







# Specification For Installation of Duct(s) for Optical Fibre Cable(s)

**10070-40-PSS-PR-EF-013**

						
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Rev. No	Date	Reason For Issue	Prepared by	Reviewed By	Approved by	Issued By

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### Amendment Record / Control Sheet (ACS)

Rev. No	Date	Reason For Issue	Prepared by	Reviewed By	Approved by	Issued By	Details of Amendment/Revision
00	03-03-12	Issued for Implementation	KRS	JPK	KKS	KKS	1. Earlier issued document No BWAOPRO-XXXX-OFC0000-PX0-ST-004 reformatted and renumbered. 2. Revised to include O&M and Construction comments.
01	12-03-12	Revised and Reissued For Implementation	KRS	JPK	KKS	KKS	Document Template Updated
02	15-03-12	Revised and Reissued For Implementation	KRS	JPK	KKS	KKS	Warning Tape Thickness change 0.5 mm to 0.2mm
03	17-03-12	Revised and Reissued For Implementation	KRS	JPK	KKS	KKS	Comments from Construction Incorporated
04	28-03-12	Revised and Reissued For Implementation	KRS	MPS	KKS	KKS	1. Warning Tape position inside Trench Modified 2. Spacing of Electronic markers 3. Requirements specific to Intra-city updated based on latest design
05	25-06-12	Revised and Reissued For Implementation	KRS	MPS	KKS	KKS	1. Typographical correction made 2. DIT test Pressure modified 3. Protective measure in case of lower depth in rocky area introduced.
06	14-07-12	Revised and Reissued For Implementation	KRS	MPS	KKS	KKS	Revised to add requirement of safe disposal of bentonite slurry
07	27-07-12	Revised and Reissued For Implementation	KRS	MPS	KKS	KKS	Section 5.3 - vi for Sand filling in MH/HH Deleted
08	04-01-13	Revised and Reissued For Implementation	KRS	MPS	KKS	KKS	1. Requirements of MH/HH 2. Requirements for water body crossings by open-cut in rocky areas added.
09	03-04-13	Revised and Reissued For Implementation	KRS	MPS	KKS	KKS	Clause 4.6.4.1 & Clause 4.6.4.2 Modified.
10	04-06-2013	Revised & Reissued for Implementation	KDP	BVN	KKS	KKS	Revised as per NPE Guideline Doc. No. R4G-20-IFN-GEN-PR-002
11	16-02-2015	Revised & Reissued for Implementation	KNB	BVN	KKS	KKS	Clause 4.2.1 & Clause 4.6.4.2 are modified
12	08-02-2016	Revised & Reissued for Implementation	NJS	BVN	KKS	KKS	Clause 4.3.2 xi, 4.6.3 iii And 4.6.4.1 iii are modified

## INDEX

1	SCOPE	5
2	REFERENCE DOCUMENTS	5
2.1	Codes and Standards .....	5
2.2	Company Specifications .....	5
2.3	Conflict and Clarification.....	6
3	GENERAL REQUIREMENTS	7
4	INSTALLATION OF HDPE DUCTS FOR OFC	8
4.1	OFC Duct Route Alignment .....	8
4.2	OFC Duct Depth.....	9
4.2.1	Inter-city (NLD) routes.....	9
4.2.2	Intra-city routes.....	11
4.3	OFC Duct Installation by Open-cut Method.....	13
4.3.1	Trenching.....	13
4.3.2	HDPE Duct Installation .....	15
4.3.3	Stone / RCC Slab Protection .....	17
4.4	Backfilling and Restoration .....	18
4.5	Installation of OFC Ducts by Trenchless Techniques (e.g. by HDD) .....	18
4.5.1	General.....	18
4.5.2	Duct Profile.....	18
4.6	Installation of Crossings .....	19
4.6.1	General.....	19
4.6.2	Crossings of Existing Utilities.....	20
4.6.3	Highways, Roads and Railroad Crossings .....	21
4.6.4	Water Body Crossing.....	23
5	MAN-HOLE AND HAND-HOLE INSTALLATION	27
5.1	Spacing Between Man-holes/Hand-holes.....	27
5.2	Installation of Man-holes/Hand-holes.....	28
6	ROUTE MARKERS	29
6.1	Concrete Route Markers / Route indicators.....	29
6.2	Electronic Route Markers .....	29
6.2.1	For Intra-city routes .....	29
6.2.2	Inter-city (NLD) routes.....	30
7	TESTING REQUIREMENT	30
7.1	Extent of Witness of Inspection/Testing of Duct Installation.....	30

7.2	Trench and Man-hole/Hand-hole Inspection .....	30
7.3	Inspection of RoW Restoration.....	31
7.4	Duct Integrity Testing (DIT).....	31
8	DOCUMENTATION	32
8.1	General.....	32
8.2	As-built Documentation.....	32
APPENDIX A		34
Formats for Inspection and Test Reports		34

## 1 SCOPE

This specification covers the minimum requirements for the laying, joining and testing of HDPE (High Density Polyethylene) Duct for Optical Fibre Cable (OFC) either by open cut methods or by trenchless techniques. The specification also covers installation of Man Holes (MH) and Hand Holes (HH) to assist blowing of OFC through ducts and jointing different segments of the OFC.

This specification shall be read in conjunctions with scope of work, requirements of the contract document and schedule of rates. Unless agreed specifically, scope covered under these documents shall be supplementary and complementary to each other.

## 2 REFERENCE DOCUMENTS

### 2.1 Codes and Standards

Reference is made in this specification to following Codes and Standards.

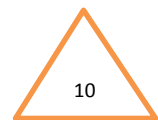
S. No.	Title	Document No.
1	Conduit Systems for Electrical Installations - Part 1: General Requirements	IS 14930 : Part 1 : 2001
2	Conduit Systems for Electrical Installations - Part 2 : Particular Requirements - Conduit Systems Buried Underground	IS 14930 : Part 2 : 2001

### 2.2 Company Specifications

Reference is made in this specification to following Company Specifications & Design Basis. The requirements of these specifications shall be complied with to an extent applicable.

S. No.	Title	Document No.
1	Specification for Optical Fibre Cable (Multi Loose Tube Design)	10070-40-PSS-PR-EF-001

S. No.	Title	Document No.
2	Specification for HDPE Ducts for installation of Optical Fibre Cable	10070-40-PSS-PR-EF-004
3	Specification for Accessories Required for Installation of HDPE Ducts and Optical Fibre Cable	10070-40-PSS-PR-EF-011
4	Specification for Installation of Optical Fibre Cable	10070-40-PSS-PR-EF-014
5	Standard Drawing for Manhole/Handhole (Type -1)	10070-40-C73-PR-EF-001
6	Standard Drawing for Concrete Route Markers	10070-40-C73-PR-EF-002
7	Warning Tape Details	10070-40-F51-PR-EF-001
8	Trench Cross-section and Additional protection for Inter-city (NLD) OFC Laying	10070-40-F51-PR-EF-002
9	Trench Cross-section and Additional protection for Intra-city OFC Laying	10070-40-F51-PR-EF-003
10	Intracity OFN Architecture & Fibre Engineering (Duct & Fibre Types, Fibre Allocation, Splicing & Termination Plan)	R4G-20-IFN-GEN-PR-002
11	Design Basis - Man Hole / Hand Hole Selection for Inter-city and Intra-city OFC Networks Guidelines	10070-40-PBD-PR-EF-002
12	To Establish Location, Size and Number of Zero Manholes at Facilities	10070-40-GDG-PR-EF-004



## 2.3 Conflict and Clarification

Any conflicts between various requirements of this specification and reference codes, standards and Company specifications mentioned under section 2.1 and 2.2 above shall be brought to the attention of Company. Until the resolution is officially made by the Company Representative, the most stringent requirement shall govern.

## 3 GENERAL REQUIREMENTS

- i The Contractor shall take utmost care during handling and transportation of free issue HDPE ducts from designated warehouse(s) to its own storage yard/place of installation so as not to damage them. HDPE duct shall comply "Specification for HDPE Duct for installation of Optical Fibre Cable" referred under Section 2 of this specification.
- ii The HDPE ducts of different colours shall be installed in the same trench. Number and colour of the ducts to be installed shall be as per Network Plan issued by NPE and Design Basis for OFC Laying works ( Doc No. 10070-40-PDB-PR-EF-001).
- iii When open-cut method is used for crossings such as national / state highways, major roads, district roads, canals, railway tracks, rivers etc., HDPE ducts shall be installed inside GI pipe, otherwise specific approval of Construction In- Charge (Site Construction Head / City Construction Manager / City Construction Cluster Manager ) as the case may be is mandatory. All records of such approval to be maintained. In addition when route crosses from one side of the road (say LHS) to other side of the road (say RHS) of a road/highway, the HDPE ducts shall be terminated in hand-hole or man-holes installed on both side of the crossing.
- iv For Inter-city routes man-holes shall be installed at all OFC jointing locations (approx. 4km apart for inter-city routes and also as per branching requirements, if any). Additional man-holes shall be installed at crossings and major turning points (e.g. when the route crosses from LHS of the road to RHS of road and vice-versa) which would otherwise make it difficult to install OFC. In case the length between two consecutive man-holes/hand-holes is more than 1km, additional hand-holes shall be installed in between so that the distance between consecutive man-holes or hand-holes or man-hole and hand-hole does not exceed 1km.

For Intra-city routes, Man-Hole/Hand-Holes shall be as per Design Basis doc no. 10070-40-PBD-PR-EF-002. Additional MH/HH will also be required at crossings, branch-off points and HDD pits.

Where Core Aggregation/NLD OFC manholes coincide with access OFC manholes, two separate manholes shall be located by staggering the two.

