NET4GAS, s.r.o

COMPRESSOR STATION JIRKOV 73 BAR

Cable and Cable Laying - Specification

24.08.2017

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1 GENERAL

1.1 Scope of the Document

The scope of this specification covers the requirements for cable and cable laying for:

a) medium voltage power cables up to 30 kV

b) low voltage power cables

c) control cables

d) instrumentation cables

e) telecommunication cables

f) fire and gas detection cables

Fibre optic cables are not part of this specification.

In contractor's scope

The scope of delivery for the "Cable and cable routing" package is defined as follows:

- Planning, design, delivery, assembly and testing of all required components for cable support systems
- Planning, design, delivery, assembly and testing of all required components for functional integrity cable support systems
- Supply and installation of medium voltage cables
- Supply and installation of low-voltage power cables
- Supply and installation of control & signal cables
- Supply and installation of instrumentation cables
- Supply and installation of telecommunication cables
- Supply and installation of fire and gas detection cables
- Supply and installation of cables for outdoor lighting
- Supply and installation of functional integrity cables
- Installation of cables provided by contractor "EMCS" which are wholly or partly through the outside
- Excavation of cable trenches
- Supply an Installation of concrete cable trenches
- Drilling for building bushings

- On site measurement and cutting of cables
- Cable storage / temporary storage
- Interface coordination with civil contractor
- Scheduling / coordination of on-site assembly work with employer / third parties, final inspection on site
- Technical Inspection Czech Republic incl. all necessary documents in Czech language
- Documentation according to chapter 7 of this specification
- Supply of spare parts for commissioning

Points which have not been clearly defined in the documents and the performance list are to be indicated in the offer. Unless stated in the documentation, the details, such as the exact location of individual installations, must be defined before commencing work with the site management.

1.2 Definitions

Term	Explanation
Project	Compressor Station Jirkov 73 bar
Employer	NET4GAS
Consultant	ILF Consulting Engineers
Contractor	Company supplying the herein described scope of work

1.3 Abbreviations

Term	Explanation
AC	Alternating Current
ATEX	Atmosphere Explosibles (guideline for explosion protection in the European Union)
CS	Compressor Station
DC	Direct current
EMC	Electromagnetic Compatibility

FOC	Fibre Optic Cable
HDPE	High-density Polyethylene
IS	Intrinsically Safe
kV	Kilovolts
PE	Protective Earth
PVC	Polyvinyl Chloride
TIČR	Technical Inspection of Czech Republic
XLPE	Cross-linked Polyethylene

1.4 References

No.	Number	Title
1	C4G-JI73-ILF-GENER-ELE-SPC-800	Design and Construction of Power Supply Systems - Specification
2	C4G-JI73-ILF-GENER-ELE-SPC-807	Earthing and Lightning Protection - Specification
3	C4G-JI73-ILF-GENER-MAR-SPC-901	General Requirements - Installation and Start-up of Control System
4	C4G-JI73-ILF-GENER-PMA-MAN-902	Tagging and Numbering Philosophy
5	C4G-JI73-ILF-GENER-TEL-SPC-801	Fibre Optic Cable - Specification
6	C4G-JI73-ILF-KS007-BOZ-TZP-903	Hazardous Area Classification Plan
7	C4G-JI73-ILF-KS007-ELE-DIA-110	Cable Bock Diagrams
8	C4G-JI73-ILF-KS007-ELE-SEZ-841	Cable List (Power & Instrumentation)
9	C4G-JI73-ILF-KS007-	Outdoor Cable Route Drawing

	ELE-SIT-305	
10	C4G-JI73-ILF-KS007-ELE-VYK-402	Administration and Control Building - Cable Route Drawing
11	C4G-JI73-ILF-KS007-ELE-VYK-412	Electrical Building - Cable Route Drawing
12	C4G-JI73-ILF-KS007-ELE-VYK-422	Compressor Building - Cable Route Drawing
13	C4G-JI73-ILF-KS007-ELE-VYK-500	Cable Route Cross Sections
14	C4G-JI73-ILF-KS007-GEN-MAN-901	Geographical Climatic and Environmental Conditions
15	C4G-JI73-ILF-KS007-GEN-SEZ-840	List of Relevant Regulations, Standards and Specifications
16	C4G-JI73-ILF-KS007-GEN-TZP-010	Description of Technical interfaces for Contractor
17	C4G-JI73-ILF-KS007-MAR-DIA-104	Instrumentation Cable Block Diagrams

1.5 Codes and Standards

The planning, installation and testing of the complete delivery item or performance and monitoring of services, including the preparation of the technical documentation, shall be carried out according to the following rules and standards, valid in their latest version.

