

 RAND WATER		RAND WATER AUTOMATION ASSET MANAGEMENT SPECIFICATION	
TITLE: FIBRE OPTIC CABLE STANDARD SPECIFICATION		DOC NO: SAM AAM 00001 Spec	
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1. PURPOSE

The purpose of this standard specification is to address the installation of Fibre Optic cables and Air Blown Fibre systems, which are installed on Rand Water sites.

2. SCOPE

This standard specification applies to Rand Water GMSAM and GMO divisions, suppliers and contractors.

3. APPLICABILITY

This standard specification applies to the installation of Fibre Optic cables and Air Blown Fibre systems, which are installed on Rand Water sites.

4. REFERENCES

Document Title	Document No.	Location
Automation Asset Management Standard Specification.	SAM AAM 00003 Spec	AAM
Automation Design Procedure	DOA 00001 Pr	DOM
Specification for plant Codification labels	RW Maint 00007 Pr	MC Office
Rand Water WKS Identification System Pocket Guide	RW/01200/L/011	MC Office
Electric and optical fibre cables – Test methods for non – metallic materials	All SANS / IEC 60811 standards	RW Library
Optical Fibres	All SANS/ IEC 60793	RW Library
Installation of Telecommunication cables Part1: Fibre Optic cable in buildings	SANS/IEC 10340-1	RW Library
Installation of telecommunication cables Part2: Outdoor fibre optic cables	SANS/IEC 10340-2	RW Library
Industrial communication networks-Network and system security Part 2-1 Establishing an industrial automation and control system security program	SANS/IEC62443-2-1	RW Library
The application of the National Building Regulations Part G: Excavations	SANS 10400-G	RW Library
Conduit systems for cable management	SANS/IEC 61386-1	RW Library

Document Title	Document No.	Location
Conduit system for Cable management	SANS/IEC 61386-24	RW Library
Degrees of protection provided by enclosures (IP Code)	SANS/IEC 60529	RW Library
Reinforced concrete pressure pipe	SANS 676	RW Library
Concrete non –pressure pipes	SANS 677	RW Library
Test on gasses evolved during combustion of materials from cables	SANS/IEC 60754 (Part 1 and 2)	RW Library
Tests on electric and optical fibre cables under fire conditions	SANS/IEC 60332 (Parts 1-1 to 1-3)	RW Library
Civil Engineering Construction DB: Earthworks (Pipe Trenches)	SABS/SANS 1200 DB	RW Library
The selection, handling and installation of electric power cables of rating not exceeding 33kV – Part 8: Cable laying and installation	SANS 10198-8	RW Library
Quality management systems - Requirements	SANS/ISO 9001	RW Library

5. TERMS, DEFINITIONS AND ABBREVIATIONS

5.1 TERMS

- 5.1.1 **Contractor:** Refers to a person, company or organisation that is appointed by Rand Water to provide goods or services or performs construction work.
- 5.1.2 **Rand Water Representative:** Refers to the person appointed by Rand Water to act as the Design Engineer, Project Execution Engineer, Programme Manager, Project Manager or Station representative for the purposes of the Contract and notified to the Contractor.
- 5.1.3 **OEM:** Means Original Equipment Manufacturer which is a company that has sole intellectual property rights to equipment that is used by Rand Water. The equipment cannot be sourced from any other supplier / manufacturer other than the OEM.

5.2 ABBREVIATIONS

AAM	Automation Asset Manager
ABF	Air Blown Fibre
CST	Corrugated Steel Tape
FO	Fibre Optic
GA	General Arrangement
GMO	General Manager Operations
GMSAM	General Manager Strategic Asset Manager

HDD	Heavy Duty Duct
HDPE	High – Density Polyethylene
IEC	International Electrotechnical Commission
IP	Ingress Protection
KML	Keyhole Mark-up Language
KMZ	Keyhole Mark-up Language Zipped
MM	Multimode
mm	millimetres
OEM	Original Equipment Manufacturer
OTDR	Optical Time Domain Reflectometer
PLC	Programmable Logic Controller
PVC	Polyvinyl Chloride
QCP	Quality Control Program
RFB	Request for Bid
RFI	Request for Information
RFID	Radio Frequency Identification
RFP	Request for Proposal
RFQ	Request for Quotation
SABS	South African Bureau of Standards
SCADA	Supervisory Control and Data Acquisition
SM	Single - mode
WKS	Water Codification System

