the conduit is owned by the other Carrier.

- Remediate manholes and pits damaged by breakouts.
- Provide drawings to Telstra InfraCo of the locations of cancelled plant.

04 Material list

The following is a list of the main components that are referred to in this document. This list is specific to the currently contracted material and may be subject to change:

Material Description	Material Number
Pipe, PE Sub-Duct 28mm ID/32mm OD	07300107
conduit, PVC 4.5m L 100mm NB 4mm THK	07300207
Bush, Pipe PVC 50mm	07300070
Bush, Pipe PVC 100mm	07300102
Multi Subduct Joiner - series ILC41 – Channel Pty Ltd	Part 140060
Joiner, Sub-Duct 32mm DIA comp 145mm LG	07300283
Plug, Conduit PE 100mm	07300044
Conduit Plug -Pressure Type	438/00024
Plug, Pipe EPDM 20mm nom	07300216
Plug, Pipe EPDM 35mm nom	07300217
Plug, Pipe EPDM 50mm nom	07300218
Installation Tool, T DUX Sealing System	07300160
Duct Sealing System, wraparound TDUX45	07300193
Duct Sealing System, wraparound TDUX60	07300194
Duct Sealing System, wraparound TDUX100	07300196
Clip, Duct TDUX-CL-20 box of 5	07300199
Clip, Duct TDUX-CL-60 box of 5	07300227
Gas Cylinder, CO2 TDUX inflation	07300229
Bearer, Cable Movable 75mm	42600005
Bearer, Cable Movable 125mm	42600006
Bearer, Cable Movable 255mm	42600007
Bearer, Cable Movable 370mm	42600008
Bearer, Cable Movable 480mm	42600009

Material Description	Material Number
Expansion Anchor ½”	089/00011
Lubricant, Cable Type A Polywater	09100030
Rope, Polypropylene Blue/Yellow 6mmx400m	67500294

Table 9 – Material List

05 References

Document number	Title
009 959	Material Management Process Overview
013 310	Contract Identification – Contractor Database Requirements
AS/NZS 4130:2009	Polyethylene (PE) pipes for pressure applications
TM00044	Optical Fibre
TM00044-A01	Optical Fibre Winch Compliance
TM00043	Copper Cable
010254W01	Pits used in Telstra InfraCo Network
010260W02	Pipe and Conduit repair
010265W06	Cable Hauling and Duct Preparation - Cable Recovery from Telstra InfraCo Network

06 Definitions

Term	Definition
ACIF	Australian Communications Industry Forum
AS	Australian Standard as published by Standards Australia
Bare Fibre	Un subducted Sheathed Fibre Optic cables
Breakout	The point in a manhole or pit where another Carrier’s conduit network enters the Telstra InfraCo conduit network.

Term	Definition
Carrier	The holder of a communications carrier license under the Telecommunications Act 1997
CFD	Construction Finalisation Document
CSP	Carriage Service Provider as defined under the Telecommunications Act 1997
CO2	Carbon Dioxide
Conduit	A tubular structure, generally circular or oblong in cross-section and manufactured from PVC, asbestos cement, earthenware, or galvanised iron, used to carry telecommunications cables in the Telstra InfraCo underground network. In practice, the term is sometimes used interchangeably with “duct”
DCAF	Duct Customer Access Framework
Duct	The bore of a conduit. In practice, the term is sometimes used interchangeably with “conduit”
DI	Deliverable Item
EPDM	Ethyl Propylene Diene Monomer
Exchange Entry Manhole	A manhole adjacent to a Telephone exchange where conduits, a tunnel or cable chase enters the Exchange building or cable chamber
Filoform FILOseal + Duct Sealant	A complete kit supplied with cable spacers and a sealant cartridge approved for use by Wholesale customers to seal their breakout conduits
ID	Internal Diameter
IAL	Inaccessible Air Leak
IEN	Inter Exchange Network
Joint	Join between copper or optical fibre cables
Joint closure	The external cover and housing used to protect joints in copper or optical fibre cable
Lead-in	The conduit entry into a building emanating from a Telstra InfraCo manhole or pit
LGA	Local Government Agreement