No.	Number	Title
1	2014/35/EU	Low Voltage Directive
2	2014/30/EU	EMC Directive
3	2014/34/EU	Product Directive (ATEX 114)
4	99/92/EC	Incorporate Directive (ATEX 153)
5	ČSN 34 7659	Distribution cables for rated voltage 0.6/1 KV
6	CENELEC - HD 620	Distribution cables with extruded insulation for rated voltages from 3,6/6 (7,2) kV up to and including

		20,8/36 (42) kV
7	DIN VDE 0271	Power cables – Specification for power cables 0,6/1 kV and above for special applications
8	DIN VDE 0816	External cables for telecommunication and data processing systems; cables insulated and sheathed with polyethylen, unit stranded
9	DIN 4102-12	Fire behaviour of building materials and building components - Part 12: Circuit integrity maintenance of electric cable systems; requirements and testing
10	ČSN EN 13501	Fire classification of construction products and building elements
11	EN 50339	Common test methods for cables under fire conditions - Heat release and smoke production measurement on cables during flame spread test - Test apparatus, procedures, results
12	ČSN EN 50577	Electric Cables – Fire resistance test for unprotected electric cables
13	ČSN EN 60228	Conductors of insulated cables
14	ČSN EN 60332	Tests on electric cables under fire conditions
15	ČSN EN 60754	Test on gases evolved during combustion of materials from cables
16	ČSN EN 60811	Common test methods for insulating and sheathing materials of electric cables and optical cables
17	ČSN EN 61034	Measurement of smoke density of cables burning under defined conditions
18	ČSN EN 61238	Compression and mechanical connectors for power cables with copper or aluminium conductors
19	IEC 60227	Polyvinyl chloride insulated cables of rated voltage up to and including 450/750 V
20	IEC 60287	Electric cables – Calculating of the current rating
21	ČSN IEC 60331	Tests for electric cables under fire conditions

22	ČSN IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV
23	ČSN EN 60708	Low-frequency cables with polyolefin insulation and moisture barrier polyolefin sheath
24	ČSN IEC 61156	Multicore and symmetrical pair / quad cables for digital communications
25	ISO/IEC 11801	Information technology - Generic cabling for customer premises
26	N4G	EMPLOYER's Standards

Reference is also made to the standards as mentioned in the "List of Relevant Regulations, Standards and Specifications", Doc. No. C4G-JI73-ILF-KS007-GEN-SEZ-840.

As far as the energy provider or permits of other authorities require additional codes and standards, respectively impose additional requirements, these are also part of the contract.

1.6 Environmental Conditions

The cables shall be designed and calculated for continuous operation at full load under the climatic and environmental conditions as described in the specification "Design and Construction of Power Supply Systems" Doc. No. C4G-JI73-ILF-KS007-GEN-SEZ-840.

2 DESIGN REQUIREMENTS

The cross section of all power, control, instrumentation and communication cables shall be determined in accordance with the current demand of the linked power consumer, the max. permissible voltage drop, the operating temperature, thermal short-circuit capacity, maximum cable loop impedance for earth faults and laying conditions. Furthermore, all stresses that may occur during operation must be considered (including fire load).

Cable cross-sections shall be determined using the manufacturer's published data and the respective reduction factors according to installation conditions.

The current-carrying capacities of power cables shall be calculated according to the type of operation, the conditions of installation and the ambient condition.

The reduction factor shall be related to the following parameters:

- ambient or ground temperature

- exposure to solar rays
- ground thermal resistivity
- grouping/ spacing
- current carrying capacity
- harmonics
- number of conductors

The max. voltage drops are limited to the values given in specification “Design and Construction of Power Supply Systems” document number C4G-JI73-ILF-GENER-ELE-SPC-800. The values for voltage drops are referred to the nominal voltage of the system.

The max. permissible continuous conductor temperature for power cables, depending on insulation material, shall be:

- PVC insulated cables 70 °C
- XLPE insulated cables 90 °C

The max. permissible short circuit temperature (short circuit duration max. 5 s) for power cables, depending on insulation material, shall be:

- PVC insulated cables 160 °C
- XLPE insulated cables 250 °C

For the individual voltage levels the following colours of the PVC insulated conductors shall be used:

- 3 x 400/230 V AC black/brown/grey (phase)
light blue (neutral)
green/yellow (protective conductor)
- 230 V AC UPS brown (phase)
light blue (neutral)
green/yellow (protective conductor)
- 24 V DC red (+)
light blue (-)
- 110 V DC red(+)
light blue (-)
- other voltages orange or manufacturers standard

It is mandatory that the neutral core and protective core have the colours mentioned above.

