



**NET4GAS, s.r.o**

Annex 1,  
Attachment 1.25

# **COMPRESSOR STATION JIRKOV 73 BAR**

## **Fibre Optic Cable - Specification**

**31.07.2017**

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## 1 GENERAL

### 1.1 Scope of the Document

This specification defines the general requirements for the engineering, supply, installation as well as commissioning of fibre optical cables and related equipment and services to be used in the project.

This includes all devices, documentation, required material and work for the complete functional fibre optics cables including the interfaces and integration work in the existing NET4GAS FOC infrastructure.

The objective of this document is to specify the fiber optic cables, related FO material and installation work to connect the new compressor station Jirkov to existing NET4GAS FOC infrastructure and also specify the internal FOC connections inside the new compressor station.

Final selection, installation and commissioning of the telecommunication systems and associated equipment shall be provided by Contractor in order to guarantee safe and reliable operation and functionality of the system in his scope of supply. Any improvement or deviation to the general requirements of this specification shall be explicitly stated by Contractor in written form for approval by Employer.

The Owner assumes that the Contractor has comprehensive experience in Fiber Optic Cable installation. It is the responsibility of the Contractor to ensure that they obtain, review and fully understand all implications on the scope of work resulting from this specification.

### 1.2 Definitions

Term	Explanation
Project	Compressor Station Jirkov 73 bar
Employer	NET4GAS
Consultant	ILF Consulting Engineers
Contractor	Company awarded to provided engineering, procurement, construction and commissioning of the scope of work
Operator	Person operating the plant local in the station
Dispatcher	Person operating the plant from the dispatching centre in Prague

The word **shall** is a verbal form used to indicate requirements strictly to be followed in order to conform to this specification and from which no deviation is permitted, unless accepted by all involved parties.

The word **should** is a verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required.

The word **may** is a verbal form used to indicate a course of action permissible within the limits of this specification.

The word **can** is a verbal form used for statements of possibility and capability.

The word **must** is a verbal form used to signify a legal or statutory requirement.

### 1.3 Abbreviations

Term	Explanation
ANSI	American National Standards Institute
CD	Chromatic Dispersion
CYY	Metallic cable for HDPE/FOC tracing
ČSN	Czech National Standard
ETSI	European Telecommunications Standards Institute
FAT	Factory Acceptance Test
FO	Fibre optic
FOC	Fibre optic cable
HDPE	High Density Polyethylene
ITU	International Telecommunication Union
LAN	Local Area Network
LDPE	Low Density Polyethylene
NET4GAS	NET4GAS, s.r.o.
ODF	Optical Distribution Frame
OLTS	Optical Loss Test Set

OTDR	Optical Time Domain Reflectometer
PMD	Polarization Mode Dispersion
SAT	Site Acceptance Test
WAN	Wide Area Network

#### 1.4 Referenced documents

No.	Number	Title
1	C4G-JI73-ILF-GENER-TEL-SPC-800	Telecommunication System - Specification
2	C4G-JI73-ILF-KS007-TEL-DIA-100	Telecommunication System - Block Diagram
3	C4G-JI73-ILF-KS007-MAR-DIA-100	Control System Architecture - Overall Block Diagram
4	C4G-JI73-ILF-GENER-MAR-SPC-800	Station Control and ESD System - Specification
5	C4G-JI73-ILF-GENER-ELE-SPC-806	Cable and Cable Laying Specification
6	C4G-JI73-ILF-GENER-ELE-SPC-807	Earthing and Lightning Protection - Specification
7	C4G-JI73-ILF-KS007-ELE-VYK-400	Administration and Control Building - Electrical Installation Drawing
8	C4G-JI73-ILF-KS007-ELE-VYK-410	Electrical Building - Electrical Installation Drawing
9	C4G-JI73-ILF-KS007-ELE-VYK-500	Cable Route Cross Sections
10	C4G-JI73-ILF-GENER-PMA-MAN-902	Tagging and Numbering Philosophy
11	C4G-JI73-ILF-KS007-GEN-SEZ-840	List of Relevant Regulations, Standards and Specifications

#### 1.4.1 General N4G References

Following company standards are relevant for design and implementation of a Telecommunication System

No.	Number	Title
1	TP_D02_00_01_01	Technical requirements on construction, repairs, and renewal of NET4GAS' cable routes
2	MP_I04_04_01_01	Technical Protections system of Net4Gas Facilities

### 1.5 Codes and Standards

All equipment must be designed, manufactured and installed according to the relevant regulations and standards as defined in the document "List of relevant Regulation, Standards and Specifications" C4G-JI73-ILF-KS007-GEN-SEZ-840-000.

