

GENERAL SPECIFICATION

ELECTRICAL

GS EP 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.

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.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
IEC 60183	Guide of the selection of High Voltage Cables
IEC 60228	Conductor of insulated cables
IEC 60269-1	Low Voltage Fuses - Part 1: General Requirements
IEC 60287 (All parts)	Electric Cables - Calculation of the current rating - All parts
IEC 60364-4-41	Electrical Installation of Buildings - Protection for Safety - Protection against Electric Shock
IEC 60364-4-43	Electrical Installation of Buildings - Protection for Safety - Protection against overcurrent
IEC 60364-5-52	Electrical Installation of Buildings - Protection for Safety - Selection and erection of Electrical Equipment Wiring Systems

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Reference	Title
IEC 60502-2	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) - Part 2: Cables for rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)
IEC 60947 (All parts)	Low Voltage Switchgear and Controlgear - All parts
IEC 61892-4	Mobile and fixed offshore units - Electrical installations - Part 4: Cables
NF C13-200	High Voltage Electrical Installations - Rules
NF C15-100	Low Voltage Electrical Installations (Whenever particular fields are not covered by the IEC recommendations)

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.

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP ELE 001	Electrical design criteria
GS EP ELE 021	Electrical design criteria for floating units
GS EP ELE 091	Minimum Contractor document requirements
GS EP ELE 161	Electrical cables

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 EP ELE 091**, 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.

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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 thermal 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
- Prospective and maximum permissible touch voltage when applicable
- Harmonic level
- When required in Project specification, economic sizing may also be considered.

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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 thermal resistivity.

Should these information not be available, the [IEC 60287](#) Part 3-1 shall be referred to for the definition of operating ambient conditions or Contractor may have to perform site survey to determine the soil thermal 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 onshore LV installation
- [IEC 60502-2](#) for onshore HV installation
- [IEC 61892-4](#) for both offshore HV and LV installation.

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

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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 thermal 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
- Flare radiation
- Hazardous areas (de-rating factor = 0.85 as per French standard [NF C15-100](#) when applicable)
- Parallel cables for same circuit
- Harmonic Level for specific loads and cases.

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

- [IEC 60364-5-52](#) for onshore LV installation
- [IEC 60502-2](#) for onshore HV installation
- [IEC 61892-4](#) for both offshore HV and LV 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.

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5.4 Voltage Drop

Unless otherwise stated in the Company project particular specification, the section 5.4 of **GS EP 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 (unless otherwise specified, 1 sec maximum for LV at minimum short-circuit value for fused protected circuit)
- 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 preliminary protection coordination study.

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 Fault protection

Proper implementation of fault protection shall be fully demonstrated since it implies personal protection against direct and indirect contact when a first or even second fault occurs (refer to Appendix 1).

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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 UPS 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.

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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.

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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 1000 A
 - 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.

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6.8 Cable Sizing software

Contractor shall perform all cable sizing calculation using IEC version of UTE approved cable calculation software.

Alternatively, the use of Contractor own cable sizing software / calculation sheet may be considered provided that Contractor provide Company with a complete validation dossier (including all source files) demonstrating full compliance to above requirements/criteria and to IEC standards.

7. Other references

Following documents are applicable:

- External documents: [IEC 60183](#), [IEC 60228](#), [IEC 60269-1](#), [IEC 60364-4-43](#), [IEC 60947](#), [NF C13-200](#)
- Total General Specifications: [GS EP ELE 021](#), [GS EP ELE 161](#).

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Appendix 1
Appendix 1 Network characteristics - Sizing criteria