Term	Definition
Multi Sub Duct Joiner	Sub duct jointing enclosure designed to interconnect more than two sub ducts to facilitate easy access to breakout subducts from a straight through Optic fibre run. Commonly known as a “H” joiner
OC	Other Carriers
OD	Outside Diameter
PSA	Product Sourcing Agreement
PE	Polyethylene
Pipe	A small conduit. In general usage within Telstra InfraCo, usually under 100mm
Pit	An underground cable chamber <u>not</u> large enough for a person to work in
POI	Point of Interconnect
Potholing	Verification of cable location by hand digging a hole immediately above the nominal cable alignment to expose the cable.
PVC	Poly Vinyl Chloride
Splice	Join between fibres of optical fibre cable
Splice closure	The external cover and housing used to protect several individual splices in optical fibre cable
Subduct	Tube placed within a Conduit/Duct for housing cable
Telstra InfraCo	Telstra InfraCo Corporation Limited
TDUX	Raychem Inflatable Duct sealing System
TEBA	Telstra Equipment Building Access
TPNI	Telstra Physical Network Inventory
WUC	Work Under the Contract

07 Attachments

Document number	Title
Appendix 1	Current Practice for Breakout Approval in Coffin Shaped Manholes
Appendix 1.1	Current Practice for Breakout Approval in Standard type Manholes (No Turret)
Appendix 1.2	Manholes with a Turret
Appendix 2	T-Dux Solutions
Appendix 3	Hauling Detail Sheet

08 Document control sheet

This document has been formally approved by the person identified below:

Approver Name	Leader, Warren
Approver Position	Pit & Duct Asset Manager
Approver Email	Pit_Duct_and_Manhole_Management@team.telstra.com

Who to reach out to if you have any queries, questions, or concerns.

Author Name	Rose, Darren
Author Position	Technical Expert
Author Email	Pit_Duct_and_Manhole_Management@team.telstra.com

If you have a suggestion for improving this document, please contact the people listed above.