Wherever codes, standards and recommendations are mentioned, the latest published revision or issue is applicable.

Standard	Title
ITU-T G.652	Characteristics of a single-mode optical fibre and cable
ITU-T G.656	Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport
ITU-T G.657	Characteristics of a bending-loss insensitive single-mode optical fibre and cable
ITU-T G.650	Definition and test methods for the relevant parameters of single-mode fibres
ITU-T L.10	Optical fibre cables for duct and tunnel application
ANSI/TIA-PN-598-D	Optical Fibre Cable Colour Coding
ETSI EN 300 019-1-3	Classification of environmental conditions, Stationary use at weather protected locations
ČSN 73 6005	Spatial layout of technical equipment networks



Additional codes and standards according to NET4GAS documentation listed in the 1.4.1 "General N4G References" shall be considered.

## 1.6 Environmental Conditions

The systems and devices for the CS must be designed, manufactured and installed according to the relevant climatic conditions as defined in the document Geographical Climatic and Environmental Conditions C4G-JI73-ILF-KS007-GEN-MAN-901.

All equipment for the fiber optic cable systems shall be designed and constructed for continuous operation at full load under the given climatic and environmental conditions.

The environmental conditions will be classified as follows:

### 1.6.1 Outdoor Conditions

Design temperature	max.	+35°C
	min.	-25°C

Relative humidity	100 %
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All equipment and materials provided for outdoor installation shall be resistant against the prevailing climatic conditions and sun radiation. In general all outdoor equipment should be equipped with sun and rain protection cover or shed.

### 1.6.2 Indoor Conditions

According to TP\_D02\_00\_01\_01 indoor conditions according Class 3.1 defined by ETSI EN 300 019-1-3 shall be provided.

## 1.7 Language

All correspondence, drawings, instructions, data sheets, design calculations and any other written information shall be in English. Operating & Maintenance Manual, documents for Authorities and commission of experts shall be in English and Czech language.

## 1.8 Lifetime

According to TP\_D02\_00\_01\_01 HDPE ducts for FOC shall have a lifetime of not less than 50 years and FOC not less than 30 years considering the environmental, climatic and further operating conditions at their individual installation site.

## 2 FIBER OPTIC CABLES

### 2.1 Scope of work

The projected new compressor station Jirkov shall be connected to existing FOC network installed along the Gazelle pipeline (WAN connection):

FOC network Gazelle shall be extended into the administrative and control building in the CS with FO cables terminated in both directions to existing Gazelle stations BS Jirkov (TU33) and BS Hrusovany (LVS2).

Using existing cable reserves of the Gazelle FOC is not sufficient to extend the FOC connection to the new compressor station without the installation of new FO cables.

The followings work shall be performed by the Contractor to connect the CS to existing NET4GAS FOC infrastructure:

The existing FO cable in the area between the existing BS Jirkov (TU 33) and new CS shall be removed from the existing HDPE ducts of the existing Gazelle FOC installations by blowing out of the FO cable.

From a suitable location of the existing Gazelle FOC installations (connection point to new CS) four (4) new HDPE ducts shall be laid to the new CS Jirkov and the previously blown out FO cable shall be installed in one of these HDPE ducts by blowing in of the FO cable. This FO cable shall be redirected to the new ODF in the administration and control building/ equipment room (new end point of the existing FOC). All fibres of the redirected FOC shall be terminated in a new ODF's front panel. Existing and new HDPE duct shall be connected by screwing HDPE couplers.

At the connection point to new CS additional four (4) new HDPE ducts shall be installed to end point of the FOC in the CS (administration and control building, equipment room, new ODF) and connected to existing HDPE ducts in direction BS Jirkov (TU 33) by screwing HDPE couplers.