The above criteria is to be used as guidelines only. Almost at all HDD pit locations, there shall be a chamber or man-hole. Actual spacing may vary depending upon the construction methodology and presence of other infrastructure where MH/HH will have to be installed.

As far as practical, the duct shall be single piece between man-hole/hand-hole to man-hole/hand-hole. However, in some cases, where it is not feasible / practical, two or more HDPE ducts pieces may be installed subject to written approval of Company. The jointing of sections of duct shall be accomplished using Company approved make and model of HDPE duct couplers. For specification of duct couplers refer "Specification for Accessories Required for Installation of HDPE Ducts and Optical Fibre Cable" listed under Section 2 of this specification.

- v The installed ducts shall be progressively tested and defects if any shall be rectified including excavation, backfilling and permissions as may be required for digging.

- vi Providing all skilled and unskilled labour, material, equipment, transportation, and facilities for joining and testing shall be in Contractor's scope.
- vii On completion of job, the Contractor shall submit the "As built" (marked-up AFC drawings) drawings which shall capture all changes that may have become necessary during installation of ducts.
- viii While carrying out installation works, the Contractor shall comply with all requirements and conditions of statutory approvals from authorities having jurisdiction over the work site(s), Government rules and regulations / bye-laws, environmental and pollution prevention requirements etc.

## 4 INSTALLATION OF HDPE DUCTS FOR OFC

HDPE ducts for installation of OFC can be accomplished by either open-cut method i.e. by trenching, laying and backfilling or by trenchless techniques such as Horizontal Directional Drilling (HDD), moiling, boring etc. where only small pits are made at either side for entry and exit and special equipment is used for making hole to pull the ducts through the hole. This section describes requirements related to such installations.

### 4.1 OFC Duct Route Alignment

OFC Duct route must be aligned according to permission granted by authorities having jurisdiction over the area. However following guidelines shall be adhered:

- i Cable and pipe locators shall be deployed to identify underground utilities and correlate with as-built information collected from authorities. Cross pits shall be dug at adequate spacing manually to check and/verify presence of underground utilities that may or may not be picked up during survey. The pits shall be dug carefully and all precautions shall be taken by the Contractor to ensure that no utilities are damaged in any way during OFC Duct installation. In case any existing utilities are located within or in the vicinity of proposed route, the Contractor shall immediately inform, in writing, to the owners of such utilities and liaison with them so that the work is carried out safely and smoothly.
- ii When open-cut method is to be used, then in addition to route centreline the trench boundaries shall also be marked with rope and lime powder prior to digging in order to align trench in a straight line. In case of trenchless technique, the route centreline shall be marked and staked for reference.
- iii In city areas route will normally follow footpath / pedestrian way along roads. At some locations it may be located at the edge of road carriage way or even under road carriage way depending on specific permissions from road authorities having jurisdiction over the area.
- iv Outside the city limits, route will normally follow boundary of roadside land. However, where road side land is full of burrow pits and/or forestation or whenever the OFC Duct will have to be installed along



culverts / bridges centreline of route may be located closer to road edge or in some cases, over embankment or shoulder of road with due permissions from the authorities.

- v For Hilly areas the duct shall be laid below the drain provided on the hill side of road. In case the ROW permissions not available on the hill side or it is not practical due to space constraint then Duct may be laid just after road carriage way towards the valley side of road with approval of ROW authorities & Company's Construction in charge (State Construction Head or City Construction Manager or City Cluster Construction Manager). All the records of such approval to be maintained.

## 4.2 OFC Duct Depth

### 4.2.1 Inter-city (NLD) routes

- i The OFC Duct (s) shall be installed at a minimum depth of 1.65 m (1650mm) below natural ground level in normal soils which do not require rock cutting tools (such as chisels, rock hammers, blasting etc.) irrespective of method of construction (i.e. by open trenching or by Horizontal Directional Drilling (HDD) method).
- ii In rocky areas where open trenching requires special rock excavation equipment such as chisels, rock hammers, blasting, etc., the ducts shall be installed at a depth of 1.20m (1200mm) or 0.40m (400mm) below the rock surface whichever is more subject to maximum of 1600mm. Additional 50mm digging shall be done to provide soft padding below the ducts. No extra-protection will be required when duct is installed at such depth. If HDD is used for installation, the depth shall be 1.650m (1650mm) only except at entry and exit pits where minimum depth shall be 1200mm + 50mm for padding as in case of open trench.
- iii For the purpose to classifying an area/stretch as rocky area/stretch, the extent of route length requiring minimum 400mm deep excavation in rock shall not be less than 100m as a continuous stretch.
- iv Where trench depth variation happens, care shall be taken that transition from lower depth to higher depth or vice-versa, is gradual (maximum gradient 15 degrees) and smooth such that ducts will have a minimum radius of curvature as 1300mm.
- v For entire rocky stretch, bottom of trench shall be padded with minimum 50mm cover of soft soil (free of rocks pieces with sharp edges and stones, etc.) measured from the highest points in the trench bottom prior to installing ducts. After placing the duct, the trench needs to be first filled with soft soil (free of rocks pieces with sharp edges and stones, etc.) to have a minimum 200mm cover of soft soil from top of ducts before backfilling the trench with excavated material.
- vi Under certain conditions, it may be difficult to maintain minimum specified depth even in soft soils due to presence of other utilities and their safety or the approving authorities may not permit installation of ducts at specified depth. In such cases, extra protection shall be provided to the ducts as per Table – 1. For rocky areas reduction in duct depth below 1200mm is not permitted.
- vii Details given in Table – 1 shall be used for selection of appropriate protection method.
- viii 'Type A' construction applies to both open-cut as well as trenchless techniques and does not require any additional protection and is the minimum required depth. .

- ix 'Type B' and 'Type C' construction is applicable when installation is done by open-cut method only. These types include requirements of special protection for the ducts (e.g. laying ducts inside DWC pipe with or without additional layer of stone/concrete tiles/ M-15 PCC) that is required to be provided to compensate for not meeting required depth for whatsoever reason. Extra protection required for such construction shall be provided at no extra cost to Company.
- x 'Type E' construction is applicable only for installation in Hilly area. While reinstatement of area back to its near original conditional, care shall be taken to maintain the slope/way for drainage (Generally provided Hill side of Road).
- xi For all cases of lesser depth than specified (without protection i.e. trench 'Type A'), deviation notes shall be raised by the Contractor and specific approval obtained from Company's Construction in charge (State Construction Head or City Construction Manager or City Cluster Construction Manager) giving reasons for not achieving the specified depth as per 'Type A' and proposed construction type (Type B or C or D or E or F). All the records of such approval to be maintained.

Table – 1 : Protection Requirements for Inter-city Installation				
Sl. No.	Construction Type	Bottom of Duct below NGL (mm)	Additional Protection Requirement	
1	A	1650 for normal soil or 1200mm or minimum 400 mm below rock surface subject to maximum 1600mm whichever is more for rocky area	No additional protection needed, Ducts laid on trench bottom (after providing 50mm padding in case of rocky strata)	Refer Attached Drawing No. 10070-40-F51-PR-EF-002
2	B	Depth <1650 but > 1200 (in normal soils only)	Ducts installed inside DWC pipe of adequate size	Refer Attached Drawing No. 10070-40-F51-PR-EF-002
3	C	Depth <1200 but > 1000 (in normal soils only)	Ducts installed inside DWC pipe of adequate size and DWC pipe covered with a layer of concrete tiles (Min. 40mm Thk.) /stone tiles (Min. 25mm Thk.)	Refer Attached Drawing No. 10070-40-F51-PR-EF-002

Table – 1 : Protection Requirements for Inter-city Installation				
Sl. No.	Construction Type	Bottom of Duct below NGL (mm)	Additional Protection Requirement	
4	D	Depth <1200 but > 800 (in Rocky area)	Duct shall be protected with a layer of concrete tiles (Min. 40mm Thk.) /stone tiles (Min. 25mm Thk.)	Refer Attached Drawing No. 10070-40-F51-PR-EF-002
5	E	Depth <800 but > 400 (in Rocky/ Normal Soil of Hilly area)	Duct shall be protected inside DWC Pipes and covered with PCC.	Refer Attached Drawing No. 10070-40-F51-PR-EF-002
6	F	Depth <400 (in Rocky/ Normal Soil of Hilly area)	Duct shall be protected inside GI Pipes and covered with PCC.	Refer Attached Drawing No. 10070-40-F51-PR-069

## 4.2.2 Intra-city routes

- i For intra-city routes, as far as practical, the duct shall be installed by employing Horizontal Directional Drilling (HDD) Technique unless agreed specifically by Company in writing.
- ii When installation is carried out by HDD, the ducts shall preferably be installed below the existing utilities. HDD profile shall be such that a clearance of approximately 500mm between installed ducts and existing utilities is maintained. Notwithstanding above stated clearance, additional safety margins as may be considered essential by the HDD contractor to account for drilling tolerances based on the HDD equipment's steering and control mechanism shall be considered while deciding the HDD profile.
- iii As a guideline, except for transition sections at entry and exit of HDD, the ducts shall be laid at minimum depth as given below or as determined by the clearance requirement specified above whichever is more.
  - a. Mumbai intra-city : 2.5m
  - b. Delhi and Other cities : 3.0m
- iv Where ducts cannot be installed by HDD technique and the Company agrees to installation by open cut trenching Where trench depth variation happens, care shall be taken that transition from lower depth to

higher depth or vice-versa, is gradual (maximum gradient 15 degrees) and smooth such that ducts will have a minimum radius of curvature as 1300mm.

