



Exploration & Production

GENERAL SPECIFICATION

ELECTRICAL

GS ELE 061

Minimum requirements for HV & LV cable sizing

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1. Scope

The purpose of this document is to define the minimum requirements for HV and LV Cable Sizing.

The CONTRACTOR shall demonstrate during the design stage (Basic or Detailed Design) that the present specification and standard requirements have been carefully evaluated and taken into account when performing the cable sizing.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Design and engineering shall conform as a minimum requirement to the current edition of the following in order of precedence:

- Applicable laws, rules and regulations of the country in which the system will be operated. In cases where no "local" regulations exist, then French laws and legislation shall be used
- COMPANY Particular Specifications (if any)
- COMPANY General Specifications
- Applicable International Electrotechnical Commission (IEC) publications
- Applicable French Standards
- Applicable recognised standards and codes (e.g. BSI, VDE, etc.) where IEC publications have not yet been issued.

Standards

Reference	Title
IEC 60183	Guide of the selection of High Voltage Cables
IEC 60228	Conductor of insulated cables
IEC 60269	Low Voltage Fuses
IEC 60287	Electric Cables - Calculation of the current rating
IEC 60364	Electrical Installation of Buildings In particular: Part 4: Protection for Safety Protection against Electric Shock Part 5: Selection and erection of Electrical Equipment Chapter 52: Wiring Systems
IEC 60947	Low Voltage Switchgear and Controlgear



Reference	Title
NF C 13-200	High Voltage Electrical Installations - Rules (available in English version)
NF C 15-200	Low Voltage Electrical Installations - Rules (Whenever particular fields are not covered by the IEC recommendations) (available in English version)

The above list shall not be considered as complete and other applicable IEC standards or French Standards can be referred to by the CONTRACTOR when performing the cable sizing calculation note.

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS ELE 001	Electrical Design Criteria

3. Deviations

The CONTRACTOR shall advise the COMPANY of any deviations made in respect of the present specification and shall request COMPANY's specific prior approval.

Should this Specification conflict with requirements of the listed standards, the CONTRACTOR shall request clarification from the COMPANY.

4. General requirements

4.1 General

With reference to the **GS ELE 001** section 9, a cable sizing calculation note shall be issued by the CONTRACTOR at the Basic Engineering phase of the project based on the present specification and listed standards.

During the Detailed Engineering Phase, the CONTRACTOR shall endorse and reissue the calculation note performed at the basic design stage based on updated VENDOR, MANUFACTURER data for:

- Cables
- Protection devices (fuses, CB, relays, etc.)
- Etc.

4.2 Required results

The calculation note shall provide all details for the appropriate selection of HV, LV power feeder, Motor feeder, AC and DC power and main lighting cables.

All the cable sizing parameters and requirements further detailed in Section 5 of the present specification shall be carefully addressed and submitted for COMPANY's review/approval.

5. Cable Sizing Requirements/Criteria

The minimum following requirements/parameters shall be taken into account when performing cable sizing:

- Site Conditions
 - Ambient conditions (soil/air temperature, soil resistivity, etc.)
 - Type of installation, above head, underground, depth of laying, number of layers, exposition to sun radiation, etc.
- Network characteristics (voltage, number of phases, neutral system IT, TN, TT, TN-S, TN-C, distributed neutral or not, etc.)
- Cable Type (armoured, non-armoured, single core, multicore, etc.)
- Cable Current Carrying Capacities according to the standard conditions
- Cable Current Carrying Capacities according to the site conditions (derating factors based on site conditions)
- Type of loads to be fed
- Steady state condition voltage drop
- Motor starting voltage drop
- Fault level of system (based on switchgear fault rating)
- Maximum permissible fault duration
- Type and setting of overload and Short-Circuit Protection with respect to the Neutral System.



- Prospective and maximum permissible touch voltage when applicable
- Harmonic level.

5.1 Site Conditions

5.1.1 Ambient Conditions

The main ambient conditions to be taken into account shall be provided by the COMPANY part of the main basic design data and documentation as follows:

- Maximum dry bulb temperature
- Maximum design temperature
- Soil temperature
- Soil resistivity (when applicable).

Should these information not be available, the [IEC 60287](#) Part 3-1 shall be referred to for the definition of operating ambient conditions and CONTRACTOR may have to perform site survey to determine the soil resistivity.