A new FO cable between BS Jirkov (TU 33) and CS Jirkov shall be blown into the white coloured HDPE duct of this section and terminated in new ODF's front panels at each side.

All fibres of the new FOC shall be terminated in new ODF's front panel using pigtails.

All fibres of the new and modified FOC shall be commissioned, tested and release according to test requirements in chapter **Error! Reference source not found.** below of his document.

The installation, modification and commissioning of the HDPE ducts and FO cables (existing and new) shall be done in such a way that the time with decreased protection capabilities of the existing N4GAS WAN installations is as minimum as possible.

Inside the compressor station additional FOCs shall be installed for local connections (LAN connections) and separate FOCs for the CCTV cameras of the security system:

A 24-fiber FOC shall be installed between administration and control building and electrical building. This FOC shall be used for control system data, office network, security cameras and security systems inside the Electrical Building.

To connect the CCTV cameras along the fence with the security cabinets in the equipment room of the administration and control building, a FOC ring with outdoor ODF boxes located on each CCTV camera's pole shall be installed. In the outdoor ODF's FOC shall not be cut completely but shall be installed continuously as much as possible. In each ODF only a pair of fibres dedicated to the CCTV camera shall be cut and terminated in ODF's connector panel in both directions.

Installation of all FOC shall be performed according to the chapters D.8.8 and D.8.9 of TP\_D02\_00\_01\_01 Employer internal specification.

Alternative methods of installing FOC into HDPE (as e.g. cable pulling) shall only be performed by Contractor with explicit written approval by Employer according to TP\_D02\_00\_01\_01, chapter D.8.8.

All FOC must be fully dielectric and suitable for blowing into HDPE conduits, filled with compound to prevent axial and longitudinal ingress of water and/or soluble chemicals throughout the cable.

Qualitative parameters of all installed FOC shall meet Employer internal specification TP\_D02\_00\_01\_01 (chapter D.2.15 Optical cables (FOC) – single mode (SM)).

## **2.2 FOC for WAN connection**

Fiber optic cables for the WAN connections shall be provided with 48 fiber loose tube construction – 4 tubes (buffers) with 12 fibers in each tube. The fibres of the first tube containing 12 fibers shall be according to ITU-T G.656 and chapter D.2.15.3 of TP\_D02\_00\_01\_01.

The fibers of the other three tubes shall meet the requirements of ITU-T G.652.D and chapter D.2.15.2 of TP\_D02\_00\_01\_01.

Colour coding for the FOC and all fibres shall be according ANSI/TIA-PN-598-D.

It is strongly recommended to use same type of FOC as used in the Gazelle FOC network – actually OFS AT-X4A12TT-048-012/036-3N.

FOC shall be marked on the outer jacket:

The markings shall be permanent, abrasion-resistant and insoluble in water and be legible for the duration of cable life. FOC shall be marked every 1m with the following information:

- Cable description: Optický kabel
- Cable owner: NET4GAS, s.r.o.
- Cable Manufacturer & type
- Date of production
- Mileage in meters

### 2.3 FOC for LAN and CCTV cameras

Fiber Optic Cables for LAN connections and for security CCTV cameras shall be according to ITU-T G.652.D & chapter D.2.15.2 of TP\_D02\_00\_01\_01 and shall be macro and micro bending resistive according to ITU-T G.657.A. Color coding shall meet ANSI/TIA-PN-598-D and loose tube construction shall be applied for the FOC.

For LAN connection is recommended to use 24-fiber cables organized to 2 tubes (buffers) with 12 fibers in each tube. For security cameras connection it is recommended to use FOC with number of fibers corresponding to number of security cameras multiplied by two and at least 12 fibers more (future reserve). FOC shall be marked on the outer jacket. The markings shall be permanent, abrasion-resistant and insoluble in water and be legible for the duration of cable life. FOC shall be marked every 1m with the following information:

- Cable Manufacturer & type
- Date of production
- Mileage in meters

## 3 OPTICAL DISTRIBUTION FRAME, TELCO RACK

Rack-mounted Optical Distribution Frame (ODF) for termination of each fibre in transmit and receive direction shall be provided for access to the transmission equipment or interfacing with other systems. The ODF for receive and transmit direction shall be dimensioned in accordance to the specified number of fibres.