- v For entire rocky stretch, bottom of trench shall be padded with minimum 50mm cover of soft soil (free of rocks pieces with sharp edges and stones, etc.) measured from the highest points in the trench bottom prior to installing ducts. After placing the duct, the trench needs to be first filled with soft soil (free of rocks pieces with sharp edges and stones, etc.) to have a minimum 200mm cover of soft soil from top of ducts before backfilling the trench with excavated material.
- vi Under certain conditions, it may be difficult to maintain minimum specified depth due to presence of other utilities and their safety or the approving authorities may not permit installation of ducts at specified depth. In such cases, extra protection shall be provided to the ducts as per Table – 2.  
Details given in Table – 2 shall be used for selection of appropriate protection method.
- vii ‘Type A’ construction applies to both open-cut as well as trenchless techniques and does not require any additional protection and is the minimum required depth.
- viii ‘Type B’, ‘Type C’, ‘Type D’, ‘Type E’ and ‘Type F’ construction is applicable when installation is done by open-cut method only. These types include requirements of special protection for the ducts (e.g. laying ducts inside DWC pipe with or without additional layer of stone/concrete tiles/ M-15 PCC) that is required to be provided to compensate for not meeting required depth for whatsoever reason. Extra protection required for such construction shall be provided at no extra cost to Company.
- ix For all cases of lesser depth than specified (without protection i.e. trench ‘Type A’), deviation notes shall be raised by the Contractor and specific approval shall be obtained from Company’s Construction in charge (Head office) / City Construction Manager / City Cluster Construction Manager / Engineering department giving reasons for not achieving the specified depth as per ‘Type A’ and proposed construction type (Type B or C or D or E or F).

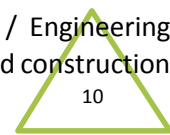
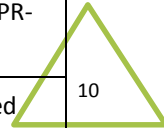


Table – 2 : Protection Requirements for Intra-city Installation (only when installation is by open cut trenching)				
Sl. No.	Construction Type	Bottom of Duct below NGL (mm)	Additional Protection Requirement	
1	A	1200 for normal soil or 1000mm or minimum 300 mm below rock surface subject to maximum 1200mm whichever is more for rocky area	No additional protection needed, Ducts laid on trench bottom (after providing 50mm padding in case of rocky strata)	Refer Attached Drawing No. 10070-40-F51-PR-EF-003
2	B	Depth < 1200 but > 1000 (in normal soils only)	Ducts installed inside DWC pipe of adequate size	Refer Attached Drawing No. 10070-40-F51-PR-EF-003

Table – 2 : Protection Requirements for Intra-city Installation (only when installation is by open cut trenching)				
Sl. No.	Construction Type	Bottom of Duct below NGL (mm)	Additional Protection Requirement	
3	C	Depth < 1000 but > 800 (in normal soils only)	Ducts installed inside DWC pipe of adequate size and DWC pipe covered with a layer of concrete/stone tiles Thickness of Concrete/stone tiles shall be minimum 40mm.	Refer Attached Drawing No. 10070-40-F51-PR-EF-003
4	D	Depth <1000 but > 800 (for Rocky soils only)	Ducts installed inside DWC pipe	Refer Attached Drawing No. 10070-40-F51-PR-EF-003
5	E	Depth <800 but > 400 (for Rocky soils only)	Ducts installed inside DWC pipe and Covered with PCC	Refer Attached Drawing No. 10070-40-F51-PR-EF-003
6	F	Depth <800 but > 400 (in normal soils only)	Ducts installed inside DWC pipe and Covered with PCC	Refer Attached Drawing No. 10070-40-F51-PR-EF-003



## 4.3 OFC Duct Installation by Open-cut Method

### 4.3.1 Trenching

#### 4.3.1.1 Precautions to be taken while Trenching

- i It is necessary from safety reasons that the dugout trenches are not kept open for long. Activities of trenching, laying of ducts and backfilling shall run in parallel as far as possible.
- ii Caution boards, plastic warning tapes, barricades, night lamps (flicker lamp, lantern with glass painted red) and watch man shall be deployed by contractor at his own cost to caution against the danger and to prevent any accident to pedestrians, vehicles or animals.
- iii Caution boards shall be set up at a height of 1.25 meters above ground level so that they are visible from a minimum distance of 25 meters. Boards shall have yellow and black background with writing in bold letters with red fluorescent paint. Boards shall be displayed at start and finish point of area in which work is under progress. Additional display boards shall be placed on either side of the trench. Board markings shall have the name of trenching authority, name of Engineer/ Supervisor in charge of work with contact phone number and planned date of opening and closing trench.

- iv The Contractor shall be responsible for any mishap or accident due to negligence or proper protection of open trenches and all claims arising due to such accidents shall be settled by the Contractor without any liabilities to Company.
- v Whenever any protective covers / messages of other services or operators are encountered during excavation, earth around them shall be gently removed so as not to cause damage to existing facility. If the underground facilities of others agencies are exposed during excavation, adequate protection shall be provided at suitable intervals along the runs of these facilities and concerned agencies / authorities shall be informed.
- vi Near foundations and boundary walls, excavation shall be taken up carried out in consultation with and in presence of owners of such facilities.
- vii Any valuable material of cultural/ historical/ archaeological importance, if found while trenching, shall be immediately brought to the notice of Company and the concerned authority. Further trenching at the location shall be stopped till further instructions are received from the Company.

## 4.3.1.2 Digging/Excavation

- i In city limits of intra-city routes as well as in built up areas along inter-city routes, Contractor shall use manual labour only, and shall ensure that no damage is caused to any underground or surface installations belonging to other public utility services and/or private party. Cross country trenching can be done using trenching machines/excavators.
- ii The Contractor shall clear, prepare and grade the Right of Way to facilitate marking of the alignment of the trench. Contractor shall remove all bushes, undergrowth, stems, rocks and other obstacles etc. ensuring minimum amount of bushes and shrubs are removed to clear way and contractor shall give all consideration to preservation of trees within right of way. Machines can be used for clearing small bushes along the route; however, trees shall not be cut or uprooted for purpose of movement of excavating machines. Where such necessity arises, permission from competent authorities to partially cut such trees shall be obtained in writing. Compensation to cut such trees for movement of machines shall be paid by the Contractor.
- iii Width of trench shall be kept to a minimum depending on trenching technique used and number of ducts to be installed. For manual trenching, width shall be minimum 450mm at top and 300mm at the bottom for ease of installation. For intra-city routes where number ducts will vary along various routes, the width of trench shall be decided on the basis of number of ducts to be installed when the ducts are placed in single layer. Multiple layers of ducts shall be avoided to an extent feasible. Specific approval will be obtained for such areas where multi-layer construction is to be used.
- iv Rock excavation shall be done by chiselling and/or controlled blasting where permitted by concerned authority. In general controlled blasting is not to be carried out for intra-city works. For inter-city works, controlled blasting may be possible subject to the Contractor having license for carrying out rock blasting and after obtaining necessary permissions from the authorities concerned. Blasting shall only be carried out after all precautions are taken to ensure no damage to public property (both below and above ground) and safety of public and staff involved in the work. The Contractor shall employ sufficient manpower for this with caution boards, flags, sign writing etc. Any consequences due to lack of precaution or otherwise, on this shall be sole responsibility of the Contractor.
- v All necessary arrangement shall be made to ensure stability of trenching. Where poor / unstable soil conditions exist, the Contractor shall take adequate precautionary measures to prevent caving in of the trenches while excavation. At such locations, width of the trenches shall be kept adequate and necessary

arrangement shall be made for safe working within trenches. Where high water table exists, the Contractor shall make necessary arrangements for pumping out sub-soil / underground water from trench.

- vi Underground power cable shall not be moved. Concerned electricity board / authority shall be immediately informed. A minimum of 600 mm horizontal and vertical separation shall be maintained from power cable. As far as possible power cable shall be crossed at right angle.
- vii Temporary foot-bridges shall be provided when trenches cross entrances of building, premises, etc.
- viii Special care shall be taken in digging footpaths with proper protection to avoid accidents and inconvenience to pedestrians.
- ix Roots of big trees should be bypassed to avoid damage while trenching and ensuring safe passage of OFC. Such negotiation shall be with a smooth curve.
- x Trench shall be located at lowest point of lower area if feasible. Trench must not come over boundary or any heap of soil / garbage dump.

### 4.3.1.3 Trench Profile

- i Bottom of trench shall be uniform and shall follow ground contour/profile.
- ii In areas with steep slope, trench profile shall be such that bottom of trench shall not have more than 23 degree gradient with horizontal (i.e. difference between two adjacent depth readings at a distance of one meter shall not be more than 250 mm).
- iii In areas of high slope, to prevent soil erosion due to free rain water flowing along or inside the trench, slope breaking barriers in the form of vertical walls of flag stones or stone masonry or bags filled with sand and cement mixture shall be installed inside the trench at spacing of 10m centre to centre after laying ducts such as using.
- iv Profile alignment of trench shall be such that HDPE ducts are laid in straight line, both laterally/horizontally as well as vertically except at locations where it has to necessarily take a bend because of change in alignment or gradient of trench. Minimum radius of two meters shall be maintained, where necessary.

### 4.3.2 HDPE Duct Installation

- i Prior to duct installation, the Contractor shall prepare a manhole installation plan based on 'Design Basis for Manhole / Hanhole Selection'. The Contractor shall also identify locations where special protective measures such as those indicated in Table -1 and 2 (as applicable) shall be required and make arrangement for all materials required for such protective measures so that after installation of ducts the trenches can be immediately backfilled.
- ii The location of man-holes and hand-holes shall be optimized so as to minimize the wastage of ducts and to avoid unnecessary use of duct couplers. Equally important is to select duct coils of suitable lengths such that minimum cut pieces are left after installation of ducts.
- iii Ducts colour and sequence shall be as indicated in drawings. Ducts of different colour shall be laid parallel inside the trench. Duct runs shall be as straight as practicable without kinks and bends. Care shall be taken to prevent twisting of ducts while installing the same inside trench.