All Cables used within the CS shall meet the requirements according to European and/or local standards. With 1st of July the new Construction Products Regulation EU 305/2011 gets mandatory. This means for cables the new fire-class classification system according to EN 13501 is to be used.

Cables shall have at least the following classification:

- Cables for outdoor application: E_{CA}
- Cables for indoor application: B_{2CA} s1, d1, a1

The design calculations / dimensioning derivations of the contractor shall be submitted to the employer for examination and approval. If laying conditions are not described in the relevant regulations or standards (for example, combination of vertical and horizontal accumulation), corresponding verification calculations must be submitted by recognized expertise.

A list of the used cables shall be submitted by Contractor before ordering.

3 CABLE TYPES

General, all cables have to be stamped on the outer sheath with at least the following data:

- Cable type
- Proofed Voltage Level
- Applied Regulation
- Manufacturer
- Year of Manufacture
- Meter markings

3.1 Power Cables for Medium Voltage

For medium voltage cables, the type N2XS(F)2Y or NA2XS(F)2Y will be used.

For the connection of VSD and motor, special cables as per compressor manufacturer's requirements may be considered.

The minimum cross section of medium voltage cables shall be 70 mm². for copper cable and 95 mm^2 for aluminium cable.

If cross sections larger than 300 mm² for copper cable or more than 400 mm^2 for aluminium cable are required, general two or more parallel cables with the same laying length shall be provided.

Power cables for medium voltage shall be designed in accordance to IEC 60502 or equivalent (e.g. CENELEC HD 620).

3.2 Power Cables for Low Voltage

Low voltage cables shall be multi- core of the following types:

- NYCY or NYCWY

  Outside of buildings

- N2XH-J

  For electrical indoor installations outside of hazardous or process areas

The minimum cross section of low voltage power cables shall be 2.5 mm².

If multi core cables with cross-sections larger than 185 mm² per phase are required, general two or more parallel cables shall be provided. For single core cable the maximum cross section shall be 300 mm².

Each power and control cable shall contain a PE conductor. Cable screens with acceptable cross sections can be used as PE conductor. PE and N conductor shall be separated at any time.

A reduced cross section for the PE conductor is allowed, if the cable loop impedance is below the maximum allowed value.

Power Cables for low voltage shall be designed in accordance to IEC 60502 or equivalent (e.g. CENELEC HD 603).

3.3 Cables with Functional Integrity

For certain system (e.g. escape way lighting) cables with functional integrity are required. The function of the cable has to be tested according to the DIN 4102-12 or similar (e.g. EN 50577).

The relevant provisions, manufacturer's regulations and test certificates must be observed.

3.4 Control and Signal Cables

Low voltage cables shall be multi-core of the type NYCY.

The cores shall be numbered with imprinted white numbers on the conductor insulation.

The following number of cores and cross section of shielding shall be used preferably:

- 2 x 1.5/1.5 mm²

- 3 x 1.5/1.5 mm²
- 4 x 1.5/1.5 mm²
- 5 x 1.5/1.5 mm²
- 7 x 1.5/2.5 mm²
- 10 x 1.5/2.5 mm²
- 12 x 1.5/2.5 mm²
- 16 x 1.5/4 mm²
- 24 x 1.5/6 mm²
- 30 x 1.5/6 mm²

The cables shall be provided with a min. of 20 % spare conductors.

Control and signal cables shall be designed in accordance to IEC 60502 or equivalent (e.g. CENELEC HD 603).

3.5 Instrumentation Cables

Instrumentation cable shall be twisted pair with stranded copper conductor and an overall screen. The cables shall be suitable for outdoor use and direct laying in earth. The cores shall be marked with imprinted numbers, the core colours shall preferably be white and black per pair. For outdoor usage the type RE-2YCYv with current-carrying outer screen shall be used. Inside of buildings the type RE-2Y(St)Y may be used. Rodent protection is mandatory.

The following number of cores and cross section of shielding shall be used preferably:

- 1 x 2 x 1.0/2.5 mm²
- 2 x 2 x 1.0/2.5 mm²
- 4 x 2 x 1.0/4 mm²
- 8 x 2 x 1.0/6 mm²
- 12 x 2 x 1.0/10 mm²
- 20 x 2 x1.0/16 mm²

The multi-pair cables shall be provided with a minimum of 20% spare conductors. The colour of outside insulation for cables in intrinsically safe circuits shall be light-blue. Instrument cables shall be designed in accordance to EN 50288-7 or equivalent. Flame retardant cables shall be used.

Unconnected cores per cable are to be placed on reserve terminals and to be connected to ground via a grounding wire.

For cables in intrinsically safe circuits, the relevant data (inductance, capacitance) relevant for the intrinsic safety data must be provided by submitting a data sheet or a test report.