6. RESPONSIBILITY AND AUTHORITY

7.1 OWNERSHIP

6.1.1 Automation Asset Manager is the custodian of this standard specification.

6.2 INTERESTED / AFFECTED PARTIES

6.2.1 The standard specification shall be made available to all interested / affected parties on request; and

6.2.2 Interested / affected parties shall adhere to the Fibre Optic Standard Specification.

6.1 CONTRACTORS / SUPPLIERS

6.3.1 The contractor or supplier shall ensure that the installations are done in accordance with the External Body standards referenced in the document.

6.3.2 Rand Water shall not issue any copies of the External Body standards referenced in the document to any contractor; it is the responsibility of the contractor to have their own copies.

6.3.3 Interested / affected parties shall only use the latest reversion of the standards referenced in this standard specification.

7. ACTION / PROCEDURE / METHOD

7.1 FIBRE OPTIC CABLE

7.1.1 Fibre Optic Cable Selections

- 7.1.1.1 For distances, greater than 1km use single mode.
- 7.1.1.2 For distances, less than 1km use multimode.
- 7.1.1.3 For all installation within buildings and between equipment Multimode fibre optic cables is preferred unless otherwise stated by the Rand Water Representative.

7.1.2 Single - Mode Optical Fibre Cable Specification

- 7.1.2.1 The cable characteristics are for inter plant and inter station.
- 7.1.2.2 Wavelength: 1550 nm
- 7.1.2.3 Diameter: 9/125 μ m
- 7.1.2.4 Outer colour of the fibre optic cable: Black fibre optic cable must be re-sleeved to yellow.
- 7.1.2.5 Fibre optic cable shall be CST armoured with following characteristics:
 - 7.1.1.5.1 Outer Polyethylene jacket for in/outdoor applications.
 - 7.1.1.5.2 Polyethylene bedding sheath.
 - 7.1.1.5.3 Core binder.
 - 7.1.1.5.4 Aramid strength member.
 - 7.1.1.5.5 Interstitial water blocking material.
 - 7.1.1.5.6 Gel filled loose tubes.
 - 7.1.1.5.7 Cable should be able to be submerged in water for long periods without affecting operations.
 - 7.1.1.5.8 Flame retardant.
- 7.1.2.6 Core count: 12 cores or as approved by the Rand Water Representative.
- 7.1.2.7 Cable losses: Shall be less than 0.25 dB/km tested at 1550 nm.

7.1.3 Multimode Optical Fibre Cable Specification

- 7.1.3.1 The cable characteristics are for inside building and inter-plant distribution.
- 7.1.3.2 Wavelength: 1300nm
- 7.1.3.3 Diameter: 50/125 μ m
- 7.1.3.4 Outer colour of fibre optic cable: Black fibre optic cable must be re-sleeved to orange.
- 7.1.3.5 Fibre optic cable shall be CST armoured.
- 7.1.3.6 Core count: 12 cores or as approved by the Rand Water Representative.
- 7.1.3.7 Cable losses: Loss of cable shall less than 0.7 dB/km tested at 1300 nm.
- 7.1.3.8 The characteristics for CST armoured cable:
 - 7.1.3.8.1 Polyethylene outer sheath.
 - 7.1.3.8.2 Polyethylene bedding sheath.
 - 7.1.3.8.3 Core binder.

- 7.1.3.8.4 Aramid strength member.
- 7.1.3.8.5 Interstitial water blocking material.
- 7.1.3.8.6 Gel filled loose tubes.
- 7.1.3.8.7 GRP centre strength member.
- 7.1.3.8.8 Cable should be able to be submerged in water for long periods.
- 7.1.3.8.9 Flame retardant.

7.2 BLOWN FIBRE OPTIC CABLE SELECTION CRITERIA

- 7.2.1 The blown fibre system shall be capable of transporting at least 12 optical fibres in each tube.
- 7.2.2 All fibre shall be individually colour coded with colours such blue, orange, green, red, yellow, brown, grey and violet.
- 7.2.3 The blown fibre system shall be capable of blowing fibre at least 500 meters in the horizontal plane and 300 meters in the vertical plane.
- 7.2.4 The installed blown fibre shall be capable of copying with at least three hundred (100) 25mm bends within a 300 meter run in any plane.