- iv Prior to installation of the duct, the trench shall be checked to ensure the minimum depth requirements are met including protective measures, if any. Trench bottom shall be free from any hard materials, rocks or any objects, which may damage or puncture the duct. Soft padding material free from sharp edged stones/hard materials shall be uniformly placed in trench before laying the duct to completely cover the hard surface with a minimum cushion of 50mm thickness over the hard surface. Company shall inspect the trench prior to laying of ducts. Records of all padding and protective measures, if any, shall be maintained for Company review and later incorporation into as-built drawing .As-built data related to trenching shall be provided and shall be made available to the Company at the time of inspection of trench.
- v The roll of HDPE ducts shall be mounted on a Vertical de-coiler assembly. The duct shall be smoothly unrolled along the trench prior to lowering into the trench. An alternate method should be the use of horizontal duct de-coiler, from which ducts shall be manually unwound and laid along or inside the tranche. Walking on the duct(s) when laid in the trench bottom shall be strictly prohibited. Pictures placed below shows examples of such de-coiling equipment. In case of intra-city works, due to number of ducts to be installed and space limitations, it may not be possible to use de-coilers at all locations. In such areas, the ducts shall be cut into smaller lengths and spread-out in a manner so as not to cause inconvenience to public and/or traffic. Care shall be taken not to twist/kink/buckle the ducts during spreading out.



Horizontal De-coiler



Vertical De-coiler



Using De-coilers at Site

- vi When inevitable, sections of ducts shall be joined using HDPE duct couplers conforming to the specifications referred under Section 2 of this specification for a locked and air and water sealed assembly suitable for direct burial. The couplers shall be installed in accordance with the Manufacturer's recommended procedure. Final assembly shall have adequate tensile strength required to prevent opening during



pneumatic blowing of OFC as well as requirements of duct air pressure testing. In no case more than two couplers shall be permitted in one section between a pair of adjacent man-holes/hand-holes when ducts are installed by open trenching. This limitation does not apply to ducts installed by HDD.. Unless specified otherwise in the Contract, duct couplers and equipment, tools and tackles required for installation of couplers shall be procured and provided by the Contractor. The location of each coupler shall be recorded (with coordinates LAT/LONG) for incorporation in as-built drawings and GIS database.

- vii The ducts shall be joined with couplers using duct cutter and proper tools only. Use of hacksaw to cut the duct is not permitted. The duct joint shall be practically airtight to ensure smooth cable blowing operation using cable blowing machines.
- viii All coupler locations shall be covered with red stone (25 mm thick X 300 wide X 1000 mm length) prior to backfilling. Coupler shall not be installed along the bent portion of duct/trench in both horizontal as well as vertical direction.
- ix As far as practical, the duct shall be laid in piece length of 1 km or in multiples of 500m in case of inter-city routes and open trenching installation. Where HDD technique is used, the duct length shall be to suit HDD shot length. In case of intra-city routes, due to space limitations, the length of ducts may be cut to suite spacing between man-hole to man-hole.
- x Ducts shall be lowered into finally prepared trench bottom in a straight line and without twisting, kinks etc. and in sequence.
- xi Ducts shall be laid in a flat bottom trench free from stones, sharp edged debris. No water should be present in trench, while laying the duct/DWC pipe. In case the trench cannot be free from water (such as high water table areas / salt pan areas etc.), anti-buoyancy measures shall be taken to ensure ducts installed stay at the bottom of the trench. Such measures include placing of non-cohesive material filled sacks on ducts at max interval of 1.0m or installation of ducts inside Hume pipes (of suitable size as per nos. of ducts). Hume pipes use shall be avoided where required trench depth is achieved. Hume pipes shall be used only when required depth is not achieved. Use of hume pipe will require specific approval prior to installation.
- xii The duct shall as straight as possible when placed inside the trench and shall be laid parallel to one another (without criss-cross).
- xiii At horizontal and vertical bends, minimum bending radius 1300mm shall be maintained.
- xiv Each duct shall be terminated inside a man-hole/hand-hole and its open ends plugged with air and watertight end caps (end plugs) to prevent the ingress of water, mud, debris or other material during the installation. Any collapsed portion of duct shall be removed before backfilling and duct made continuous by putting couplers.
- xv Company shall inspect the laid ducts prior to backfilling operations.

### 4.3.3 Stone / RCC Slab Protection

- i Locations where there is high probability of construction activity in near future, stone slabs (Flag stone) of size 300mm (Wide) x 500mm (Long) x 25 mm (Thick) shall be placed inside the trench after 100mm thick layer of soft padding has been put over ducts. In case stone slabs are not available, RCC slab of size 300mm (Wide) x 500mm (Long) x 40 mm (Thick) may be used. Stretches for this protection shall be identified as part of route survey. This protection is meant for areas where, otherwise, trench depth is

adequate. The location and extent of such additional protective measures shall be as per instructions of Engineer-in-Charge.

## 4.4 Backfilling and Restoration

- i Backfilling shall be done with well compacted excavated material after ensuring soft material padding. Adequate dry compaction shall be done before Crowning. Compaction shall be done in layers of 50 cm each.
- ii A crown of 250mm shall be made at the top of the backfilled trench to cater for soil settlement. Crowning shall be confined over width of trench only. No surplus soil shall be left outside trench. Entire area shall be restored and debris removed and disposed-off in a safe manner and in line with requirements of the authority having jurisdiction over the area.
- iii Back-fill shall be maintained by Contractor against wash-out, settlement below original level, until final completion of work and till NOC from the land owners has been obtained and handed over to Company.
- iv The trench shall be filled up to the required height (Measured from top of ducts as per Trench cross-section drawing issued for construction) and a 0.2mm thick high density polyethylene warning tape of design approved by the Company shall be placed above the ducts prior to further backfilling. Company reserves the right to verify presence of warning tape even after the trench is backfilled at random locations in case of a doubt. Installation of warning tape shall be as per guideline issued.

## 4.5 Installation of OFC Ducts by Trenchless Techniques (e.g. by HDD)

### 4.5.1 General

- i The ducts in the intra-city fibre routes (including such inter-city routes that are common with intra-city routes) shall be installed by Horizontal Directional Drilling method unless approved by the Company in writing for installation by other methods.
- ii The Contractor shall mobilize equipment suitable to install the ducts up to required / specified depth below ground in all types of soils.
- iii All concerned authorities (water, oil and gas pipeline operators, telecom operators, power companies etc.) who may have their underground utilities in the area shall be informed well in advance and as built drawings obtained to ensure proper planning of HDD operation and drilling profile.
- iv Cross pits shall be made across approved duct alignment to verify information about existing underground utilities/facilities as provided by authorities having jurisdiction over the area and also to ascertain type of soil for safe working of HDD equipment.

### 4.5.2 Duct Profile

- i Unless specified and /or agreed in writing by Company, the duct for intra-city networks shall be installed at a specified depth below ground except at entry and exit areas. The minimum depth at entry and exit pits shall be 1.2m for intra-city networks.

The installation of ducts by HDD along inter-city routes (except those in common with intra-city routes) shall be at the same depth as specified for inter-city ducts installation by open-cut (i.e. 1.65m) or as per requirements of the authorities(e.g. in case of NH/SH/Railway/canal crossing etc.).

- ii Entry and exit pits shall be dug at both ends of the segment which shall later on become either a location for man-hole/hand-hole in case of intra-city routes or for installing duct couplers in case of inter-city routes. For inter-city routes MH/HH locations shall be as per issued for construction drawings only.
- iii The drilled hole profile between entry and exit pits (except transition areas) shall be as straight as possible. The final HDD profile shall become part of as-built documents.
- iv The hole made by HDD equipment shall be of adequate diameter to allow pulling all the ducts in one go as a bundle. The ducts in the bundle shall be properly bundled using suitable spacers and tied together during pulling. The capacity of pulling equipment shall be at least 1.5 times of theoretical calculated pull force.
- v The Contractor shall submit a detailed HDD procedure for review/approval of Company. The procedure shall include at least following information:
  - a. Proposed locations, size and depth of entry and exit pits.
  - b. Proposed number of holes, hole diameter and hole profile for pulling HDPE duct(s).
  - c. Proposed HDD machine details along with drilling direction control/steering system details.
  - d. Pulling load calculations and details of pulling equipment (pull head, winch, rope, etc.).
  - e. Method of safe disposal of bentonite slurry.
  - f. Drawing showing information at a) and b) above.
- vi Upon obtaining approval of procedure, the Contractor shall prepare site by marking route and digging entry/exit pits at predetermined locations and drill the hole of required size for pulling the ducts through. Once the hole is ready, required number of ducts, already de-coiled and spread on the ground, shall be connected to a pulling head and pulled through the hole. Suitable swivel joint shall be used during pulling to prevent twisting of ducts during pulling.
- vii The drilling machine and pulling equipment shall be removed and moved to new locations. The pits shall be replaced with man-hole/hand-hole for termination of ducts and later blowing of cable and remaining area backfilled and restored to a conditions agreed to with the authorities having jurisdiction over the area. Bentonite slurry, if used, shall be recovered from the pits and disposed-off in a safe and environmental friendly manner and at locations approved by Authorities.
- viii The Contractor may have to deploy more than one set of HDD equipment to achieve required lay rate demanded by contract schedule.