3.6 Telephone and Communication Cables

Multiple core, twisted pair cables A-2YF(L)2YB2Y St III Bd according to VDE 0816 or equivalent (e.g. IEC 60708), suitable for outdoor use, shall be provided. Cables with 10 pairs, 20 pairs or 30 pairs and conductor diameter ≥ 0.8 mm shall be used preferably. The cables shall be provided with a min. of 20 % spare pairs.

3.7 Network Cables

For a structured cabling system, a CATEGORY 7 STP (4x2x0.8 AWG 23 PIMF) cable shall be provided according to ISO/IEC 11801 or equivalent. The structured cabling system shall be terminated within a 19”-patch panel. Each port has to be fully wired to the patch panel.

3.8 Fire Detection Cables

As a fire detection cable for outdoor use, cables can be used which correspond in structure to the aforementioned cable types of the control and signal cables or instrumentation cables for outdoor use or telecommunications cables. Solid copper conductors are also permitted. With the exception of intrinsically safe signals, however, the fire detection cables must have a red outer jacket with the imprint "fire detection cable" or equivalent in Czech language.

For connecting detectors within buildings and other constructional devices J-Y(St)Y BMK cables are to be used as a fire detection cable. Fire detection cables must be self-extinguishing and flame-retardant according to EN 60332-1-2 or equivalent.

3.9 Fibre Optic Cables

The requirements regarding the fibre optics cables can be found in the document “Fibre Optic Cables – Specification Doc. No.: C4G-JI73-ILF-GENER-TEL-SPC-801.

Fibre optic cables inside the buildings shall be laid on cable trays in segregated sections to other cable types. HDPE conduits shall be used for outdoor laying of fibre optic cables.

3.10 Bus Cable

Profibus DP cables shall be type A and suitable for indoor and outdoor use, compliance with profibus DP standard, resistant to specified environmental conditions and with typical violet outer jacket. Profibus cable for outdoor installation shall be suitable for direct laying in the ground.

For connections via Modbus 2 x 2 x 0.8, RE-2YCYv PiMF and via Profibus 1 x 2 x 0.64 cables shall be used preferably.

4 CABLE LAYING

4.1 General

Main cable routes, according to:

- C4G-JI73-ILF-KS007-ELE-SIT-305
  Outdoor Cable Route Drawing
- C4G-JI73-ILF-KS007-ELE-VYK-402
  Administration and Control Building - Cable Route Drawing
- C4G-JI73-ILF-KS007-ELE-VYK-412
  Electrical Building - Cable Route Drawing
- C4G-JI73-ILF-KS007-ELE-VYK-
  Compressor Building - Cable Route Drawing
- C4G-JI73-ILF-KS007-ELE-SEZ-841
  Cable List (Power & Instrumentation)

shall be used as far as possible.

The cable list contains correct tagging and a measured length of the cables. Before starting the works, Contractor shall check the length of the cables with onsite measurements.

Any other document which is needed to execute the scope of work shall be created by the Contractor.

Within the station the cables shall be routed:

a) aboveground:
   - cable trays inside buildings
   - cable trays along structures, like coolers
   - cable ladders inside concrete cable trenches and shafts

- raised cable floors inside the Administration and Control Building
- for small cable quantities to the various equipment in protection conduits of (non ex-zone) and metal conduits (ex-zone and outdoor)
- C-Profiles and ladders

b) underground:

- concrete cable trench (main outdoor routes)
- directly buried flexible protection conduit
- directly buried in cable trenches
- Cable transit from underground to aboveground to single field consumer in conduits of hot dip galvanised steel or UV resistant protection conduits
- Cable for main earthing network directly buried

The routing and general arrangement of all cables shall be planned concurrently with main pipe racks and vehicle access ways, etc., in order to provide unimpeded direct routes wherever possible. Power cables, instrumentation and control cables as well as cables for intrinsically safe circuits shall be segregated from each other to eliminate any possibility of electrical interference.

In general, excavation work on existing underground facilities should be performed by hand, unless a different procedure has been agreed with the Employer or his authorized representative. It is in the Contractors responsibility to check if his work could damage any existent water pipes, existing cables, sewage pipes or similar. Further has the Contractor the liability to ensure enough human safety measures are taken to avoid accidents at cable trenches, pits or similar. Any damage caused from the Contractor will be claimed.

The Contractor has to take measures for cordoning off and guarding his construction site equipment, if the Employer does not provide any precautions.

Cable sections shall be measured and cut in one length. If in special cases cable joints are necessary, the approval of the employer has to be obtained.

After laying, all cable ends have to be carefully protected against humidity until start of connection works.