7.3 BLOWN FIBRE TUBE DISTRIBUTION CLOSURES

- 7.3.1 Tube distribution closures are used when branching out from one duct to another.
- 7.3.2 These enclosures are used to connect fibre and do repairs on fibre ducts.
- 7.3.3 Shall be able to handle tube break outs in "H", "T" and "Y" configurations.
- 7.3.4 Shall be able to branch off 7, 12, 19 and 24-way tube bundles.
- 7.3.5 No jointing shall be required at each branching point.
- 7.3.6 IP rating: IP68.
- 7.3.7 When joining allow for expansion and contraction of the cable.

7.4 BLOWN FIBRE MANUFACTURERS TRAINING

- 7.4.1 The Contractor must have attended a Blown Fibre manufacturer's course, especially in the use of the compressed air device, joining and the testing the fibre optic cable.
- 7.4.2 The contractor must be certified in the use of the blower, cutting of the tube cable and testing the tubing.

7.5 BLOWN FIBRE DUCT SPECIFICATION

- 7.5.1 HDPE duct assemblies shall be used fully filled with PVC between the tubes.
- 7.5.2 Duct assemblies shall have markings showing the tube length.
- 7.5.3 All ducts shall be suitable for use with standard push fit connectors.
- 7.5.4 All fibre ducts shall be dual-extrusion with low friction and anti-static lining and with a low fire hazard, zero halogen sheathing to conforming to the SANS 60332-1 and SANS 60754 standards.
- 7.5.5 Fibre ducts shall have an inside diameter of 3.5 mm and an outside diameter of 5 mm, or an inside diameter of 6 mm and an outside diameter of 8 mm.

- 7.5.6 The 5-mm ducts shall be used for cable runs up to 500 meters and the 8-mm for cable runs up to 1000 meters.
- 7.5.7 There shall be a minimum of six tubes per duct and this shall not include the strength member.
- 7.5.8 The ducts shall be suitable for use with the current fibre infrastructure.
- 7.5.9 Maximum bending radius shall be 12 times the tube outer diameters.
- 7.5.10 The duct shall be installed in a conduit, see Section 7.9.1 for Conduit specification.
- 7.5.11 The blown fibre system shall be supported by the manufacturer's warranty.

7.6 BLOWN FIBRE INSTALLATION REQUIREMENTS

- 7.6.1 Fibre optic strands shall be guided and fed into the micro duct using compressed air.
- 7.6.2 A network of tube-cables shall be installed first between relevant locations, and thereafter the fibre shall be blown into the tubes as required.
- 7.6.3 There shall be a maximum of two ninety-degree bends allowed where a conduit is used.
- 7.6.4 The minimum bend radius of any cable conduit shall be 750 mm.
- 7.6.5 The exposed ends of the multi ducts pulled into cable conduit shall be totally covered with a heat shrink cap or other waterproof method.
- 7.6.6 Ducts must not be contaminated by water or dirt.

7.7 UNDERGROUND CABLE INSTALLATION IN DUCTS BY BLOWING

- 7.7.1 The distance a cable can be blown will depend on many factors and all will need to be taken into account when deciding what method is the best for the particular route, the factors influencing the blow distance are as follows:
 - 7.7.2 The cable weight (the heavier the cable the shorter the distance).
 - 7.7.3 The duct area ratio (the larger this is the shorter the distance).
 - 7.7.4 The straightness of the route (the more bends and inclines the shorter the distance).
 - 7.7.5 The compressor size and air condition (too small a compressor the shorter the distance, the wetter the air the shorter the distance, the drier the air the shorter the distance);
 - 7.7.6 The duct material (friction).
 - 7.7.7 The cable construction (the more flexible the cable the shorter the distance).