## 4.6 Installation of Crossings

### 4.6.1 General

- i HDPE ducts Crossing existing and / or proposed utilities (pipelines, cables, drains etc.), manmade infrastructural facilities (Highways, Railroads, roads, tracks, footpaths, canals, drains, bridges, culverts etc.) and natural obstructions (rivers, streams, nalas, estuaries, caves, gorges, etc.) may be crossed by

open-cut method, trenchless techniques or other suitable methods subject to approval by the authorities having jurisdiction over such utilities/infrastructure/areas. It shall be the responsibility of the Contractor to delineate of all such obstructions before starting installation works and plan for most appropriate method of installation of HDPE Ducts.

- ii Whenever underground utilities such as pipelines (water, drainage, gas or oil etc.) or cables (communications or power) are encountered during survey and/or excavation of trial pits or during actual trenching, they shall be cleared with utmost care. Precautions shall be taken to maintain their stability and safety during the works by providing adequate supports.
- iii When these utilities obstruct the ducts alignment in any way, the owners of the utility shall be informed and requested to be present during execution of work to ensure trouble free execution. It shall be expressly understood that in the event of damage to any existing utility, the same shall be repaired and restored, to operating conditions as it were prior to damage, by the Contractor at no additional cost to the Company.
- iv Special protective measures shall be taken during installation of crossing to prevent damage to existing facility/utility or HDPE Ducts in future.
- v Following sections provide minimum special requirements for protection of ducts as well as some suggested techniques for installation of ducts crossing various obstructions.

## 4.6.2 Crossings of Existing Utilities

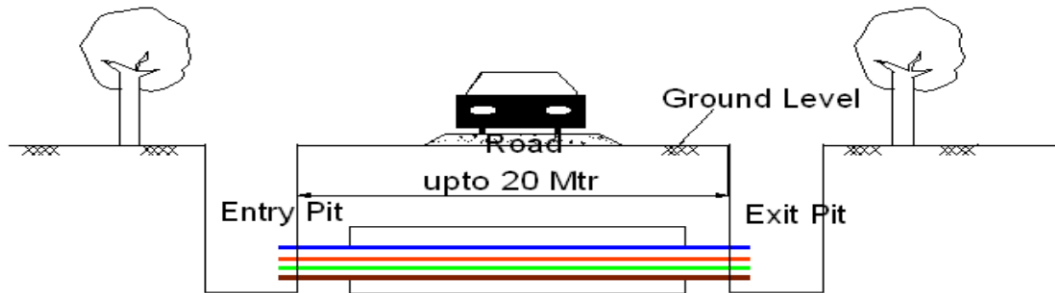
- i Utilities may be crossed by open-cut or trenchless technique as appropriate / approved by the authorities. However, Contractor to note that it is extremely dangerous to attempt crossing of existing utility by trenchless technique without full and complete knowledge of existing utilities.
- ii For crossing by trenchless technique (HDD, Moiling/thrust boring etc.), it is important to know exact position (both horizontally as well as vertically) of exiting utility by either making trial pits or by other means (e.g. electronic pipe/cable locators) or by obtaining correct as-built data from owner of utility. The GI/DWC pipe shall be encased in 100mm thick concrete if it is at a location susceptible to damage by third party .Under hung/side supported crossing need not be encased in concrete.
- iii Once the location has been established, the HDPE profile shall be selected in such a manner that adequate clearance is maintained between existing utility and the Ducts. The crossing profile within utility corridor shall be designed considering laying of HDPE duct in a straight line, parallel to ground, for at least 2m from the edge of extreme utility on both sides of crossing.
- iv For installation by HDD, minimum 0.5m vertical clearance from the nearest utility is required. Requirements of installation by trenchless technique as given under Section 4.5 shall also be complied with.
- v For open-cut installation, HDPE ducts shall be laid with a minimum vertical clear separation (outer surface to outer surface) of at least 500mm between the existing utility and HDPE ducts unless agreed/approved by concerned authorities for lesser separation.
- vi The ducts shall normally cross below the nearest existing utility after maintaining specified clear separation between existing utility and HDPE Duct. In case the existing utility is already laid deep enough so that duct installed at specified depth will result in a clear separation of 500mm or more between top of existing utility and bottom of ducts, then the HDPE Duct may cross above existing utility.

- vii Back filling on public, private roads, and footpaths in city areas shall be performed immediately after laying HDPE ducts. Back filling at such location shall be carried out by dry compaction in layers of 500mm and thoroughly rammed; so as to ensure that original condition is achieved and made safe to traffic. All excess soil/material left out on road/footpath shall be removed.
- viii The Contractor shall be responsible to maintain the backfilled area till completion of work and /or until first monsoon season whichever is later. Any settlement observed during this period shall be reinstated to keep levelled condition as acceptable to the highway/local authorities.

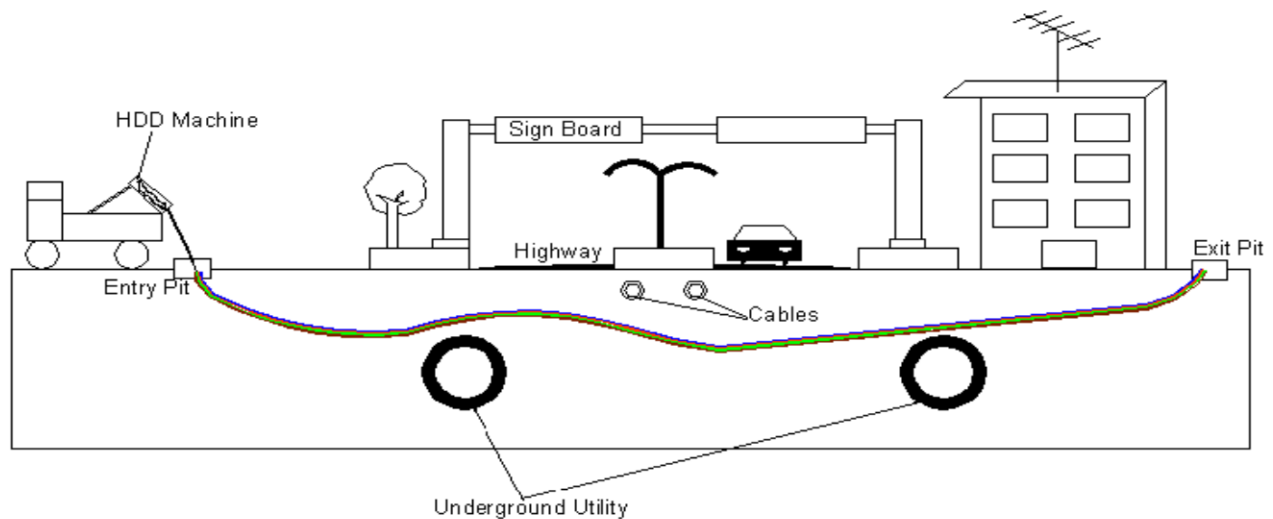
## 4.6.3 Highways, Roads and Railroad Crossings

- i Highways/Roads/railroads may be crossed by open-cut or trenchless technique (HDD/Moiling) as appropriate / approved by the authorities (refer typical sketches at the end of this section). Moiling method is generally not suitable for crossing width of more than 20 meters. For such crossings only HDD should be used when trenchless technique only is approved by authorities.
- ii GI pipe shall be provided as additional protection to HDPE ducts at these crossing locations as a measure to prevent third party damage. GI pipe shall extend at least 2m beyond highway/road/railroad RoW on each side. The size of GI pipe shall be decided based on the number of ducts to be installed. In no case number ducts shall be less than three. At minor roads (e.g. WBM roads, Village/Panchayat roads, Kachha roads, etc.) where open cut method may be accepted by authorities, instead of GI pipe, DWC pipe of suitable size may be used.
- iii Unless agreed otherwise by authorities, GI/DWC pipe shall be installed in a straight line within road RoW. The GI/DWC pipe shall be installed at a minimum depth 1200mm from lowest points within RoW (e.g. drains running parallel to highway/road/railroad) or 3000mm from top of road surface/tracks whichever is higher. At minor roads (e.g. WBM roads, Village/Panchayat roads, Kachha roads, etc.) where open cut method may be accepted by authorities, DWC Pipe shall be installed at a minimum depth of 1650mm from the lowest point (i.e. bottom of drain on either side of road) within ROW. In case approving authorizes required higher depth than as specified above, the same shall be complied with.
- iv When more than one GI pipe is used, the sections of pipe shall be welded together to form required length. Use of GI couplers is not recommended as the same can impact/damage duct during pulling. As well as make it prone to theft. Where such possibility does not exit GI coupler can be accepted on case to case basis subject to approval of Engineer-in-Charge. Bends in GI pipes shall be avoided. In case it is necessary to use bends, suitable pipe bender shall be used. Bend radius shall be between 20 – 30 times the outside diameter of GI pipe so as to allow easy pulling of ducts through GI pipe. Use of bends of shorter radius shall need specific approval of the Company.
- v HDPE ducts shall preferably be inserted into GI/DWC pipe string prior to its installation. Else a wire rope of suitable size shall be inserted into GI/DWC pipe for subsequent pulling of HDPE ducts. Rubber bushes shall be used at the both ends of the GI pipes to prevent any damages of HDPE ducts during insertion/pulling.
- vi After exiting GI pipe/DWC pipe, the HDPE ducts shall be installed in a smooth transition up to the adjoining duct and/or man-holes provided at each side of the crossing.