In according to chapter D.2.17 of TP\_D02\_00\_01\_01 a RACK-mounted ODFs with front panel connectors shall be used. For WAN FOC is strongly recommended to use OFS (former Lucent Technologies) LSC1U-072/12.

ODF's shall be installed in according to chapter D.8.9 of TP\_D02\_00\_01\_01.

ODFs in the administrative building in the CS shall be installed in the new TELCO RACK. A 19" RACK with 600mm width, 800mm depth, a height of 42 units with perforated door and roof shall be installed in according to chapter D.3.3 of TP\_D02\_00\_01\_01.

Fibre optic distribution panels shall be equipped to secure optical fibre patch cables and pigtails to prevent damage during all operation and maintenance functions.

the ODF panels shall be equipped with splice trays for storage and protection of fusion splice connections of single-mode fibre optic cable and pigtails.

## **4 PIGTAILS, OPTICAL PATCH CORDS AND COUPLERS**

The patch cord consists of a single mode fibre optic cable with plug connections on both ends. Pigtails are fibre cables pre-assembled with a connector at one end. The optical plug connection consists of a plug and an adapter for the connection with a further plug.

Pigtails, optical patch cord connectors and couplers shall fulfill the requirements of TP\_D02\_00\_01\_01 Employer internal standard.

In accordance to chapter D.2.18 of TP\_D02\_00\_01\_01 pigtails shall be used for the termination of the fibers in ODF's connector panels. Pigtails shall have corresponding type of fiber as the terminated fiber of FOC. E2000/APC ceramic connectors shall be used.

Optical connector couplers (adapters) shall be simplex, from the same manufacturer as connectors of the installed pigtails and colour marked depending on direction and usage of the particular fibre :

- WAN FOC fibers
  - Brown colour for G.656 fibres in all directions
  - White colour for G.652.D fibres in north direction (TU 33 Jirkov)
  - Yellow colour for G.652.D fibres in south direction (Hrušovany)
- LAN FOC fibers
  - Green colour
- Security camera FOC fibers
  - Green colour

Pigtails, optical patch cord connectors and couplers shall be installed according to chapter D.8.9 of TP\_D02\_00\_01\_01.

## **5 CABLE CONDUIT AND ACCESSORIES**

### **5.1 Cable Conduits**

Cable conduits shall be used to protect the FOC runs between manholes along the pipeline routes and in all locations where the FOC shall be installed below ground.

Supply and installation of the HDPE ducts shall be according to chapter D.8.4 of TP\_D02\_00\_01\_01.

Between the administration and control building in the CS and existing Gazelle FOC 8 HDPE ducts 40/33mm in colors white, green, blue and red for both directions shall be laid.

White HDPE ducts shall be used for blowing or pulling the FOC, green is reserve for service purposes, blue and red is object reserve for future use.

HDPE cable ducts shall support the following characteristics:

- Geometrical parameters:
  - Outside diameter: 40 mm (+0.4mm)
  - Wall thickness: min. 3.3mm
  - Ovality max. 5%
- Mechanical details
  - Inner friction coefficient max. 0,1
  - Visual assessment: without defects
  - Crush resistance min. 1800 kPa with max. 15% inner diameter deformation
  - Impact strength no cracks on 10 samples by impact energy 132J and temperature -18°C
  - Expansion coefficient approx.  $1.6 \times 10^{-4} \text{ K}^{-1}$
  - Shrinking max. 3% according to ČSN EN ISO 2505 (at 110°C, 60 min)

According to chapter D.2.1, TP\_D02\_00\_01\_01 SILICORE™ inner surface with friction coefficient < 0,1 shall be used.

## 5.2 Conduit Couplers

To guarantee tensile strength and pressure-tightness of the HDPE conduit, conduit couplers shall be used. Conduit couplers shall be suitable for the respective laying procedure shall fulfil the requirements of TP\_D02\_00\_01\_01.

In according to chapter D.2.3 of TP\_D02\_00\_01\_01 only screwable PLASSON couplers are allowed. Using pluggable couplers is strictly forbidden.