Sufficient additional cable lengths on both ends for proper connection on the various cabinets and equipment shall be provided.

Single core cables shall be laid as a triangular bundle, which is achieved through EMC compatible cable tapes. The cable tapes shall be mounted every 50 cm.

Energy cables and short-circuit-proof cables shall be laid securely (e. g.: clamps and c-rails).

The CONTRACTOR of the cable must also install this cable and connect it on both sides. Exceptions are cables, which extend completely or partly through the outer area. These are laid by the general contractor, but are still clamped by the supplier of the cable.

4.2 Cables laid aboveground

All supports and auxiliary structures necessary for cable installations on equipment, motors, transformers, steel structures, junction boxes, raised cable floors, etc., shall be made of hot dip galvanized steel.

Cable trays may not be installed on stairs, railings, pipes and other removable constructions.

Before installation of the cable tray support arms, the construction shall be checked regarding the maximum allowable load. The mounting shall be done through clamps, preferably. Welding is not permitted. Cable trays shall be mounted for their maximum achievable load according to the manufacturer. To avoid deflections, a gap of maximum 1.5 m between support arms shall be considered. If required wide-span cable ladder must be used. For distances over 10 m a possible expansion of the supporting structure shall be considered and appropriate measures be taken.

Cutting edges shall be burred and cold galvanised (excludes stainless steel) on the same day. Sharp surfaces shall be also burred and cold galvanised. Edge protection shall be used where applicable. Cable tray supports shall be protected with caps or bumpers.

Potential equalization for cable trays shall be foreseen. If the manufacturer can proof the electrical consistency of connected single sections with a certificate no additional connection between the sections is necessary. The cable trays shall be connected to the earthing system at the beginning, at the end, every 30 m and at every penetration of hazardous areas (in & out). The connection topology shall be star-shaped. Cable trays may not be used as an earthing conductor.

Cable ladders, trays and racks shall also be provided of hot dip galvanized steel. The clear diameter of trays and racks may only be used up to 70 %

Cables with different voltage level, instrument cables and non – Exi and Exi cables have to be separated by use of different ladders or trays. For a limited amount of cables, barrier strips between the different types of cables may also be used, except for medium voltage cables which always must be laid in a separate ladder or tray.

Inside buildings, field cables and internal cables have to be separated by use of different ladders / trays. Crossings of these routes have to be carried out right-angled for minimizing electromagnetic induction from field cables to the internal cables. If in special applications a minimum safety margin cannot be kept, e.g. in cable entries of marshalling cabinets etc., measures shall be taken to anticipate induction between internal and field cables.

Cable ladders / trays in accessible areas have to be protected by use of a cover.

Cable fixing shall be carried out using hot dip galvanized clamps at least every meter, for vertical installations at least in distances of 0.5 to 0.6 m. For horizontal installation, the use of cable ties for fixing is allowed, too.

The three single core cables of a medium voltage system have to be bundled triangular by the use of an EMC compatible cable tape. These tapes have to be designed in quantity and quality to withstand the mechanical forces in the case of a short circuit. If more than one cable per phase is used, always three cables of different phases shall be bundled.

All fixing material for cable installation, as fixing strips on cable trays and supports, pull-relief fasteners, etc. shall be provided.

For certain system (e.g. emergency lighting) cable trays with functional integrity are required. These cable trays shall be protected by use of a cover and need to have the same functional integrity as the cable system. The cable trays must be certified according to DIN 4102-12 or similar (e.g. EN 50577).

The relevant provisions, manufacturer's regulations and test certificates must be observed.

4.3 Cables laid underground

Electrical and instrumentation cables within the stations shall mainly be laid in concrete cable trenches. For areas where is not possible or not reasonable to install concrete trenches, cables shall be laid inside protection tubes or in exceptional cases directly in the ground. For signalling & control cables and for fibre optic cables protective pipes always shall be used. Where protective pipes are used, cable shafts will be used for major direction changes. Medium voltage cables will be direct buried in ground.

4.3.1 Concrete Cable Trenches

Cables, on the main cable routes outside of buildings (see C4G-JI73-ILF-KS007-ELE-SIT-305 Outdoor Cable Route Drawing) shall be laid into concrete cable trenches with removable reinforced concrete slabs. The compartments shall have separate power cables, intrinsic safe cables and instrument cables.

Straight sections of the cable trenches shall be provided in lengths of 2,000 mm with the following internal dimensions:

- Type 1: Single cable trench 1 x 300 mm x 300 mm
- Type 2: Double cable trench 2 x 300 mm x 300 mm
- Type 3: Triple cable trench 3 x 300 mm x 300 mm

The covers of the cable trenches in the ground shall be suitable to bear the load of normal traffic.