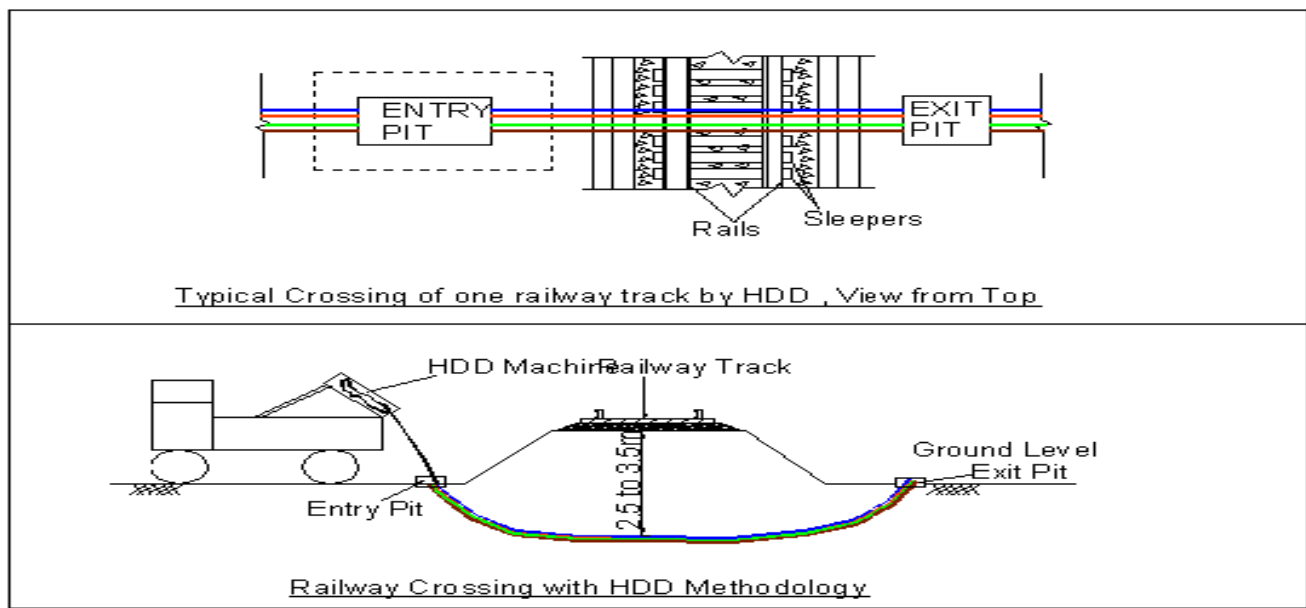
- vii The ends of the HDPE ducts shall be sealed with end caps to prevent ingress of water, mud, debris or obstacles inside the man-hole.
- viii Sketches below are indicative only.



SINGLE ROAD CROSSING BY MOILING / BORING



Crossing highways by HDD Methodology



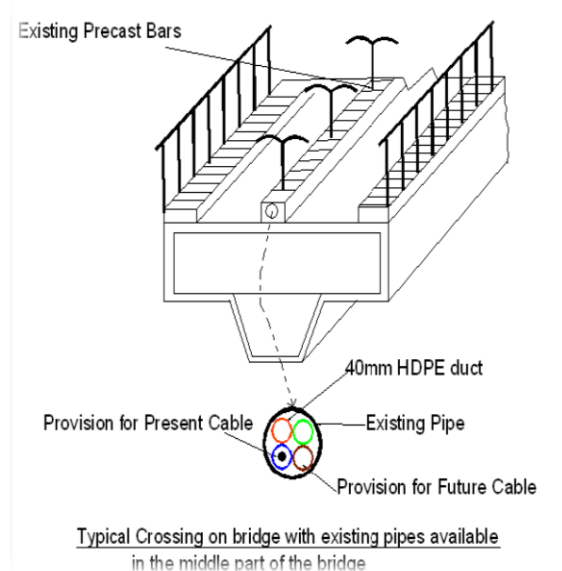
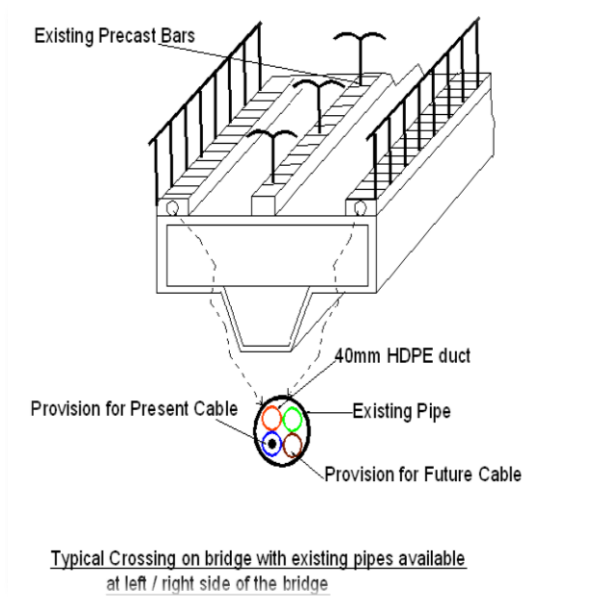
## 4.6.4 Water Body Crossing

- i Water bodies and other natural obstructions can be crossed by open-cut method, trenchless techniques or using existing infrastructures such as bridges and culverts depending upon the nature of water body (dry/stagnant/flowing) and availability of permissions from concerned authorities for using existing infrastructure.
- ii In all cases, installation technique shall be such that protection of HDPE ducts is ensured. Necessary protection as described herein below shall be provided depending on installation technique used.

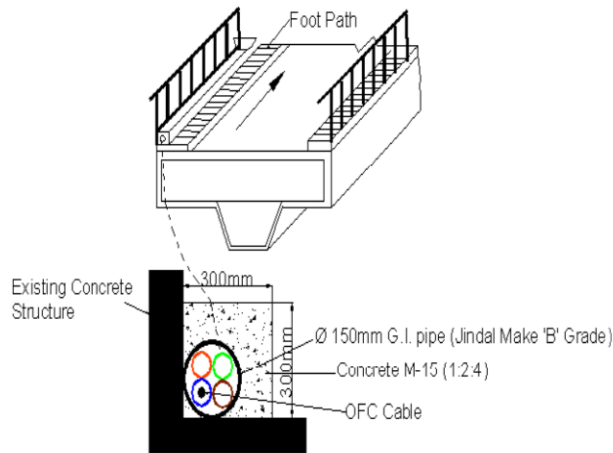
### 4.6.4.1 Crossings Using Existing Bridges / Culvert

- i Existing infrastructure for crossings water bodies such as nalas /streams / rivers / canals, etc. shall be used wherever possible and permission to use the bridge or culvert is available.
- ii Ducts shall be installed inside GI/DWC pipes (of diameter suitable for specified number of ducts) when duct are laid on/along bridge/culverts at locations approved by authorities. DWC pipe shall be used when the location is not exposed to direct sunlight. For locations exposed to direct sunlight, high winds or heavy rains GI pipes shall be used as protective measure. In exceptional cases, where authority does not permits use of GI pipe, DWC pipe shall be covered with a GI sheet to prevent direct sunlight and rain falling on DWC pipe. As far as practical GI sheet should not touch the DWC pipe. Wooden/other low thermal conductivity material spacers can be used to maintain gap between DWC pipe and GI sheet.
- iii GI Pipe/DWC duct shall extend at least for 10 meter beyond the banks/limits of water body / embankment of bridge on both sides of crossing. Specified protection shall also be extended accordingly for respective trench depths, as mentioned in Cl. No. 4.2 of this document. Man-hole/hand-hole shall be located minimum 10 meter further away from end of GI/DWC pipe or as indicated in IFC drawings.

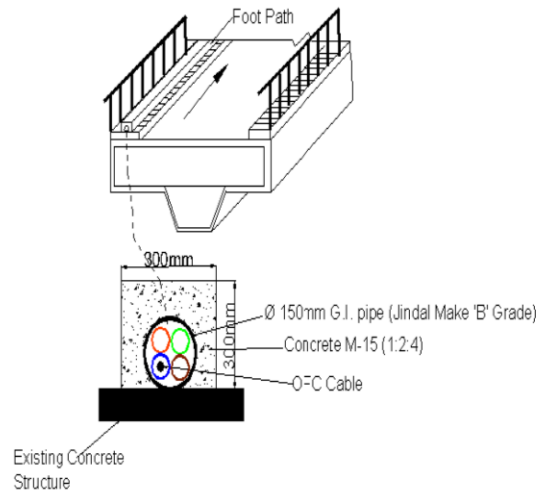
- iv On arch type bridges where depth up to 300 mm is possible to dig, a trench (minimum 150mm wide) shall be made in tar road section of the bridge. DWC pipe then shall be installed inside this trench as per IS - 14930. Concreting (using concrete mixture of cement, sand and aggregates in 1:2:4 ratio) shall be done over the DWC pipe up to the road level. The ducts shall be pulled into DWC pipe.
- v Bridges where it is not possible to make trench, GI pipe / DWC pipe (selected as per criteria at given above) shall be installed at safe available place on the bridge designated for the utilities. The pipe shall be fixed in place firmly using clamps and/or encasing in M15 concrete. HDPE ducts then shall be pulled into this pipe.
- vi When GI pipe/duct is installed on the underside of bridge or culverts, additional measures shall be taken to prevent it getting washed out during flooding. The ducts laid on adjacent areas (banks of water body) shall also be protected against washout or settlement of backfilled area.
- vii Before crossing bridge/culvert the engineer from concerned authority (PWD/NHAI) must be consulted for future plan of expansion or re-construction and to decide the alignment of trench.
- viii Following pictures shows typical installations on bridges for reference/guidance purpose. Actual construction may vary as per site conditions.