Installation of conduit couplers shall be done according to chapter D.8.4 of TP\_D02\_00\_01\_01 and the manufacturer's instructions.

### 5.3 Tracing cable

Supply and installation of tracing cable CYY shall meet the requirements of TP\_D02\_00\_01\_01.

Existing tracing cable of Gazelle FOC shall be extended to CS together with new HDPE ducts and FOC. Two metallic tracing cables CYY shall be laid with HDPE ducts between the connection point to CS and administration and control building – one for each directions of Gazelle FOC network.

Existing tracing cable of Gazelle FOC shall be cut at the connection point and both directions shall be connected to new laid cables and redirected to Administration and Control Building in CS Jirkov. Both cables shall be inside the administration and control building in CS terminated on new cable socket and grounded.

The CYY cable socket according to chapter D.2.12 of TP\_D02\_00\_01\_01 shall be installed on the wall near the HDPE entry to the Administration and Control Building and near electrical 230V outlet. It shall be easy-accessible for future connecting of locator signal source module.

Tracing cable connecting shall be according to chapter D.8.5 of TP\_D02\_00\_01\_01 with using two layers of hot melting adhesive equipped heat shrink tubes according to chapter D.2.10.

Laid tracing cables shall be according to chapter D.2.9 of TP\_D02\_00\_01\_01. It is recommended to use cable NYY 6 with black cable jacket.

### 5.4 Warning tape

According to ČSN 73 6005 orange coloured LDPE warning tape shall be laid continuously above all HDPE ducts and FOC. Warning tape shall be laid 200-300mm above the HDPE ducts with min. 50mm overlap at each side of the line.

Warning tape shall have black colour printed identification of FOC owner "NET4GAS, s.r.o." at intervals of not more than 2 meters. The printing shall be permanent, insoluble in water and be legible for the duration of HDPE cable ducts life.

## 6 TESTS

All materials/equipment forming part of the supply shall be inspected, tested and certified, fully in accordance with the requirements of this specification and referenced codes and standards.

### 6.1 Factory Acceptance Tests

#### 6.1.1 Fibre Optical Cable

The WAN and LAN fiber optic cables and all fibre optic accessories shall be factory tested and delivered together with the respective test reports.

- Attenuation tests of each fiber at 1.310 +30/-15 nm and at 1.550 +30/-70 nm with optical time domain reflectometry (OTDR); double-sided.
- Dispersion tests of each fiber at 1.310 and 1.550 nm with optical dispersion measurement.  
These measurements shall be performed on each fiber prior to cable manufacturing and on the fabricated cable.
- Installation capability (bending under tension, repeated bending, impact, kink, torsion), cable bend, crush, temperature cycling, water penetration, as homologation tests according to IEC 60794-1-2.

4 weeks prior to the factory test the CONTRACTOR shall submit a test procedure that is subject to approval by the EMPLOYER

Before the goods are dispatched from the factory the relevant test certificates showing results of test carried out factory tests in accordance with this specification shall be signed by accountable persons of EMPLOYER and the CONTRACTOR.

#### 6.1.2 Cable Conduits

The fibre optic cable conduits and all accessories shall be factory tested and delivered together with the respective test reports.

A pressure test of the drummed FO cable conduit pipe shall be performed with 16 bar (air) and shall show that the pressure drops after temperature equalisation max. 0.1 bar within 30 minutes

Before the goods are dispatched from the factory the relevant test certificates showing results of test carried out factory tests in accordance with this specification shall be signed by accountable persons of EMPLOYER and the CONTRACTOR.



## **6.2 Cable Conduit Tests**

### **6.2.1 Pre-Installation Test**

A pressure test of the FO cable conduit pipe (on the drum) shall be performed with 6 bar (air) and shall show that the pressure drops after temperature equalisation max. 0.1 bar within 30 minutes

### **6.2.2 Pressure Test**

After refill of trenches the contractor shall perform section wise a pressure and calibration test in according to chapter D.8.7 of TP\_D02\_00\_01\_01.

All damages and deformations of the cable Conduit that would hinder or make the blowing of the fiber optic cable impossible shall be repaired by the Contractor. After the repair the above mentioned tests have to be repeated for the repaired section.