In case the concrete cable trenches have to cross roads, the covers of these trenches shall be suitable to bear heavy traffic.

The ends and outlets of the concrete cable trenches shall be plugged with polyurethane foam or appropriate material in order to avoid penetration of earth and sand. This procedure applies for conduits with and without installed cables.

For cable trenches entering, crossing or leaving hazardous areas (see “Hazardous Area Classification Plan”, Doc. No. C4G-JI73-ILF-KS007-BOZ-TZP-903), the trenches shall have gas traps, after cable laying. The trenches shall be filled at least for the length of one element (app. 2 meters) before and behind the Ex-Zone. The gas traps are also shown in the “Outdoor Cable Route Drawing”, Doc. No. C4G-JI73-ILF-KS007-ELE-SIT-305.

4.3.2 Buried Cables and Conduits

Directly buried cables and conduits shall be laid at a minimum depth of 0,8 m. Street crossings shall be realized with HDPE pipes and laid at a minimum depth of 1 m. A depth of more than 1,2 m shall be avoided, expect transits into buildings, cable shafts or similar.

The cable routes shall be defined on site and afterwards, if in the applicable layout is nothing different stated, excavated to a minimum depth of 0.9 m for single cable layer. Before filling in a 0.1 m fine sand bedding, the trench bottom needs to be free of any stones, roots or similar. For multi-layer cable routes, between every layer of cables a 0.1 m fine sand level shall be filled. On the top layer, another 0.15 m layer out of fine sand shall be used. Above top fine sand layer, a polyethylene-cover (yellow, 2 mm thin) shall be laid. The cover shall have a width of minimum 0.3 m. For routes with a width of more than 0.5 m 2 covers parallel shall be used. Before backfilling the topsoil, 0.05 m find sand shall be put over the polyethylene-covers. MV cables shall be protected with plates. Additionally, directly buried cables and conduits have to be protected by a plastic warning tape placed 30 cm below the ground level. The tape shall have the inscription “ATTENTION CABLE” or equivalent in Czech language. For cable routes with a width more than 0.5 m an additional warning tape has to be laid. Every cable trench shall be equipped with a flat steel earthing conductor (V4A) as a screen. The whole trench shall be in the impact area of the screen. More details can be found in specification “Earthing and Lightning Protection”, Doc. No.: C4G-JI73-ILF-GENER-ELE-SPC-807.

As far single consumers like actuators, motors or sensors must be accessed in the field with their dedicated control or power cables, a protective-conduit shall connect the concrete cable trenches with the outlet point next the component to be reached. The con-

crete cable trenches will be provided with cut-outs, filled with PU foam or similar, to allow leaving of the cables, at the dedicated positions in the field.

Where electrical consumers are part of the electrical installation, like light poles, control cables for escape doors in the surrounding fence, etc. cables may be buried and directly embedded in sand.

Medium voltage cables will be directly buried in ground, backfilled with fine sand or covered by lean concrete for medium voltage cable and backfilled to final surface.

As described above, directly buried cables can be covered with lean concrete for thermal stabilization. This lean concrete shall have a thermal conductivity of at least 1,0 W/(mK).

4.3.3 Cable Markers

Cable trenches on the CS area shall be marked every 30 m, direction changes, crossings and street crossings with concrete cable markers.

4.4 Cable Distances

The following distances between the several layers of cables shall be observed:

Type of Cable	Clear Distance
Instrument cable (Exi) beside instrument cable (Exi)	not necessary
Instrument or control cable (not Exi) beside instrument or control cable (not Exi)	not necessary
Instrument cable (Exi) beside instrument or control cable (not Exi)	10 cm
Instrument cable beside low voltage cable	20 cm
control cable beside low voltage cable	5 cm
Low voltage cable beside low voltage cable	diameter of cable (but max. 5 cm)
Medium voltage cable beside Instrument cable	60 cm
Low voltage cable beside medium voltage cable	30 cm
Medium voltage cable beside medium voltage cable	10 cm

When required (e.g., strong heating) the distance between the power cables is to be increased.

For telecommunication cables and FOC, the same distances as instrument or control cables shall be used.

4.5 Cable Transits

4.5.1 Transition of Walls

For the passage of cables from buildings, shelters, etc. into earth / cable trenches, modular watertight transit systems shall be installed into the exterior walls of the buildings. For cables passing fire protection walls or rooms with Ex-Zones, modular, cable sealing-systems shall be used providing the necessary sealing of the transit. These sealing-systems shall be designed in order to fulfil the respective fire protection and Ex-Zone requirements. Wall sealing between different fire protection zones shall have a fire withstand time of the same time as the wall, but at least a minimum of 30 minutes. The sealing also has to be closed for gas.