7.8 BLOWN FIBRE TERMINATION REQUIREMENTS

- 7.8.1 Special connectors shall be required everywhere the tube-cable branches to another location and at the end of every length of tube-cable.
- 7.8.2 Special push/pull connectors shall be required to connect the ducts in one tube-cable to the ducts in another tube-cable.
- 7.8.3 Multimode connectors can be directly terminated on-site and those for Single-mode shall be factory-made pigtails.
- 7.8.4 The insertion loss across any two joined connectors shall not exceed 0.75dB irrespective wavelength used.

- 7.8.5 The fibre termination equipment shall be a 19-inch rack mounted and supplied by the ABF manufacturer or approved by them.
- 7.8.6 Any termination other than the one specified shall be have to be approved by the Rand Water Representative.

7.9 SLEEVING, CONDUITS AND MANHOLES

7.9.1 Sleeving / Conduits

- 7.9.1.1 All sleeves shall be joined by appropriate push fit couplings with rubber seals connectors.
- 7.9.1.2 Couplings shall be sand and water tight.
- 7.9.1.3 Sleeves or Conduits shall be 110mm HDPE double walled corrugated type conduits which are oil, petrol and water resistant.
- 7.9.1.4 The bore shall be smooth.
- 7.9.1.5 All conduits shall be SABS approved and in line with SANS/IEC 61386-24:2005.
- 7.9.1.6 Conduits shall not have a bending radius of less than 250mm.
- 7.9.1.7 The conduits must be laid in the trench at a depth of 600mm.
- 7.9.1.8 For a single conduit, the width of the trench shall not be narrower than the diameter of the conduit plus 200mm to allow for adequate working space and the initial compaction around the conduit.
- 7.9.1.9 The weather needs to be taken into consideration when laying conduits.
- 7.9.1.10 On very hot days and for long conduit runs the conduit shall be laid into the shadow at the bottom of the trench and allowed to cool and contract before backfilling is done.
- 7.9.1.11 Cable conduits shall be laid as straight as possible between manholes.
- 7.9.1.12 The conduits are very flexible and should be anchored with a heap of soil at one end of the trench, pulled in a straight line, and then backfilled.
- 7.9.1.13 Where multiple conduits are installed in the same trench each conduit shall have a minimum spacing horizontally and vertically of 30mm from each other, or one third of the outside diameter, whichever is greater.
- 7.9.1.14 All conduits / sleeves shall be inspected by the Rand Water Representative before the trenches are closed.

7.9.2 Manholes

- 7.9.2.1 Inspection manholes shall be installed at intervals of every 200m on straight runs and at every bend, kink or split in the fibre cable sleeve or conduit route.
- 7.9.2.2 Manholes shall be installed on both sides of road crossings.
- 7.9.2.3 Manholes shall be round.
- 7.9.2.4 Manholes should have, either a 6mm galvanised metal cover or PVC cover filled with concrete and painted Cornflower blue.
- 7.9.2.5 Manhole cover shall have a locking mechanism.
- 7.9.2.6 The manholes shall be made of calcamite.
- 7.9.2.7 Manholes shall be waterproof.

- 7.9.2.8 The depth of the lid/cover shall be relative to ground level or unless otherwise specified by the Rand Water Representative.
- 7.9.2.9 The size of the manholes must be 1 meter in diameter.
- 7.9.2.10 The Rand Water Representative shall inspect that the manholes are free of damage, chips or cracks before installation.

7.10 INSTALLATION OF BURIED FIBRE OPTIC CABLES IN TRENCHES

7.10.1 Preparatory Work

- 7.10.1.1 The Rand Water Representative shall inspect and approved each stage of the trench development before the contractor shall proceed to the next stage.
- 7.10.1.2 The Contractor shall do service detection prior to trenching.
- 7.10.1.3 Excavation shall be done in accordance with SANS 10400-G:2011.
- 7.10.1.4 It is the responsibility of the contractor to ensure that the excavation is safe.
- 7.10.1.5 The contractor shall adequately protect the excavation by a barrier or fence at a height of at least 1 m and as close to the excavation.
- 7.10.1.6 The contractor shall ensure that all surfaces, unless otherwise specified, disturbed in the execution of the work performed are left as near to the original condition as possible.
- 7.10.1.7 The contractor must source all existing station fibre optic drawings.
- 7.10.1.8 The Rand Water Representative must approve the proposed route for the fibre optic installation before any trench work in commenced.
- 7.10.1.9 The trench details and the cable route layout shall be clearly marked up on a drawing and submitted for approval to the Rand Water Representative prior to commencement of construction.
- 7.10.1.10 The contractor shall also identify all proposed locations of closures (manholes, etc.) and establish their accessibility and availability in accordance with the installation program.
- 7.10.1.11 The contractor shall determine the proposed locations at which drums (or reels) are to be positioned for the installation program and establish the accessibility and availability at those locations.