The tests shall be performed by the Contractor and be accompanied by personnel responsible for fiber optic cable installation who shall confirm successfully performed tests by his signature on the test reports

The pressure test shall confirm that the cable conduit is tight and waterproof. The pressure test shall be performed with 250kPa (air) reached at the far end of the duct. After 30 minutes (pressure stabilization) will be read out and used as the initial value of pressure for the pressure test. Allowed pressure loss is 0,5% for every duct coupler, max 20% for whole tested section after 24 hours.

It is allowed to use 60 minutes test with recalculated value for 24 hours.

### **6.2.3 Calibration Test**

The cable conduit shall be blown through with compressed air to blow out any debris prior to the calibration test.

The calibration test shall confirm proper internal clearance and cleanliness of the Cable Conduit for all installed conduits. The calibration test shall be performed by blowing with a mandrel (plastic or rubber cylinder) with 28mm diameter and minimum length 150mm.

## **6.3 Fiber Optical Cable Tests**

### **6.3.1 Pre-installation Test**

The CONTRACTOR shall carry out a testing before installing the cable at site (on-the-drum test) to verify that the cables have not been damaged during shipping:

- Insertion Loss (end-to-end attenuation) with an Optical Time Domain Reflectometer (OTDR) at 1,310 and 1,550 nm

On delivery to site, all FOC drums shall be inspected and tested in accordance with required field test procedures. Installation of the FOC shall only proceed when the field test report confirms that there is no damage or defects in the FOC drums.

OTDR testing shall include the launch set-up and pigtail check. The launch lead / dummy fibre core shall be at least 1 km in length for OTDR continuity and optical length tests.

The OTDR test data shall be recorded electronically, and submitted to Employer for review in native electronic and hardcopy format (as originally stored by the testing device), along with a full, licensed copy of the necessary software application to view the results.

Test results of the on-the-drum tests are subject to approval by the Employer.

### 6.3.2 FOC Post-installation Test

After the FOC has been blown into the cable conduit, a test pigtail shall be spliced to each fibre of both ends of the cable and a final bi-directional OTDR test shall be made for each fibre core of the FOC to ensure that no possible damage incurred during the FOC blowing activities.

Each fusion splice shall be tested in accordance with the following parameters:

- a) Visual Inspection: No defects
- b) Tensile Strength: > 5 N
- c) Insertion Loss: < 0.15 dB
- d) Return Loss: > 60 dB

Test results of the post-installation tests are subject to approval by the Employer.

### 6.3.3 Final Post-installation Test

After laying, installation, splicing and termination of each Fibre Optic Cable section the following tests shall be performed

After the completion of the FOC installation and termination a complex fiber measurement shall be performed on each fibre in according to chapter D.8.12 of TP\_D02\_01\_01.

#### 6.3.3.1 FOC tests for WAN connection:

- Attenuation and optical return loss test of each fiber at 1310 and 1550nm  $\pm$  20nm for G.652 fibers and at 1310, 1550 and 1625nm  $\pm$  20nm for G.656 fibers using OLTS EXFO FOT 930; double-sided

- Attenuation and fiber point discontinuity tests of each fiber at 1310, 1550 and 1625nm  $\pm$  20nm using 1000 or 2000m long launch cable and EXFO FTB OTDR equipment; double-sided
- Chromatic Dispersion at wavelength range 1475-1626nm using EXFO FTB 5700 measuring equipment
- Polarization Mode Dispersion at wavelength 1550nm using EXFO FTB 5700 measuring equipment
- Determination of optical length

#### 6.3.3.2 FOC tests for LAN connection and security cameras:

- Attenuation and optical return loss test of each fiber at 1310 and 1550nm  $\pm$  20nm using OLTS EXFO FOT 930; double-sided
- Attenuation and fiber point discontinuity tests of each fiber at 1310 and 1550nm  $\pm$  20nm using 1000 or 2000m long launch cable and EXFO FTB OTDR equipment; double-sided
- Determination of optical length

#### 6.3.3.3 Acceptance criteria for the FOC tests

Test results of the final post-installation tests are subject to approval by the Employer.