All individual sealing modules or fire barriers shall be suitable for the outer diameter of the respective cable. In general, a spare capacity of 30% shall remain within all cable transits for future extensions after installation of all cables.

4.5.2 Transition Soil / Air

All cables running from the ground to the equipment have to be protected with heavy duty hot dip galvanized steel tubes, 40 cm below and 30 cm above ground level. After completion of the connection works these pipes have to be sealed durable and water resistant.

4.6 Transportation and Unloading

All cables shall be shipped and transported on cable drums. Smaller length of cables can be only accepted for special cables with short length requirement.

Before delivering, the Contractor or his supplier has to proof the cable against their cable specification or the applicable standard and submit the results of these tests to the Employer. These results are also to deliver with the cables as hardcopy.

MV cables shall be winded in a certain way on the drum, so that both ends are easily accessible for tests (e. g. insulation tests) before the cables are unrolled and processed.

It is important to ensure that the cable ends are carefully protected against penetrating moisture or other damaging environmental conditions up to the connection work or are protected after cutting.

Drums shall be lifted by means of a crane or by means of a loading ramp. Throwing and dropping down of cable drums shall be strictly avoided. In order to prevent drums moving

during transportation, these must be securely wedged to prevent movement. Before unloading it is necessary to verify that the drum is received in proper condition.

The directional arrow of the drums has to be observed during rolling. The slop of the loading ramps shall not surpass the relation of 1:4. When rolling the drum on the ramp this must be controlled by ropes and with aid of winches or pulley blocks and tackle.

Empty cable drums have to be stored on a suitable central store place. Return transport to the cable manufacturer of returnable drums is the contractor's responsibility.

4.7 Personnel and Tools

Sufficient staff for drum transportation and for unwinding and laying of the cables has to be foreseen. If cables are laid simultaneously at different areas, each cable laying team has to be permanently supervised by a qualified person to ensure that all works are carried out in accordance with the specifications.

Unskilled staff has to be instructed on handling of the cable material before start of work.

4.8 Cable Pulling

When putting the drums on lifting jacks, the direction arrow shall point to the opposite direction. After removing the protection boards the cable shall be inspected for visual defects. When unwinding the cable, the drum has to be moved by hand in order to avoid a stress on the cables.

Cable laying below +5 °C is not permitted.

Small cable length may be unwound without lifting jacks beside the cable trench and then laid into the trenches.

Dragging of the cables on the ground has to be avoided in any case.

When pulling the cables, especially when joints are necessary, special care has to be paid to the fact that each individual length shall be laid in the same direction. This means that the B-end meets the A-end of the next length and the wires of the same colour can be connected without crossing in the joint.

The cables shall be supported by cable rollers, placed in a distance of 2 – 4 m. At curves, corner cable rollers according to the minimum bending radius shall be situated. On the cable end grips shall be fixed. On these cable grips the rope shall be mounted.

The cable manufacturer’s specifications considering the maximum allowable force for cable pulling shall be strictly observed.

The actual strength will be controlled by dynamometers installed in the pulling rope. These reports shall be handed over to the Employer or his representative. Small cables will be laid manually. Attention will be given when pulling them into conduits.

Before pulling the cables through cable routes with cable conduits or pipes, the free way in the routes has to be inspected. It may only be pulled on straight sections. Even if corner rollers are installed, every pull point has to be watched by an inspector.

At the beginning and at the end of conduit routes, the cable shall not touch pipe or stone edges. The edges have to be rounded up, or suitable supports of cardboard or jute cushions penetrated with grease have to be placed under the cables. The openings have to be plugged to avoid penetration of sand.

At the start and the end point of cable conduits, the cables have to be laid in an S-bend in order to equalize settlements of the cable trenches. Cables, mounted at instruments shall have spare length to enable maintenance and movement of the instrument, without disconnecting the cable.

Close to cable connections to consumers or junction boxes, cable loops allowing spare length have to be provided before leaving the earth or the trench.

The clear diameter of conduits shall only be used up to 70 %.

The maximum admissible bending radius of the various cable types has to be observed strictly.

The ends of the cables shall be sealed, immediately after laying of the cables, to protect the ends against penetration of moisture.

4.9 Cable and Cable Route Tagging

The cables have to be marked when entering and leaving switchgears, distribution boards, cabinets, equipment, conduits, etc. below ground laid cables shall be also marked on:

- The beginning/end of protective conduit
- The building entering and exit/leaving
- The main route branch
- At the beginning and at the end of a protective pipe

The marking shall be carried out with high resistant (UV exposure resistant) plastic material cable identification markers, in conformity with the cable number in the cable lists. For cables placed in cable trenches additional cable markers every approx. 5 m along the cable routes have to be provided. The marking shall be according to the cable list.