7.10.2 Trench Excavation

- 7.10.2.1 Trenches shall be dug by hand (pick and shovel) or by mechanical means (backacter, trenching machine).
- 7.10.2.2 Trenches should be visually inspected for rocks or debris that could potentially damage the cable.
- 7.10.2.3 The contractor shall ensure that all trenches are properly barricaded.
- 7.10.2.4 Trenching in the vicinity of power cables, mechanical means shall not be used within 3 m of any existing service.

7.10.3 Trench

- 7.10.3.1 Trench Excavation and backfilling shall be done in terms of SABS 1200 DB.
- 7.10.3.2 Installation depths (to the floor of the trench) should be 1 to 1.2 meters.
- 7.10.3.3 The bottom of the cable trench shall offer a firm base such as compacted soil and shall be free of stones; if stones are present, an approximately 150mm high layer of sand or finely sieved granular soil shall be added and soil shall be compacted by using a compaction machine.
- 7.10.3.4 150mm to 250mm stone free sand shall be placed above the cable conduit and only hand compaction tools shall be used to compact the soil above the cable.
- 7.10.3.5 Bedding soil may be obtained by sifting the excavated material (if suitable).
- 7.10.3.6 The trench shall be filled by another 300mm of sand and machine compaction shall be used.
- 7.10.3.7 No Clay type material shall be allowed as bedding or backfill.
- 7.10.3.8 The contractor shall place a danger tape 300mm below the ground level or road surface to warn future workers in the area that an optical fibre cable lies below.
- 7.10.3.9 The danger tape shall be made of PVC or PE material.
- 7.10.3.10 Topsoil shall be used for the top 150mm of the trench.
- 7.10.3.11 For entry and exit into a building the same manhole and trench leading to the building shall be used but under no circumstances shall the main link or redundant/ backup fibre optic cable be allowed to run in the same conduit or the same trench as the main link or main fibre optic cable.

7.10.4 Trenches Running Under Roadways

- 7.10.4.1 At the crossings of roadways or installations longitudinal under roads, cables shall be placed in conduits.
- 7.10.4.2 When crossing roadways, the contractor shall use horizontal directional drilling, or unless otherwise stated by the Rand Water Representative.
- 7.10.4.3 When cables run parallel to a road, the conduits between trenches should cross the roadway at an angle of about 45°.
- 7.10.4.4 Trenches shall try to follow a path as close to the road as possible; the contractor shall avoid cutting across big areas of open land.
- 7.10.4.5 Replace tar with like for like.

7.11 UNDERFLOOR INSTALLATION OF CABLES

- 7.11.1 Cables installed in an under floor system (raised, cable basements or computer flooring) shall be installed in an open or closed cable trays.
- 7.11.2 Fibre optic cables shall not run in conduits or tubes.
- 7.11.3 Cable routes shall follow a path parallel to the buildings walls.
- 7.11.4 Fibre optic cables shall not be installed in the same cable trays as the electrical cables.
- 7.11.5 If fibre optic cable is installed in the same tray as copper ones, always place the copper cables below.

7.12 CORE DRILLING OR CUT OUTS

- 7.12.1 The contractor shall do all core drilling where the fibre optic cable shall enter the building or between floors.
- 7.12.2 All core drilling shall be approved by the Rand Water Representative before commencement of work.
- 7.12.3 All box cut outs for new buildings for fibre optic cables shall be marked up on the drawings and given to the Rand Water Representative.