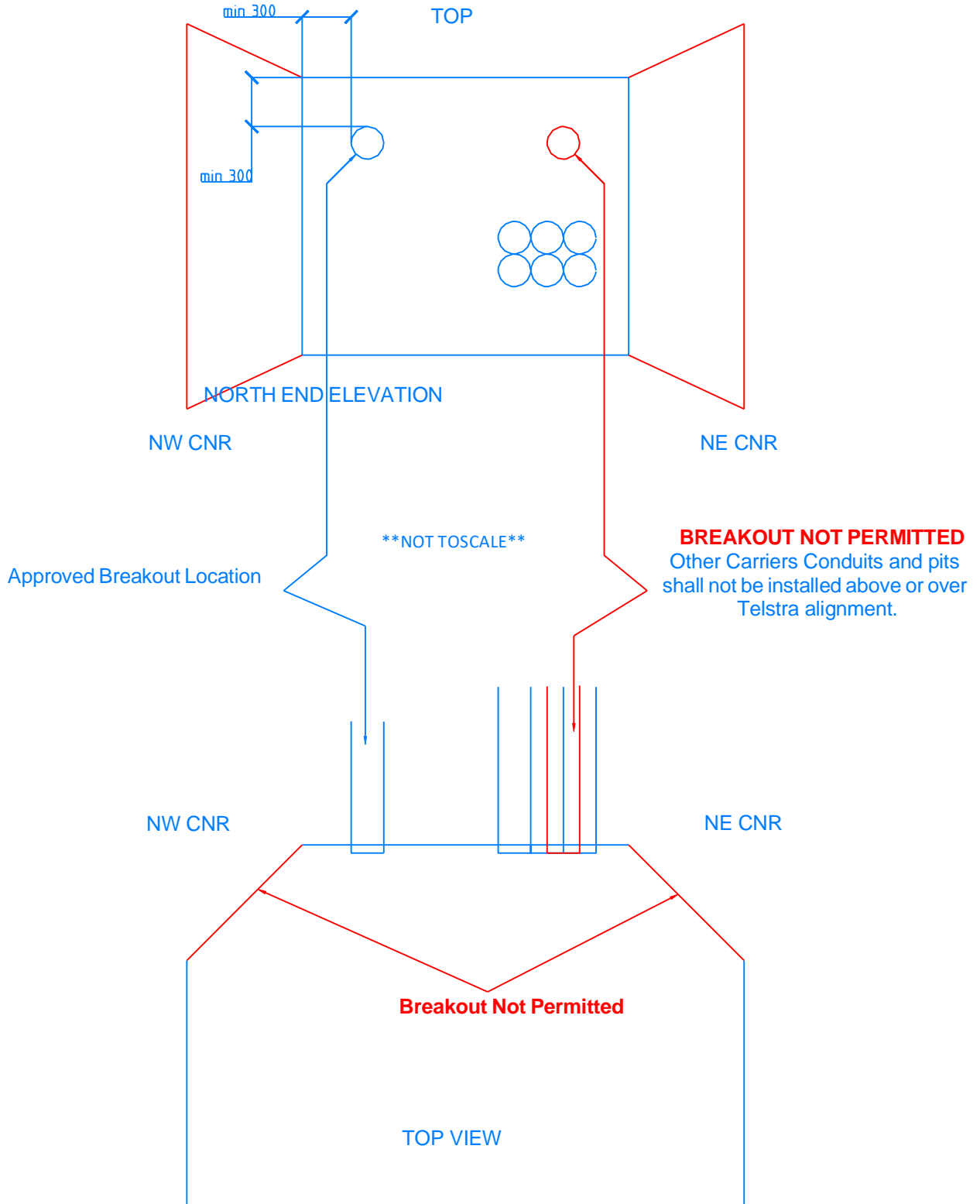
09 Record of Issue

Issue num'	Issue date	Details on the change
1	08 March, 2023	<p>Document title changed from TM00042A01 to 010260W07.</p> <p>3.4. Wording changed for over hauling.</p> <p>3.4.2. Bare Optic Fibre Cable Modify section.</p> <p>3.4.1.1. Multi Subduct Joiner & sub ducts Removal of section and figures.</p> <p>3.4.3.1 Modify section Occupied Ducts.</p> <p>3.4.3.3 Selection of conduit for Subducting and bare fibre and over-hauling up to 200pr copper cables.</p> <p>3.4.4.1. Overview wording changed.</p> <p>3.4.4.2 Breakout Conduit Type inclusion of P20 conduit.</p> <p>3.4.4.3 Conduit Bushes removal of wording.</p> <p>3.4.4.4 Other Carrier L/in wording changes.</p> <p>3.4.7 wording change and multi subduct material no removed.</p> <p>3.4.12. Labelling of Plant Removal of text duplication.</p> <p>3.4.13. Recording of Plant Removal of reference to obsolete document.</p> <p>3.4.13.1. Recording of Subduct and Other Carriers Plant within the Telstra InfraCo Network Rewording from valid for 90 Business days to 180 Calendar days.</p> <p>3.4.17.1. Installation in Manholes some minor wording change.</p> <p>3.4.17.9 Remove Multi Subduct Interchange reference.</p> <p>3.4.18.6. Remove Multiple subduct joiner figures.</p> <p>3.6.18.5 Removed reference Hauling Winch Requirements / Compliance.</p> <p>3.6.18.6 Removed Hauling Detail sheet.</p> <p>3.6.19 Removed Cable and Splice Closure Installation.</p> <p>3.6.19.8. Removed Secondary Protection.</p> <p>3.7.2 Inspection reworded.</p> <p>3.7.3 Removed Handover.</p>