5.1.2 Site Installations

The main general rules for the cable routing (above ground on trays/ladders, directly buried, buried in duct, etc.) shall be defined in the COMPANY general and project particular specifications, however, it remains the CONTRACTOR responsibility to ensure that the appropriate parameters (number of layers/ladders/spacing between ladders/cables, number of cable layers, etc.) are suitably taken into account when evaluating the site conditions derating factors.

5.2 Network Characteristics

The network characteristics shall be carefully reviewed to identify the specific sizing criteria to be performed/checked.

In particular the Neutral System, the distribution or not of the neutral and relevant overload and short-circuit protection shall be identified to ensure that the final cable selection provides the appropriate personal and electrical equipment protection (refer to the tabulation given in Appendix 1 which defines the main guidelines/sizing criteria).

5.3 Cable Current Carrying Capacities and Derating Factors

For the definition of site cable current carrying capacities, the CONTRACTOR shall first refer to the cable rated characteristics as provided in the relevant standards and then apply the appropriate derating factors to account for the site conditions.

5.3.1 Cable Current Carrying Capacities

The CONTRACTOR shall first refer to the cable rated current carrying capacities listed in the relevant standards:

- [IEC 60364-5-52](#) for the LV installation
- [NF-C-13 200](#) for the HV installation.

Note: Such tabulations shall be provided in appendix to the calculation note so as to allow for COMPANY review.

5.3.2 Derating factors

The following site conditions/parameters shall be carefully reviewed so as to determine the final overall derating factor that shall be applied on cable standard rated current carrying capacities.

- Ambient conditions: Air/soil temperatures
- Soil resistivity
- Depth of installation when underground
- Laying and grouping factors (French standards derating factors shall apply even for IEC based calculation when grouping factors are not defined in the IEC, as an example multiple cable layers on ladder shall be based on French Standards)
- Sun radiation
- Hazardous areas (de-rating factor = 0.85 as per French standard [NF C 15-100](#), to be applied even for IEC based calculation)
- Parallel cables for same circuit
- Harmonic Level for specific loads and cases.

The following standards shall be strictly referred to for such derating factors calculation:

- [IEC 60364-5-52](#) for the LV installation
- [NF-C-13 200](#) for the HV installation.

The CONTRACTOR shall provide all details for the definition of the overall derating factor. As a minimum, Standards derating factor tabulation references shall be provided, copy of these tabulations may also be attached in Appendix to the calculation note. All site conditions that may be encountered shall be carefully addressed and the relevant site current carrying capacities assessed.

For cables routing through different conditions (above ground, underground, etc.), the most stringent one shall be used for the final cable selection.

5.3.3 MANUFACTURER Data

During the detailed design stage, the ESPCC CONTRACTOR shall refer to the cable MANUFACTURER data when MANUFACTURER consolidated cable current carrying capacities and installation derating factors are provided. When performing the overall derating factor calculation, the CONTRACTOR shall carefully evaluate the data since the basis (ambient air or ground temperatures, soil thermal resistivity, etc.) may differ from the IEC and/or French standards.

In such a case, the CONTRACTOR shall update the Cable Sizing Calculation Note accordingly and to provide the full details.

5.4 Voltage Drop

Unless otherwise stated in the COMPANY project particular specification, the section 6.4 of "Electrical Design Criteria" [GS ELE 001](#) shall apply for the maximal steady state and transient operation voltage drops within the cables.

The CONTRACTOR shall clearly define in the calculation note the voltage drop and formulae that are used for COMPANY review.

5.5 Overload and Short-Circuit Withstand

The CONTRACTOR shall evaluate the cable overload and short time thermal withstand capability based on:

- Neutral System
- Maximum permissible fault duration (5 sec max unless otherwise specified)
- Overload protection
- Short-circuit protection (fuses or circuit-breaker characteristics, relay setting and operating time)
- Fault level of system (based on switchgear fault rating)
- Cable characteristics (conductor and insulation type, etc.) and relevant permanent and maximum admissible conductor and insulation temperature.

As a reminder, the protection tripping time shall be defined in accordance with the expected time threshold to ensure suitable selectivity, both personal and equipment protection and maximal service continuity.

Basically, final feeders (such as motor feeder) may be sized based on 100 to 150 ms protection tripping time. For upstream cables (network or power generation cables), a tripping time of up to 1 sec may have to be considered.

This evaluation will allow for the definition of a minimum cable cross section as well as a maximum cable length to allow for:

- Suitable cable withstand to fault conditions
- Suitable protection device trip/operation within the acceptable permissible fault duration.