7.13 OPTICAL FIBRE SPLICES

- 7.13.1 All splices shall be done using fusion splicing (i.e. the process of using localised heat to fuse the ends of two optical fibres together).
- 7.13.2 All splices with a loss of more than 0.1 dB shall be rejected by the Rand Water Representative.
- 7.13.3 Optical Fibre splices shall not exceed a maximum optical attenuation of 0.3 dB
- 7.13.4 Optical Fibre splices shall have a minimum return loss of 20 dB for Multimode and 26dB for Single-mode.
- 7.13.5 All cores of the fibre optic cable shall be spliced, including the spare cores.
- 7.13.6 All Optical fibres shall be spliced colour to colour.
- 7.13.7 All slack cable shall be coiled neatly into the manhole in a slack box.
- 7.13.8 Care shall be taken that the manufacturer's minimum bending radius is adhered to and that no torsion is imparted to the cable.

7.14 INSTALLATION CONSIDERATIONS

- 7.14.1 10 to 15 meters' slack shall be allowed for at each terminating point on the Fibre Optic Cable.
- 7.14.2 Where Fibre Optic cables run up the walls cable trays or galvanized Trunking (Unistrut P1000) shall be used, Rand Water Representative to approve.
- 7.14.3 The contractor shall ensure that the Fibre Optic Cable has a bend of less than 90°.
- 7.14.4 The cable should not be pulled over a bend radius smaller than twenty (20) times the cable diameter.
- 7.14.5 After completion of the pull, the cable should not have any bend radius smaller than ten (10) times the cable diameter.
- 7.14.6 The contractor shall ensure that cable ties or cable straps used are not over tightened thereby causing localized bending and fibre stress.
- 7.14.7 Every cable shall have a WKS number at each end.
- 7.14.8 For WKS numbering refer to the **Rand Water WKS Identification System Pocket Guide RW/01200/L/011** and **Specification for plant codification labels RW Maint 00007 Pr.**
- 7.14.9 Every manhole and panel shall also have a WKS number.
- 7.14.10 Label cables and cores, Grafoplast or General Markings must be used for labeling.
- 7.14.11 Clean all connectors after removing protective caps before connecting to equipment or other cables.
- 7.14.12 All the spare cores shall have their protective caps intact.

- 7.14.13 The clearance between electrical (power) cables and fibre optic cables in conduits should be at least 600mm in terms of SANS 10198-8.
- 7.14.14 All installations to strictly conform to the Quality requirements as documented in the SANS/ISO 9001 standard and to general safety requirements.

7.15 OTDR TESTING

7.15.1 OTDR Testing Before Installation

- 7.15.1.1 The contractor shall do an OTDR test on the fibre optic cable to ensure that the cable is fault free before installation.

7.15.2 OTDR Testing after Installation

- 7.15.2.1 OTDR tests shall be performed on all cores from both ends of the cable and be submitted to the Rand Water Representative for approval.
- 7.15.2.2 The contractor shall ensure that the OTDR is within the calibration period as recommended by manufacturer.
- 7.15.2.3 The contractor shall provide the Rand Water Representative with a copy of the OTDR's calibration certificate.
- 7.15.2.4 The Test result information for each link shall be recorded in the memory of the OTDR upon completion of the test
- 7.15.2.5 A paper copy of the test results shall be provided to the Engineer that lists all the links that have been tested with the following information:
- 7.15.2.6 The identification of the link should be in accordance with Rand Water's naming convention.
- 7.15.2.7 The overall Pass/Fail evaluation of the link-under-test including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value).
- 7.15.2.8 The date and time of when the test results were saved in the memory of the equipment.
- 7.15.2.9 OTDR traces shall provide for the complete length of fibre (patch panel enclosure to patch panel enclosure), indicating the distance to joints and the total length of the fibre as well as the loss at each joint.
- 7.15.2.10 Bidirectional measurements under the same test conditions are required to eliminate the effects of back-scatter coefficient differences.

7.16 ADDITIONAL ACCESSORIES

- 7.16.1 For each core that is spliced, the contractor shall supply all connectors, accessories and ancillaries required to ensure the correct operation of the equipment.
- 7.16.2 This shall include but not limited to all mid couplers, pigtailed and patch leads.
- 7.16.3 Patch leads for Multimode shall be orange.
- 7.16.4 Patch leads for Single-mode shall be yellow.
- 7.16.5 Ruggedised patch leads with UV protection for Indoor or outdoor use (Rand Water Representative to specify).