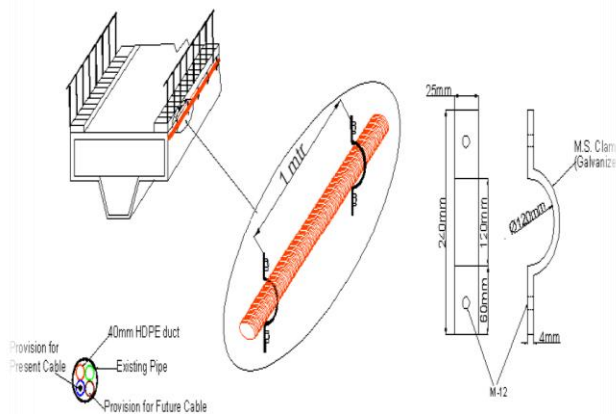




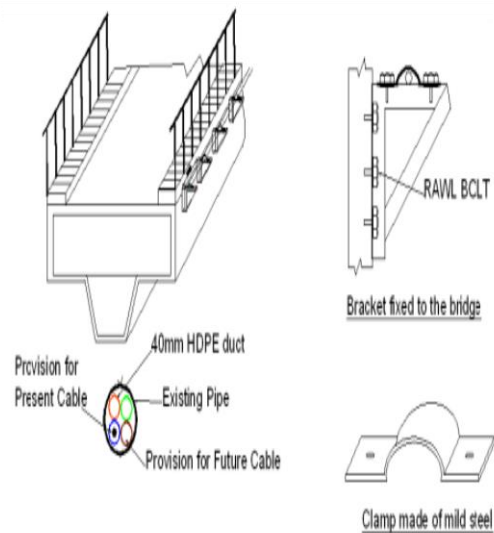
Laying of 150mm G.I. Pipe in Re-inforced concrete placing on existing concrete structure



Laying of 150mm G.I. Pipe in Re-inforced concrete placing on existing concrete structure



Crossing of Bridge on one side with a DWVC Fixed with C Clamps



Crossing of Bridge on one side with a G.I. Fixed on Brackets

## 4.6.4.2 Crossing by Open-cut method

- i Open-cut method can be used when installation on bridge / culvert is not available. This method however is more suited to seasonal water bodies (prone to flowing water such as nala / stream / river / canal etc.) which may be completely / partially dry during installation period. This method can also be used for small water bodies where it is possible to divert water for a short period of installation.
- ii In case there is only one Hume pipe up to 600mm dia. used as a culvert to equalise the water level on both side of road, the duct can be laid at a min depth of 1.65 m from NGL without any protection. For more than one 600mm dia. pipe and all sizes of Box-culverts, ducts shall be installed as clause iii) below.
- iii In Case the water body bed is not rocky (i.e. normal soil is present), a trench 2.0 meter below the bottom of culvert bed shall be dug out and DWC pipe of suitable size shall be installed inside the trench. In case the bed is rocky in particular section then minimum depth of trench shall be 1.5 m. A 50mm thick sand padding (covering highest point on the trench bottom surface) shall be provided before installing DWC pipe.

For protection of ducts, after installation of DWC pipe, trench shall be backfilled as follows:

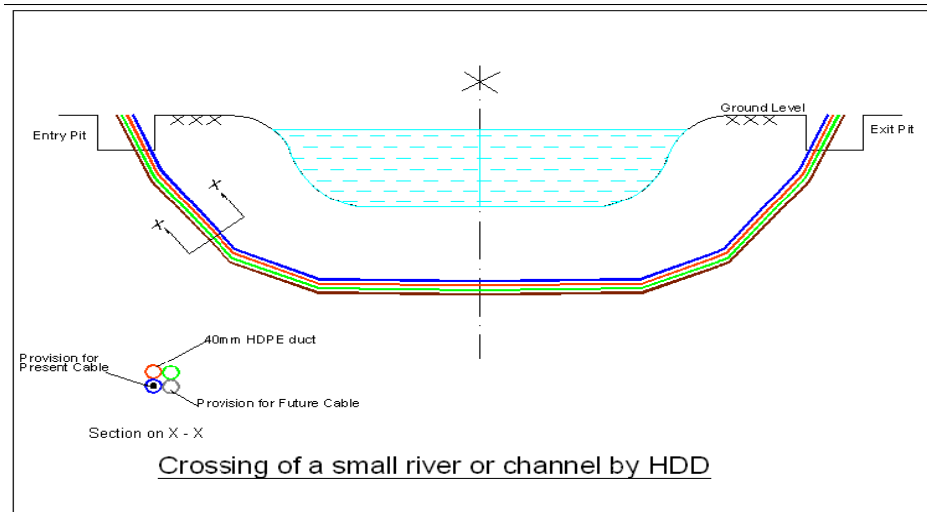
- a) **When the water body is full of water and PCC cannot be done**
  - i Trench to be filled with sand for a height of 200mm from top of DWC pipe.
  - ii 300mm thick layer of crushed rock/stones of size 50-100mm be filled in the trench and compacted.
  - iii Remaining trench be filled with excavated material and compacted.
- b) **When the water body is dry and PCC can be done**
  - i Trench to be filled with M15 plane cement concrete (1:2:4 mixture of cement, sand and aggregate) for at least 300mm above top of DWC pipe.
  - ii Remaining trench be filled with excavated material and compacted
- iii HDPE Ducts shall be pulled through the DWC duct.
- iv In case where it is not possible to dig a trench of 1.5 M depth in rocky beds due to some unavoidable reasons then this installation can be carried out as per Drawing Number “10070-40-EF-F51-PR-097”.

## 4.6.4.3 Crossing by Trenchless Techniques

- i Where there is no bridge or culvert on water body and/or open cut method is not feasible due to continuous presence of water that cannot be diverted, crossing of water body can be made by HDD (if crossing length is more than 20m) or by moiling if length is less than to 20m.
- ii The ducts shall be installed inside GI pipe installed by HDD. The size of GI pipe shall be suitable for the number of HDPE ducts to be installed. HDPE ducts can be pre-installed in GI pipe before it is installed.

The ducts shall be terminated inside man-hole/hand-hole located on both sides of crossing. The picture below shows typical installation by HDD.

- iii The installation shall follow requirements as given under Section 4.5 of this document except that depth of ducts within water crossing (bank to bank shall be min 3.0 m). Entry and exit pits shall be at least 10 m away from banks.



## 5 MAN-HOLE AND HAND-HOLE INSTALLATION

### 5.1 Spacing Between Man-holes/Hand-holes

- i Man-holes/hand-holes shall be provided to facilitate optical fibre cable blowing, jointing and storing loops of fibre cable for future use during maintenance activities. There is no difference in construction of man-hole and hand-holes. They are named so to distinguish the functions they perform. Man-hole is used for jointing of fibre and joint closures will be installed inside the man-hole chamber. The hand-hole shall be used for only storing extra optical fibre cable loops.
- ii In case of inter-city routes, man-holes shall be installed along the route at a spacing not exceeding 4km. In between two man-holes, hand-holes shall be installed. The spacing between two adjacent man-hole/hand-hole and hand-holes/man-hole shall not exceed 1km.
- iii For intra-city routes (Including inter-city routes in common with intra-city routes) man-hole/hand-hole spacing shall be as per guidelines issued with document 'Design Basis for MH/HH Selection'.
- iv In case of Hilly areas Manhole / Handhole spacing for Intercity routes may be less than 1Km due to presence of sharp/hair pin bends. Also in some cases it may not be feasible to install MH/HH to desired depth due to limited space/other utilities. In such cases, depth of MH/HH can be reduced to minimum 600mm, however, the dimensions of MH/HH shall be 800 mm (breadth) x1200 mm (length) for core network and 600 mm (breadth) x1200 mm (length) for CSS and Inter-city network. Design of Man-hole/Hand-holes refer NPE released document no. R4G-20-IFN-GEN-PR-002.
- i Design of man-holes and hand-holes shall be as per as per guidelines issued with document 'Design Basis for MH/HH Selection'. Typical drawing for Inter-city is referred under Section 2 of this specification. MH on intra-city section of inter-city routes (i.e. NLD City Network Type) shall be rectangular or square as per

intra-city specifications. Depth of MH shall be 1200mm for cities where primary installation method is specified as HDD and 1650mm where primary mode of installation is specified as open trenching.

- ii Man-hole / hand-hole covers for intra-city routes shall be suitable for grade MD-10 or HD-20 or EHD 35 as defined in IS 12592 depending on their location. MH body and cover ring shall be suitable for corresponding loading. These MH shall be supplied as free issue by Company. Drawings for installation are attached in the tender document. Type and grade of manhole to be used shall be as per guidelines. Generally covers of MH on footpaths / non carriage way areas shall be suitable for grade MD-10, one on road carriage way shall be suitable for grade HD-20 and those installed on carriage way of roads having high frequency heavy traffic shall be suitable for grade EHD-35.
- iii Man-holes and hand-holes shall be of adequate size to accommodate number of joint closures and associated loops for each OFC. Minimum MH size for various paths shall be as per Design Basis for Manhole / Handhole (Doc No. 10070-40-PBD-PR-EF-002).

MH supplied as free issue can be of RCC (one piece/multi-piece design) or Steel frame with FRP covering and concrete covers or any other suitable material.



- iv Use of Cast-in-situ concrete MH/ hollow block MH made at site shall be minimized unless pre-cast/pre-fabricated MH cannot be used due to presence of utilities or other space constraints. In case of cast/made at site MH cannot be avoided, all materials except MH collar ring for cover and MH cover shall be in contractor's scope of supply. Company will supply only collar ring for cover and MH cover of suitable grade.