The following acceptance criteria shall be met as minimum:

- Fiber splice attenuation: max. 0.15dB, average value  $\leq$  0.06dB
- Optical connector attenuation: 0,5dB (for two coupled connectors)
- Optical connector return loss: min. -60dB
- Polarization Mode Dispersion: 0.2ps/km<sup>-1</sup>
- Chromatic Dispersion: 3,5ps/nm/km at 1310nm,  
18,0ps/nm/km at 1550nm

## 6.4 Tracing cable

Newly installed tracing cables shall be tested for continuity and isolation state according to chapter D.8.10 of TP\_D02\_00\_01\_01.

Isolation state shall be measured with open end using the Metra PU311 measuring equipment. The resistance value between the tracing cable and the earth potential shall be 200-500M $\Omega$ .

Continuity test shall be done using underground utility locator at frequencies  $1\text{kHz} \pm 0.1\text{kHz}$  and  $10\text{kHz} \pm 0.2\text{kHz}$ . The continuity test shall be done without any signal loss or signal decrease.

## **7 TOOLS AND TEST EQUIPMENT**

The CONTRACTOR shall supply, as part of the delivered System, all specialized test equipment and tools necessary to operate, adjust, and maintain the equipment and system for minimum 2 years.

The CONTRACTOR shall provide maintenance tools and test equipment as recommended by manufacturer to provide field maintenance on the equipment and for making field repairs. The maintenance tools shall be supplied in a proper toolbox.

### **7.1 OTDR Calibration**

All calibration, test, and simulation equipment that are required to demonstrate correct operation of the system shall be supplied by CONTRACTOR. Calibration Certificates for all necessary test equipment shall be valid and traceable to Czech National Standards.

Calibration, tests and simulation equipment shall be used for pre-installation, installation, commissioning and site testing. All equipment shall be maintained in calibration throughout the testing and commissioning period by CONTRACTOR.

All test equipment shall be calibrated and suitable for the work required. Relevant calibration information shall be recorded at the time of each test and this information shall be included in the test package that shall ultimately be handed over to the CONTRACTOR.

All calibration, test, and simulation equipment shall be made available for EMPLOYER use during the testing and commissioning period.

All test results shall be recorded, all OTDR traces collated, and all OTDR splice losses and attenuation tests shall be submitted with two (2) hardcopy and (2) electronic copies to EMPLOYER for review.

### **7.2 Test Protocols**

Test protocols shall be provided for all activities conducted in course of tests. Test protocols shall at least contain the information required by TP\_D02\_00\_01\_01.

For creation of required optical measurement protocols the following software shall be used:

- Zdepesoft ZDOTDR
- EXFO FasTest Report
- EXFO CD+PMD Report

### **7.3 Labelling and Marking**

All parts, devices, cables, equipment, networks and systems have to be labelled and marked according to the Tagging and Numbering Philosophy C4G-JI73-ILF-GENER-PMA-MAN-902 and shall be subject of review by Employer.

In general all inscription plates and labels must be clearly visible and durable against the ambient conditions. Fixing of plates and labels has to be done by screws or rivets only. Adhesive labels may be allowed for small relays, electronic cards, etc. only. Under no circumstances, paper labels will be allowed for any kind of equipment.

The following shall be considered:

- Name and rating plates for outdoor equipment instrument parts: Stainless steel plates with engraved black letters.
- Inscription plates for indoor panels, cabinets, cubicles, equipment: White hard plastic plates with engraved black letters. Minimum size of letters 5 mm.

All the equipment such as devices, panels, cabinets, etc. must be equipped in addition to the manufacturer's name and rating plate with the respective tag and/or plant identification number. This number must be fixed on the equipment with appropriate sized inscription plates.

The selected marking or marking system must be sampled and released by the Employer or his authorized representative.

### **7.4 Spares**

The Contractor shall supply a comprehensive list of the manufacturer recommended spare parts for minimum 2 years maintenance for further consideration to the EMPLOYER.

As a minimum the contractor shall consider 5% extra fibre optic cable and cable conduit length to cover for spare and installation tolerances.

## **8 QUALITY ASSURANCE**

All the equipment manufacturers shall operate a quality system preferably based on ISO 9001: 2008 series of standards to satisfy the requirements of this Specification. The

manufacturer shall demonstrate compliance by providing a copy of the accredited certificate or the manufacturer's quality manual.