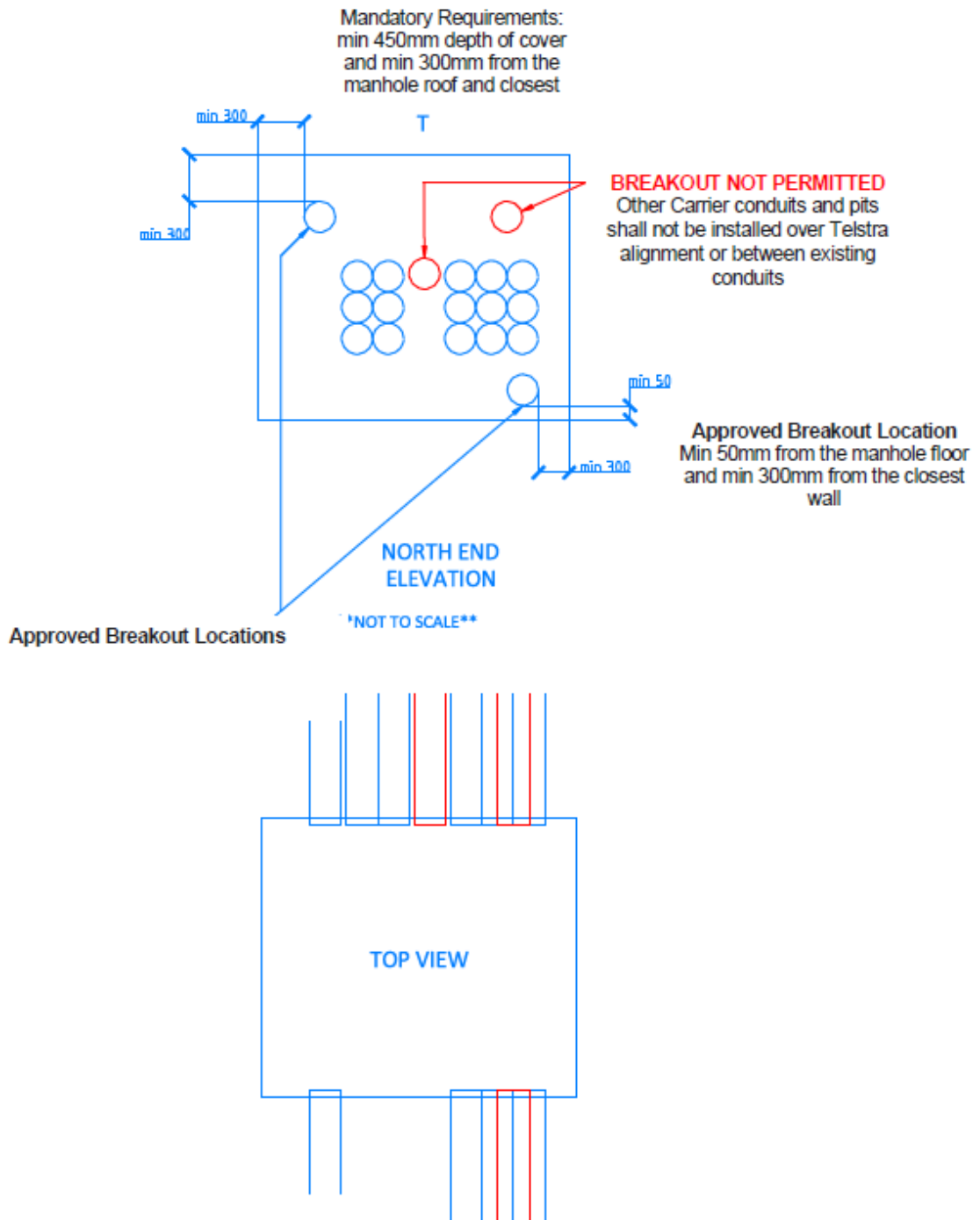
A1 - Current Practice for Breakout in Coffin Shaped Manholes

Mandatory requirements:

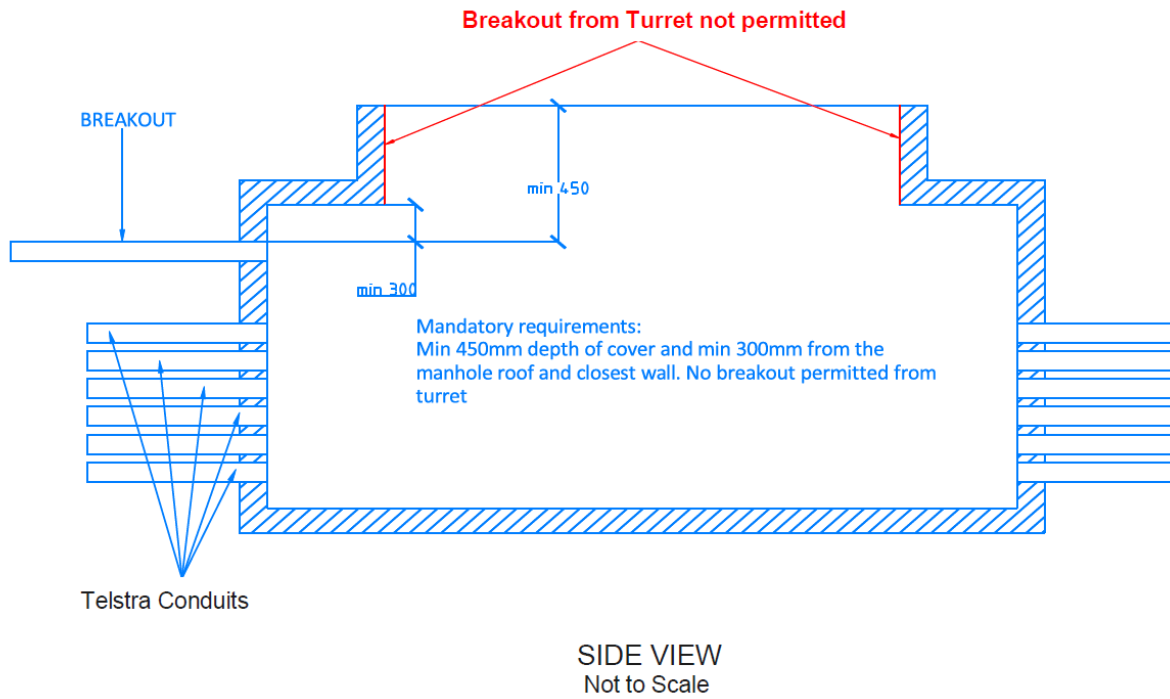
Min 450mm depth of cover and min from the manhole roof and closest wall