- 7.16.6 The use of splice boxes and splice trays is recommended; the Rand Water Representative shall confirm.
- 7.16.7 Splice boxes shall be IP68.
- 7.16.8 The Rand Water Representative shall approve the 9U Cabinets design.

7.17 FIBRE OPTICAL CABLE MARKERS

- 7.17.1 Concrete cable markers shall be used.
- 7.17.2 Three aluminum plates to be mounted on concrete marker:
 - 7.17.2.1 One on the top of marker
 - 7.17.2.2 One on the side.
 - 7.17.2.3 One on the side or face.
- 7.17.3 Each cable marker shall have its own marker ID in a three-digit reference number.
- 7.17.4 The letters FO should be moulded on the side of the cable marker with the marker ID.
- 7.17.5 Cable marker size: 900mm high, 250 x 150mm
- 7.17.6 Cable marker painted with yellow road marking paint.
- 7.17.7 Specification: road marking paint, SABS 731, Ref TP41.
- 7.17.8 Cable markers installed for every 50 meters and at each cable bend or turn.
- 7.17.9 Cable direction must be indicated with an arrow on the top aluminum plate.
- 7.17.10 Cable numbers must be engraved on the side aluminum plate.
- 7.17.11 The following information shall be displayed on the cable markers:
 - 7.17.11.1 Cable tag
 - 7.17.11.2 Cable length
 - 7.17.11.3 Distance from source
 - 7.17.11.4 Destination
 - 7.17.11.5 GPS coordinates

7.18 DELIVERY AND OFF - LOADING OF FIBRE OPTIC CABLES TO SITE

- 7.18.1 The contractor is responsible for the delivery, off-loading and safe keeping of the fibre optic cable and the conduits stored on Rand Water premises.
- 7.18.2 The contractor shall ensure that no mechanical damage (kinking, unraveling or twisting) occurs to the fibre optic cables during off-loading from vehicles.
- 7.18.3 The contractor shall ensure that storage conditions are suitable (according to supplier and manufactures storage recommendations) for the fibre optic cable and conduits, taking into account mechanical and environmental considerations.
- 7.18.4 Suitable protective caps should be fitted to the exposed ends of the fibre optical cable.
- 7.18.5 End caps should be handled carefully to avoid damage during installation and if end caps are damaged it should be repaired or replaced.

7.19 DOCUMENTATION

7.19.1 Documentation before Installation

The contractor shall provide the following designs and documentation to the Rand Water Representative prior to the procurement or construction:

- 7.19.1.1 Fibre optic route layout.
- 7.19.1.2 Trench details.
- 7.19.1.3 Manhole GA
- 7.19.1.4 Cable route marker GA.
- 7.19.1.5 Cable route marker location drawing.
- 7.19.1.6 Cable schedule showing the type of cable and cable lengths.
- 7.19.1.7 The cable schedule must also show the following:
 - 7.19.1.7.1 Cable length source of the core.
 - 7.19.1.7.2 Destination of the core.
 - 7.19.1.7.3 Depth of the fibre optic cable.
 - 7.19.1.7.4 Wavelength of transmission.
- 7.19.1.8 Signed QCP indicating the hold points for Fibre Optic cable installation.

7.19.2 Documentation after Installation

- 7.19.2.1 Fibre Optic cable route layout in DWG (AutoCAD) format.
- 7.19.2.2 Google KMZ or KML file with detailed information on location of all manholes, cables, etc.
- 7.19.2.3 ODTR traces and results
- 7.19.2.4 Cable schedule indicating the type of cable and cable length.
- 7.19.2.5 Hold points must be signed off by the contractor and the Rand Water Representative.
- 7.19.2.6 Transmitter and receiver power for each transceiver and attenuator values if used and joints if any.

8. RECORD AND DATA KEEPING

Record Document	Form/Doc Number	Location	Retention Period
Project File	As per project	Document Management Office	5 years

9. DOCUMENT CHANGE HISTORY

The following table contains the history of this document with a description of each revision.

Date	Previous Revision Number	New Revision Number	Description of Each Revision
June 2018	None	01	Combined RW AAM 07003 and RW AAM 07001 into one standard specification
March 2019	01	02	Document number changed and Definitions changed.