## 5.2 Installation of Man-holes/Hand-holes

- i In general and specifically for inter-city routes, the man-holes/hand-holes shall be installed such that the lid would be buried below the natural ground surface as per Drawing issued. In case if Intracity Manholes are used for intercity routes then the installation shall be as per drawing no. 10070-40-EF-F51-PR-101.
- ii In intra-city where adequate depth of burial is not available, the man-hole lid shall be installed flush with ground surface. In no case the lid shall protrude above surrounding surface.
- iii Manholes at the crossings shall not encroach into the easement / RoW of the existing utility/facility.
- iv The man-holes/hand-holes shall be installed over well compacted ground and over a layer of concrete base as shown in drawing to avoid their tilting under their own weight and external loading.
- v The entry of the duct into man-hole/hand-hole shall be smooth and at its floor level. Sharp bends to force the entry shall be avoided. Ducts shall enter the man-hole/hand-hole in a single layer and in the sequence mentioned in document no. 10070-40-PDB-PR-EF-001 'Functional Specifications for OFC Laying works'. Always, sequence of ducts on both entry and exit side shall be same.
- vi All openings after installation of ducts shall be closed with cement grout or equivalent method to prevent entry of rodents, snakes, insects etc.

## 6 ROUTE MARKERS

Entire route of the ducts shall be marked using route markers for ease of identification at a later date. Two types of markers are to be provided as described below:

### 6.1 Concrete Route Markers / Route indicators

- i Route markers made of RCC (1:2:4) shall be provided at a distance of every 250 meters or wherever there are crossings or major deviation in the route from being straight. Additionally route markers shall be installed on both sides of the crossing. Route markers shall also be put at duct coupler locations and man-hole / hand-hole locations.
- ii Markers shall be of length 1250 mm with base of 100 mm x 250 mm tapering to 100 mm x 200 mm. Name/logo of Owner shall be engraved on the surface of marker. Aboveground surface of route marker shall be painted in Blue colour. Route Markers placed at coupler locations shall be painted yellow. Markers placed at the man-holes shall be painted red in colour. Owner name/logo shall be filled with fluorescent white. Refer Drawing No.10070-40-C73-PR-EF-002 for details of markers and colour scheme and thickness of painting.
- iii Markers shall be installed in a manner that 500 mm length is below ground and 750 mm is exposed. Fixing of the route markers shall be done at 0.5 M from the trench and away from the road centre
- iv Route markers and manhole markers should not be put together. If any normal route marker is falling within 50m of any Man-hole/Hand-hole/ Duct coupler marker then the normal route marker is not required.
- v For intra-city routes, installation of concrete markers may not be feasible at most of the locations. In general when ducts are installed under roads/footpaths or through highly congested areas, concrete markers are not required. Only along sparsely populated areas such as outskirts of cities, concrete markers shall be required to be installed as indicated in above paragraphs.

### 6.2 Electronic Route Markers

When specified in Contract electronic route markers shall be installed as given herein below. These route markers shall be supplied by Company as free issue material.

#### 6.2.1 For Intra-city routes

- i Electronic Route Markers shall be placed inside each man-hole/hand-hole.
- ii Electronic Markers shall be located with electronic locator after tuning at specified frequency.
- iii Location of electronic markers with GPS coordinates shall be recorded and incorporated in "As-built" documentation.

## 6.2.2 Inter-city (NLD) routes

- i Electronic Route Markers shall be placed on top of man-hole/hand-hole cover prior to back filing.
- ii Electronic Markers shall be located with electronic locator after tuning at specified frequency.
- iii Location of electronic markers with GPS coordinates shall be recorded and incorporated in “As-built” documentation.

## 7 TESTING REQUIREMENT

### 7.1 Extent of Witness of Inspection/Testing of Duct Installation

The Contractor shall carry out 100% inspection and testing as specified. The Company reserves the right to witness 100% inspection and testing if deemed necessary .As minimum Company shall perform inspection and testing as indicated in the table below.

Sr No	Inspection/Test	Sampling (%)
1	Depth of trench	10% of length
2	Inspection of crossings	20%
3	Verification of protection measures through test pits	5%
4	AS-built data verification (coordinates, distances, location of existing utilities/infrastructures, etc.)	15%
5	Manhole/Hand-hole verification (including location coordinates)	20%
6	Route markers (Electronic)	15%
7	HDD verification ( HDD pits)	5%
8	Duct integrity tests as per this specification	100%
<b>Note:</b>	If the depth variation is found more than 20% of specified depth as per Construction drawings, the sampling shall be increased to 15% of length	

### 7.2 Trench and Man-hole/Hand-hole Inspection

This inspection shall be by Contractors QA personnel and all inspection data/measurements shall be recorded during trenching and duct laying operations in formats to be devised by the Contractor and agreed by Company. In addition photographic records shall also be made available in digital form. This data shall be submitted as part of as-built documentation.

- i Trench dimensions

- ii Padding of trench with a soft soil layer of 100mm before laying of ducts (especially in rocky areas)
- iii Protective measures provided (DWC/GI Pipe/concrete slabs/PCC etc.)
- iv Duct laying and sequence
- v Duct jointing by couplers
- vi Usage of spacers for multiple duct laying
- vii Embedding the ducts with min. 100mm of fine sieved soil or sand on top of ducts.
- viii Warning tape position as required
- ix Backfilling and adequate compaction in layers
- x All ducts terminated inside MH/HH and ends closed with end caps/end plugs
- xi Openings of ducts and accessories located at the specified locations and positions on the wall of the man-hole/hand-hole.
- xii The surface of the concrete (must be free from cracks and water infiltration) and duct entrance to man-hole/hand-hole (must be leveled and smoothed).inspect proper installation of route markers and electronic markers including their proper functioning.

## 7.3 Inspection of RoW Restoration

Where Authorities or RoW owners require separate inspection before providing NOC for restoration of RoW, such inspection shall be jointly arranged by the Contractor and required NOC secured

## 7.4 Duct Integrity Testing (DIT)

Company reserves the right to witness one or all duct integrity testing as specified herein below. The Contractor shall give sufficient notice of time to allow Company to be present for witnessing DIT. The following Duct Integrity Tests (DIT) shall be performed on the HDPE duct(s) between two manholes and/or hand-holes by the Contractor and test results recorded:

- i A foam cleaning pig shall be blown through the duct to remove water, mud and obstacles.
- ii A gauge pig (shuttle of wood diameter equal to 80% of the duct nominal I.D and length 150mm) shall be blown through the duct to ensure there are no kinks or obstructions.
- iii An air pressure test of at 7-10 barg (But no less than blowing compressors rated pressure) for 30 minute duration. The test pressure shall not decay by more than 0.1 bar / minute (1.45 psi / minute).Compressed air temperature during test shall not exceed 55 deg C
- iv A duct Jointing Inspection Report shall be completed for all duct joints with acceptance / rejection criteria indicated. A log of all duct joints made of the project shall be progressively compiled and included as an "As Built" quality record.
- v Air testing of the HDPE cable ducts will be performed in accordance with procedure to be prepared by Contractor and approved by Company. Testing of the HDPE ducts at crossings may be performed at completion of the crossing, and will be incorporated into longer test sections at a later date

- vi The Contractor shall prepare a Duct Integrity Test Report as per attached format (*refer Appendix A, Format A: Duct Integrity Test Report*) and submit to Company for acceptance. Payment shall be released only after Acceptance Test Report has been duly accepted by Company.
- vii Modifications/rectifications of trench during DIT to be captured and submitted as part of DIT records and also included in as-built drawings and data records.

## 8 DOCUMENTATION

### 8.1 General

- i All documentation prepared by the Contractor shall be in English language.
- ii The Contractor shall prepare work execution plan, environment management plan and installation procedures (including HDD, Moiling, crossings etc.) and submit the same for review/approval of Company.

### 8.2 As-built Documentation

- i The Contractor shall provide all as-built marked up drawings and inspection and test records (including photographic records) in both hard copy as well as electronic form on CD. The format for inspection and test records shall be submitted to the Company for approval a minimum of thirty (30) calendar days prior to starting the job.
- ii As a minimum following details shall be verified and provided in the form of as-built documents:
  - Location (LAT/LONG coordinates) of each man-hole/hand-hole with route distance, segment distance and cumulative distance.
  - Drawing of each man-hole/hand-hole showing the relative position of the HDPE duct entering and exiting from the man-hole/hand-hole.
  - Route plans duly marked with as-built information regarding depth of ducts, sequence (using color code), turning points, special protections provided, if any, location of duct couplers, and location of man-hole/hand-holes, location of intermediate facilities (Inline Amplifiers, ROADM, FOADM/branch-off if any).
  - All inspection reports.
  - All material test reports for the materials procured by the Contractor.
  - Duct Integrity Test Report.
  - Material Appropriation Report for the Free Issue Materials.
  - As-built Information required for updating GIS database. For this the contractor shall collect the data as given below at the time of construction :
  - Offset every 50 m



- Depth every 50 m
- Deviations from designated route where applicable
- 3 point reference for all man-holes / hand-holes their GPS coordinates (LAT/LONG)
- Locations of other facilities (ILA/ROADM/FOADM etc. if any) along the route.
- HDD profile (as recorded by HDD machines guidance system or through separate tracking system such as DigiTrack)
- Route marker locations and coordinates
- Duct coupler locations and coordinates Crossing location, length and duct position w.r.t. facility being crossed.

## APPENDIX A

### Formats for Inspection and Test Reports

Sl. No.	FORMAT	Title
1	A	Joint Duct Inspection Report
2	B	Duct Integrity Test Report