## **9 DRAWINGS AND DOCUMENTS**

### **9.1 General**

All requirements according to contract conditions and Employer's standards (see Par. 1.4.1 "General N4G References") shall apply.

Generally for all fibre optical cables and auxiliaries a complete set of documentation shall be provided by Contractor. Documentation provided by Contractor shall cover design, installation, commissioning, maintenance, test reports and certifications.

All documents supplied by the Contractor hereunder including drawings, data sheets, etc. shall be submitted in English and Czech, with the exception of the Maintenance and Operating Manuals that shall be prepared in Czech.

All documents (drawings, data sheets, manuals, etc.,) shall be developed using the templates files models submitted by Employer.

The documents shall be passed on by the Contractor to the Employer for approval, respectively to the engineering company, via e-mail using the appropriate document transmittal.

The documentation shall be provided on electronic format as follows:

- List                      Excel (office 2016)
- Document              Word (office 2016)
- Drawing                AutoCAD 2018
- Circuit diagram       E-Plan, E-Cad, WS-Cad or similar

Documentation in electronic format shall be provided in original editable format and PDF format as well.

Review and comments by Employer and his representative, or any failure to review, shall not alter any of the terms and conditions of the Purchase Order, nor relieve the Contractor of any responsibility or liability for the accuracy and completeness of data and materials, nor be interpreted so as to imply approval of such documents.

The modified area of the document shall be indicated by:

- A triangle (containing the current revision number) located outside of a clouded area (drawings);

- A triangle (containing the current revision number) and a revision line drawn in the left margin of any and all modified lines and paragraphs (other documents).

## 9.2 Document schedule

The Contractor shall prepare and furnish the following documents for approval:

- Technical documents of the FO cable, cable conduits and accessories and catalogues
- Drawing and document schedule
- Time schedule
- Spare part list

Document	Date of Delivery
Drawing and document schedule	4 weeks after award of contract
Time schedule	4 weeks after award of contract
Cable duct laying and testing method statement	10 weeks after award of contract
FO cable installation and testing procedure	10 weeks after award of contract
Fibre cable splicing method statement	10 weeks after award of contract
Bill of material	12 weeks after award of contract
Spare list	12 weeks after award of contract
Cabinet documentation including cover sheets, index, standards, cabinet layout, wiring diagrams, material list, cable list., etc.	12 weeks after award of contract
Technical documents of the hardware and software, leaflets and catalogues.	12 weeks after award of contract

Test procedures for all tests to be performed according chapter <b>Error! Reference source not found.</b>	6 weeks before start of installation of cable conduits
Final Documentation	8 weeks after Final Post-installation Test

### 9.3 Documents to be submitted with Tender

The offer shall be compiled in such a way to allow an easy understanding and appraisal of all the technical aspects related to the proposed system. The following documents shall be provided with the bid:

- Confirmation of full compliance of the proposed systems with the functional requirements specified in the tender documents. In case the solution is not fully compliant, a table listing all the deviations shall be provided. The table shall contain a reference to the requirement that is not met (including title and document number of the specification, chapter and paragraph) and a description of the deviation.
- All necessary certifications/verifications
- Technical Description of the fibre optical cables and all accessories (including detailed description of optical cable structure with dimensions of each part, Typical refractive index and profile of the fibres for this project, drum weight etc.)
- Technical standards, producing technology and quality assurance system for both the optical fibre and the optical cable
- Technical Description of the cable conduit and all accessories
- Technical standards, producing technology and quality assurance system for the cable conduits and accessories
- Cable duct laying and testing method statement
- FO cable installation and testing procedure
- Fibre cable splicing method statement
- Drawing and document schedule (or part of an overall schedule)
- Time schedule (or part of an overall schedule)
- Certificate of quality assurance system (ISO9001)
- List of reference projects



#### **9.4 Final Documentation**

The Contractor shall issue the following final documentation in the number of hardcopies and CD/DVD defined in the contract according to D.12 of TP\_D02\_01\_01.

In addition the existing operational and service documentation of NET4GAS shall be updated.