The CONTRACTOR shall provide the full calculation details (formulae and samples) to allow for COMPANY review.

5.6 Prospective and maximum permissible touch voltage

The prospective and maximum permissible touch voltage shall be calculated and carefully taken into account when applicable (refer to Appendix 1) since it implies personal protection against direct and indirect contact when a first or even second fault occurs.

These calculations shall be implemented according to the relevant IEC and French standards and mainly based on:

- Neutral System
- Maximum permissible fault duration (refer to Appendix 1)
- Short-circuit protection (fuses or circuit-breaker characteristics and earth leakage relay when implemented)
- Cable characteristics (presence or not and section of a Protective conductor).

As for above Section 5.5, this calculation will allow for the definition of a minimum cable cross section as well as corresponding maximum cable length to allow for:

- Suitable cable withstand to fault conditions.
- Suitable protection device trip/operation within the acceptable permissible fault duration.

The CONTRACTOR shall provide the corresponding formulae and samples to allow for COMPANY review.

5.7 Main Cable Sizing Criteria Summary

The tabulation provided in Appendix 1 summarises the different network characteristics and relevant criteria that shall be accounted for when sizing the cables.

The final selected cable sizes shall be the combination of the most stringent criteria for both the conductor cross section and maximal cable length.

6. Cable Sizing Calculation Note - Documentation

6.1 General

The calculation note to be submitted by the CONTRACTOR shall address all details and criteria mentioned in previous sections for the appropriate selection of:

- All HV cables
- All LV power feeder cables
- Typical Motor feeder cables (selection chart)
- AC and DC power cables (selection chart)
- Lighting cables (selection chart).

As previously highlighted, all standards tabulations shall be strictly referred to so as to facilitate COMPANY review.

6.2 HV Cables

The CONTRACTOR shall provide all the detailed calculations for each HV cable (either distribution or motor feeder).

All cable current carrying capacities as well as all the derating factors for the different site ambient and installation conditions shall be clearly listed and identified.

A tabulation shall summarise for each HV cable all the calculation criteria (as per above section 5) and shall define the final selected cable type and cross section.

6.3 LV Power Feeder Cables

The CONTRACTOR shall provide all the detailed calculations for each LV power distribution cable:

- Transformer secondary cables
- Transformer feeder
- Main distribution feeder between MCC



- EDG Incomer
- Etc.

All cable current carrying capacities as well as all the derating factors for the different site conditions and installation conditions shall be clearly listed and identified.

Then a tabulation shall summarise for each cable all the calculation criteria as defined in previous section and shall define the selected cable type and cross section. All protection devices characteristics that have been considered shall be provided in appendix.

6.4 Typical LV Motor Feeder Cables

The CONTRACTOR shall provide a typical LV motor feeder cable sizing selection charts in accordance with the one define in Appendix 2 for each installation condition and type that may be encountered on the project.

The following information shall therefore be available on such chart:

- System characteristics
- Installation summary complete with relevant overall derating factor
- Cable rated current carrying capacities as per the standards
- Cable site current carrying capacities as per overall derating factor
- All motor related data:
 - All IEC motor rated power
 - Motor rated efficiency, power factor, current
 - Motor starting current and starting PF
 - Protection characteristics (CB ratings, CB magnetic current, Fuse rating and type, etc.).

All the protection (fuses, CB, etc.) detailed characteristics and curves shall be provided in appendix. At the detail design stage, the MANUFACTURER confirmed data shall be used.

As mentioned in previous sections, samples of the applied formulae shall be provided to allow for COMPANY review.

6.5 Typical LV Distribution Feeder Cables

The CONTRACTOR shall provide a typical LV distribution feeder cable sizing selection chart in accordance with the guidelines defined in Appendix 2.

The following information shall therefore be available on such a chart:

- System characteristics
- Installation summary complete with relevant overall derating factor
- Cable rated current carrying capacities as per the standards
- Cable site current carrying capacities as per overall derating factor
- All feeder related data:
 - All expected feeder rated power from 1A to 1000A
 - Feeder rated current and power factor



- Feeder expected transient current and transient PF (that may refer to downstream biggest motor starting and/or reacceleration condition, etc.).
- Protection characteristics (CB ratings, CB magnetic current, Fuse rating and type, etc.).