A1.1 - Current Practice for Breakout in Standard type Manholes (No Turret)

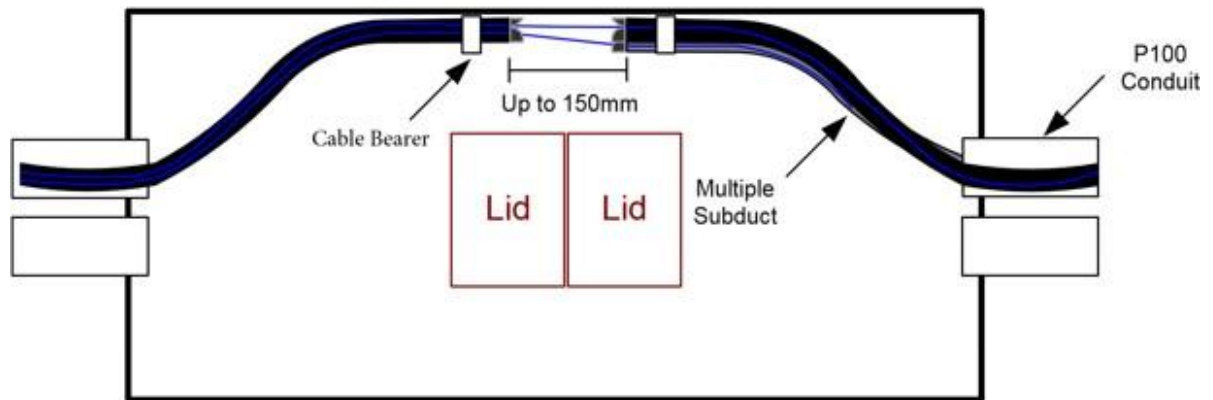


A1.2 - Manholes with a Turret

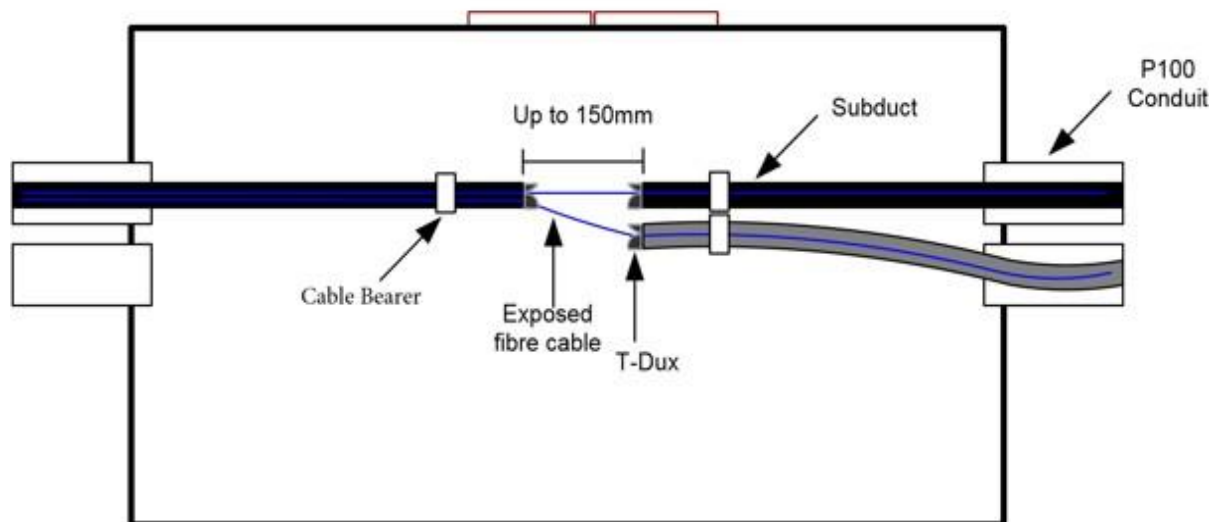


A2 - T-Dux Solutions

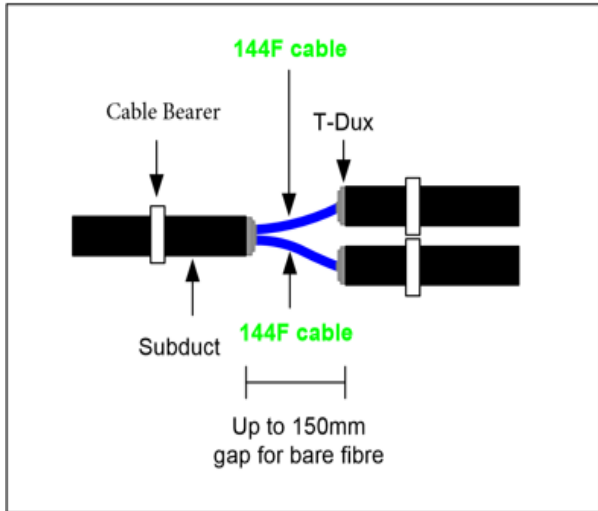
Proposed Multi Subduct Interchange Design – Top View



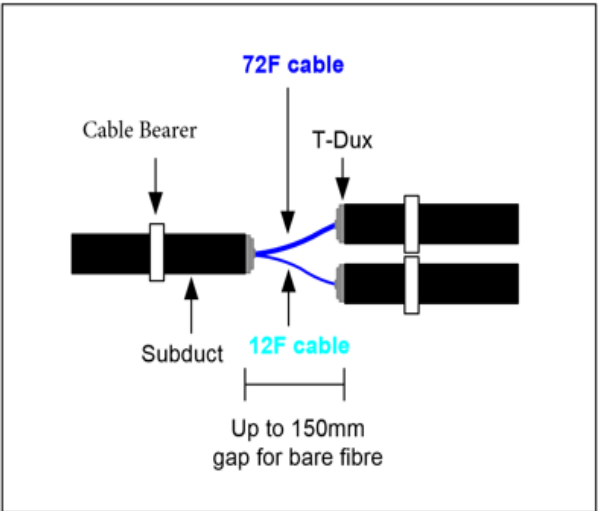
Proposed Multi Subduct Interchange Design – Side View