NETWORK CHARACTERISTICS						CABLE SIZING CRITERIA							
Neutral System	Neutral to Earth	Cable with Protection Conductor	Distributed Neutral	Protection Device	Diff. Protection	Current Carrying Capacity	Voltage Drop	Voltage Drop during starting	Short Circuit Calculation for 3Phase, 2Phase and 2Phase to earth fault	Protective devices/circuit impedances	Fault protection of persons as per IEC 60364-4-41		Definitions
						Smin	Lmax	Lmax	Smin and/or Lmax		Maximum Disconnecting Time (Tmax) of final circuits		
											table 41.1		
TT	Y	N	Y/N	CB	Y	Y	Y	Y	Smin for Icc Max Lmax versus S for CB tripping current	Section 411.5.3 $R_A \times I_{\Delta n} \leq 50 \text{ V}$	Uo (V)	Sec	R_A is the sum of the resistance in Ω of the earth electrode and the protective conductor for the exposed conductive-parts. $I_{\Delta n}$ is the rated residual operating current of the RCD.
TT	Y	N	Y/N	Fuse	Y	Y	Y	Y	Smin (fuse) Lmax versus S For Icc min / Tmax (fuse tripping curve)		≤ 120 ≤ 230 ≤ 400 > 400	0.3 0.2 0.07 0.04	
TNC / TNS	Y	Y	Y	CB	N	Y	Y	Y	Refer to fault protection	Section 411.4.4 $Z_s \times I_a \leq U_o$	Uo (V)	Sec	Z_s is the impedance in ohms (Ω) of the fault loop comprising: • The source (maximum impedance, i.e. minimum short-circuit power, shall be considered) • The line conductor up to the point of the fault, and • The protective conductor between the point of the fault and the source. I_a is the current in amperes (A) causing the automatic operation of the disconnecting device within the specified time. U_o is the nominal a.c. or d.c. line to earth voltage in volts.
TNC / TNS	Y	Y	Y	Fuse	N	Y	Y	Y	Refer to fault protection		≤ 120 ≤ 230 ≤ 400 > 400	0.8 0.4 0.2 0.1	
IT	N	N	N/Y	CB	Y	Y	Y	Y	Smin for Icc Max Lmax versus S for CB tripping current	For 2 nd fault Section 411.6.4 $R_A \times I_{\Delta n} \leq 50 \text{ V}$	Uo (V)	Sec	R_A is the sum of the resistance in Ω of the earth electrode and the protective conductor for the exposed conductive-parts. $I_{\Delta n}$ is the rated residual operating current of the RCD.
IT	N	N	N/Y	Fuse	Y	Y	Y	Y	Smin (fuse) Lmax versus S For Icc min / Tmax (fuse tripping curve)		≤ 120 ≤ 230 ≤ 400 > 400	0.3 0.2 0.07 0.04	

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Appendix 1

NETWORK CHARACTERISTICS						CABLE SIZING CRITERIA							
Neutral System	Neutral to Earth	Cable with Protection Conductor	Distributed Neutral	Protection Device	Diff. Protection	Current Carrying Capacity	Voltage Drop	Voltage Drop during starting	Short Circuit Calculation for 3Phase, 2Phase and 2Phase to earth fault	Protective devices/circuit impedances	Fault protection of persons as per IEC 60364-4-41		
						Smin	Lmax	Lmax	Smin and/or Lmax		Maximum Disconnecting Time (Tmax) of final circuits		Definitions
											table 41.1		
ITS	N	Y	N	CB	N	Y	Y	Y	Refer to fault protection	For 2 nd fault Section 411.6.4 $2 Z_s \times I_a \leq U$	U ₀ (V)	Sec	U is the nominal a.c. or d.c. voltage in V between line conductors.
ITS	N	Y	N	Fuse	N	Y	Y	Y	Refer to fault protection		≤120	0.8	Z_s is the impedance in Ω of the fault loop comprising the source (maximum impedance, i.e. minimum short-circuit power, shall be considered), the line conductors and the protective conductors of the circuit.
											≤230	0.4	
											≤400	0.2	I_a is the current in A causing operation of the protective device within the required time.
											>400	0.1	
ITS	N	Y	Y	CB	N	Y	Y	Y	Refer to fault protection	For 2 nd fault Section 411.6.4 $2 Z's \times I_a \leq U_0$	U ₀ (V)	Sec	U is the nominal a.c. or d.c. voltage, in V, between line conductor and neutral conductor or mid-point conductor, as appropriate.
ITS	N	Y	Y	Fuse	N	Y	Y	Y	Refer to fault protection		≤120	0.8	Z's is the impedance in Ω of the fault loop comprising the source (maximum impedance, i.e. minimum short-circuit power, shall be considered), the line conductor neutral conductor and the protective conductors of the circuit.
											≤230	0.4	
											≤400	0.2	
											>400	0.1	I_a is the current in A causing operation of the protective device within the required time.

Definitions:

- Smin minimal required cable cross section
- S cable cross section
- Lmax maximal acceptable cable length
- U₀ phase to neutral voltage
- U phase to phase voltage