All the protection (fuses, CB, etc.) detailed characteristics and curves shall be provided in appendix. At the detail design stage, the MANUFACTURER confirmed data shall be used.

As mentioned in previous sections, samples of the applied formulae shall be provided to allow for COMPANY review.

6.6 Typical AC and DC UPS Power Cables

The CONTRACTOR shall provide:

- Detailed calculation for the battery cables as well as DC and AC UPS secondary cables up to the distribution boards
- Typical DC and AC UPS distribution feeder cable sizing selection chart in accordance with the guideline form define in Appendix 2.

All the protection (fuses, CB, etc.) detailed characteristics and curves shall be provided in appendix. At the detail design stage, the MANUFACTURER confirmed data shall be used.

As mentioned in previous sections, samples of the applied formulae shall be provided to allow for COMPANY review.

6.7 Lighting Cables

Main lighting cables selection chart shall be provided at the basic design stage in accordance with the guidelines provided in Appendix 2.

For final lighting circuits, a separate dedicated calculation note shall be issued at the detailed design stage.

Appendix 1 Network characteristics - Sizing criteria

NETWORK CHARACTERISTICS						CABLE SIZING CRITERIA								
Neutral System	Neutral to Earth	Protection Conductor with Cable	Distributed Neutral	Protection Device	Diff. Protection	Current Carrying Capacity	Voltage Drop	Voltage Drop during starting	Short Circuit Calculation	Touch Voltage Calculation	Maximum Disconnecting Time for the Touch Voltage (*0)			
						Smin	Lmax	Lmax	Smin and/or Lmax	Lmax				
TT	Y	N	Y/N	CB	Y	Y	Y	Y	Smin	N/A	N/A			
TT	Y	N	Y/N	Fuse	Y	Y	Y	Y	Lmax / S 2 phase fault (*1)	N/A				
TNC / TNS	Y	Y	Y	CB	N	Y	Y	Y	Refer to Touch Voltage	Lmax (*1) For I = Imag CB	Uo (V)	Sec	Sec	
TNC / TNS	Y	Y	Y	Fuse	N	Y	Y	Y	Refer to Touch Voltage	Lmax (*1) For I fuse within max tripping time	120	0.8	0.35	
											230	0.4	0.2	
											400	0.2	0.05	
											>400	0.1	0.02	
IT	N	N	N/Y	CB	Y	Y	Y	Y	Smin (ICCmax) Lmax (Imag) (*1)	N/A	N/A			
IT	N	N	N/Y	Fuse	Y	Y	Y	Y	Smin (fuse) Lmax (Ia – t max) (*1)	N/A				
ITS	N	Y	N	CB	N	Y	Y	Y	Refer to Touch Voltage	Lmax (*1) (2 nd Default)	Uo/U (V)	Sec	Sec	
ITS	N	Y	N	Fuse	N	Y	Y	Y	Refer to Touch Voltage	Lmax (*1) (2 nd Default)	120/240	0.8	0.4	
											230/400	0.4	0.2	
											400/690	0.2	0.06	
											580/1000	0.1	0.02	
ITS	N	Y	Y	CB	N	Y	Y	Y	Refer to Touch Voltage	Lmax (*1) (2 nd Default)	Uo/U (V)	Sec	Sec	
ITS	N	Y	Y	Fuse	N	Y	Y	Y	Refer to Touch Voltage	Lmax (*1) (2 nd Default)	127/220	5	1	
											230/400	0.8	0.5	
											400/690	0.4	0.2	
											580/1000	0.2	0.08	

(*0) As per IEC 60364-4-42 table 41A, 41B, 41C. Unless other specified in the Project Particular Specification, CONTRACTOR to apply the recommendation of the IEC 60364-7 for the conventional touch voltage selection ($U_L = 50V$ or $25V$ RMS for AC systems).

(*1) CONTRACTOR to refer to the relevant standards for the formulae to be applied in order to verify that criteria

Definitions:

- Smin > minimal required cross section
- Lmax > maximal acceptable cable length
- Uo > phase to neutral voltage
- U > phase to phase voltage
- U_L > Conventional touch voltage



Appendix 2 Typical cable sizing result chart for motor and distribution feeders



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Appendix 2

ELECTRICAL MOTORS CABLES CHART FOR CABLES IN OPEN AIR, AT 40°																																		
Maximum permissible lengths (m) :															FINAL RESULTS															Data for Cable Type:				
																														Cu/XLPE - cables in free air ***				