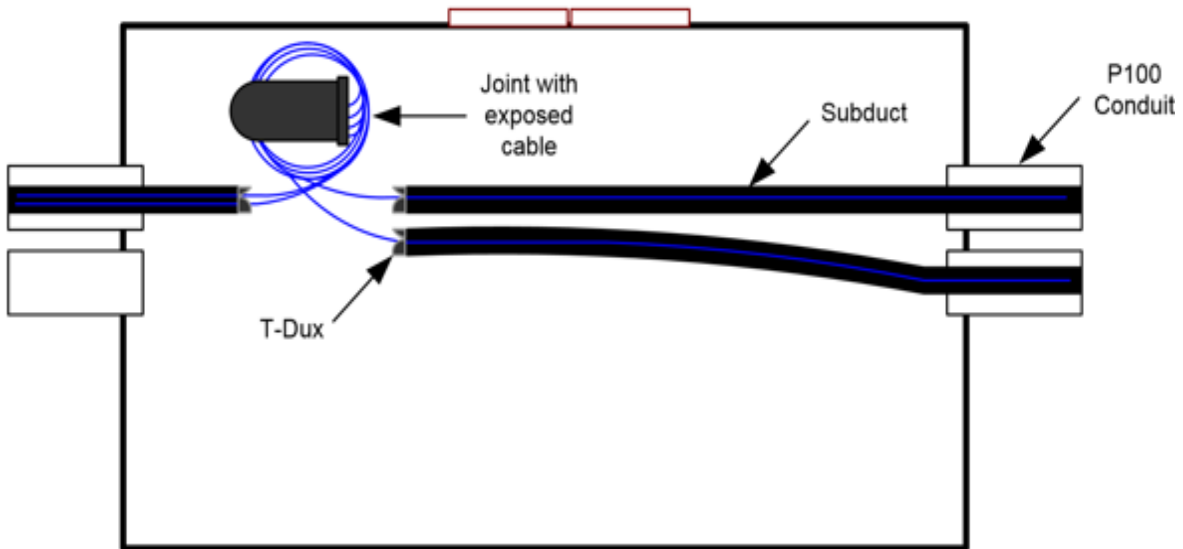
2x 144F T-Dux Solution



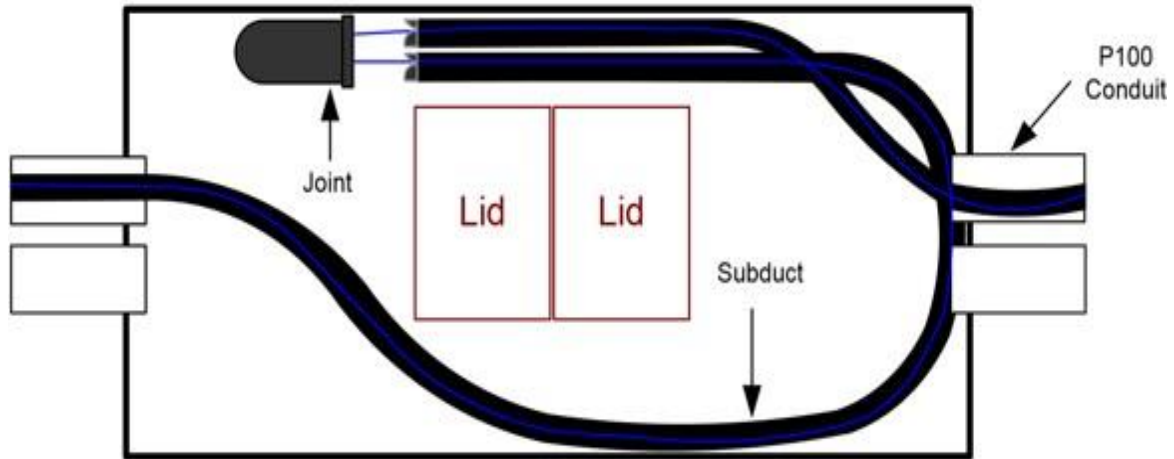
1x 72F & 1x 12F T-Dux Solution



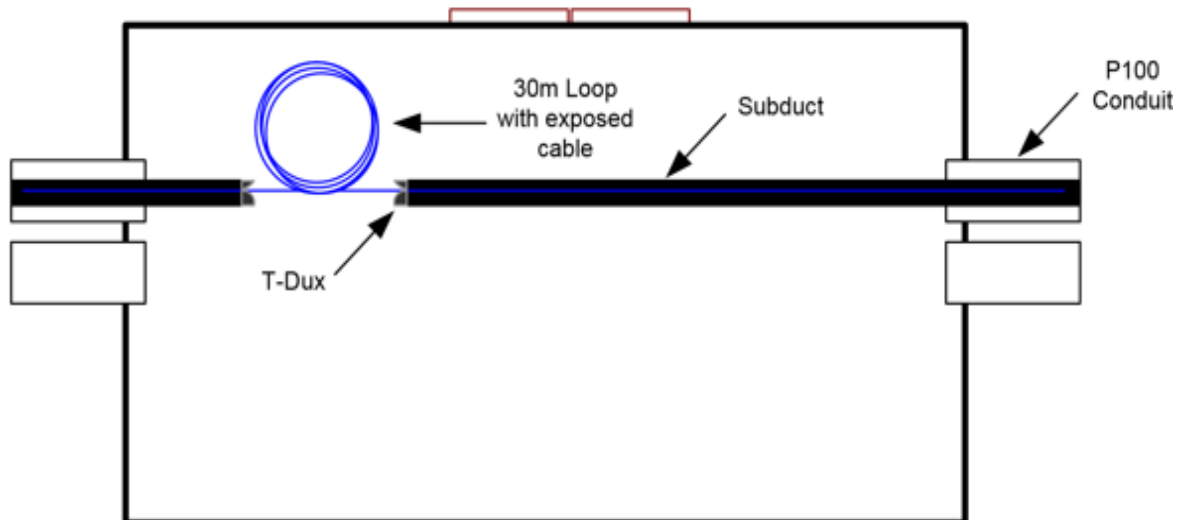
Existing Joint Design – Side View



Existing Joint Design – Top View



Existing Loop Design – Side View



Existing Loop Design – Top View