For buried cable routes, cable route markers in order to identify the routes have to be placed directly above the cable route, every 30 m along the route, at all changes of direction and at road crossings. Cable route markers shall be concrete blocks, approx. 15 x 15 x 50 cm, 3 cm visible over ground. The route direction shall be marked on the top of the concrete block.

4.10 Junction Boxes

Junction boxes shall be used for connection of single control, signal and instrumentation cables with summarized common cables and for connection of different local equipment.

Junction boxes for electrical power circuits shall be manufactured according to specification “Design and Construction of Power Supply Systems”, Doc. No.: C4G-JI73-ILF-GENER-ELE-SPC-800.

5 TERMINATING

For termination of the cables into the various switchboards and equipment, the instruction of the switchboard or equipment manufacturer shall be strictly followed.

Fastening and fixing material as delivered or specified by the equipment manufacturer, shall be used for cable connection only.

All spare wires shall be connected to available spare terminals. Screens shall be connected to the ground terminals. Spare wires shall be connected to the equipotential bonding rail at one terminal site.

Cable glands shall be suitable for the respective type of cable. For use in hazardous areas, certified types of glands shall be used.

The outer screen of NYC(W)Y cables shall be used as earthing conductor (PE - conductor) and connected to the earthing grid directly after building entry. For more information about earthing of cables, reference is made to the specification for “Earthing and Lightning Protection” Doc. No. C4G-JI73-ILF-GENER-ELE-SPC-807.

6 INSPECTION AND TEST

All cable trenches, conduit routes and cable trays have to be inspected and approved by the Employer or his representative before starting of cable laying works and after cable laying.

After laying and before starting with backfilling and cable termination works, the following tests on the cables shall be executed:

- Continuity test, using a current limiting continuity test device, for all power, control, signal and instrument cables.
- Insulation test for all power cables (conductor-conductor and conductor-ground) with 1,000 V motor driven megger or electronic megger.
- Insulation test for all instrument cables (conductor-conductor and conductor ground) with 300/500 V motor driven megger or electronic megger.
- HV test (very low frequency AC voltage test routine, VFL) for all medium voltage cables.
- Photo documentation
- Verifying cable list with laid cables and note eventual changes

For testing the terminated cables, loop impedance tests shall be carried out before and after backfilling.

All test certificates have to be signed by the contractor and submitted to the employer or his representative immediately after completion of test works.

In case of unsuccessful test results the employer or his representative has to be informed immediately, cable must be replaced on request.

7 DOCUMENTATION

Complete documentation shall be provided for the design, installation, test and commissioning. Additional documentation requirements shall be followed as described in following document “Description of Technical interfaces for Contractors – document number C4G-JI73-ILF-KS007-GEN-TZP-010”.

All documents shall be in English language.

Documents which are mandatory for a Third-Party approval (e. g. through TIČR) have to be in Czech language. The costs for translating and any other additional costs for this procedure have to be borne by the Contractor.

The “red line” site documentation is part of the “as built” documentation and must also handed over.

The final documentation shall include the following documents and drawings (minimum requirements):

a) cover sheet, table of contents

b) technical documents and certificates of all materials used

c) cable route drawings

d) cable route drawings within buildings

e) detail cable trench and conduit route layout and sections

f) conduit and couplings datasheet

g) cable lists

h) block diagrams cabling

i) terminal connection drawings with indicated cable numbers and connected wires and counter terminations

j) photo documentation of all construction phases, of all cable trenches (marking in earth), of all conduits

k) spare parts list

l) measurement reports (test protocols)

m) CE declaration of conformity

n) cable calculations including load and thermal / bursting short circuit withstand calculations

The documents shall be handed over for approval, too.

Additional plans and documents, not specifically specified, but which are necessary for the proper manufacture, installation, commissioning, operation and maintenance of the equipment or installations are also to be provided.

No later than two weeks after the order has been submitted, the contractor must submit a timetable for the delivery of the documents as well as production schedules and quality and inspection plans, which must also be approved by the Employer.

Special attention has to be given to the fact, that documentation must be submitted with sufficient time allocated for approval prior to manufacturing/assembly.

Documentation has to be prepared in accordance with the relevant ISO standards or in the absence of relevant details in those standards the EN standards shall apply.

The final documentation shall be delivered on paper in 3 copies and in electronic form also. Signed protocols shall be scanned and attached to the electronic documentation. The original signed protocols shall be in the first of the three documentation tranches. The type of the electronic files and the number of copies shall be agreed with the Employer.