

GENERAL SPECIFICATION

ELECTRICAL

GS EP ELE 460

Engineering Studies

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1. Scope

This document is intended to define the minimum requirements for documents to be issued by Contractor.

These requirements are the minimum one's and any additional information necessary for the complete execution of the Basic Design and/or Detailed Engineering and for the final documentation shall be prepared and added by the Contractor.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

Design and engineering shall conform to the appropriate sections of the latest editions (with amendments) of the relevant IEC, CENELEC standards and codes.

The following order of precedence applies specifically to electrical equipment:

- 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 regulations shall be used
- Company Particular Specifications and data sheet (if any)
- Company General Specifications
- Applicable International Electrotechnical Commission (IEC) standards
- Applicable European Standards by CENELEC
- Applicable recognised standards and codes (UTE-NFC, BS, VDE, etc.) when 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 60027	Letter symbols to be used in electrical technology
IEC 60050	International Electrotechnical Vocabulary
IEC 60071 (Parts 1; 2)	Insulation co-ordination - Parts 1; 2
IEC 60079 (Parts 0; 10; 14; 17; 19)	Explosive atmospheres - Parts 0; 10; 14; 17; 19
IEC 60617	Graphical symbols for diagrams
IEC 60865 (Parts 1; 2)	Short-circuit currents - Calculation of effects - Parts 1; 2

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Reference	Title
IEC 60909 (Parts 0; 1; 2; 3; 4)	Short-Circuit Current Calculation in 3 phase AC Systems - Parts 0; 1; 2; 3; 4
IEC 62305-2	Protection against lightning - Part 2: Risk management

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 061	Minimum requirements for HV & LV cable sizing
GS EP ELE 091	Minimum Contractor document requirements
GS EP ELE 221	Electrical Control System (ECS)
GS EP INS 134	Design and supply of integrated control and safety system
GS EP TEC 007	Obsolescence and Lifetime Cycle Management

3. General

Any deviation to the Electrical General Specifications shall be subject to Company approval.

All documents shall have a date, a revision number and the clear explanation of the revision (issued for comment, as built, etc.).

The revised portion of the document shall be highlighted.

All documents shall be in a standardised format, the recommendation is ISO A0, A1, A2, A3 and A4.

Units shall be from SI.

On all drawings, a legend shall give a clear explanation of all symbols and markings used.

At the end of each project stage (basic engineering, detailed engineering, as-built etc.) project documents shall be provided in electronic file (native and Acrobat formats).

4. Contractor documents

4.1 Electrical Deliverable List

The documents required are listed in **GS EP ELE 091**. A schedule of electrical document delivery shall be prepared and shall be updated periodically.

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4.2 Basis of Electrical System Design, Protection and Control Philosophy

The purpose of this document is to define the general principles for the design, control philosophy and installation of the power generation, distribution and associated electrical systems required for the project.

It shall be based on the relevant pre-project documents (e.g.: Statement of Requirements) and **GS EP ELE 001** or **GS EP ELE 021**.

All applicable items as described in the general specifications **GS EP ELE 001** or **GS EP ELE 021** shall be developed as required and options shall be chosen.

4.3 Electrical Consumer List and Load Balance

This document shall include:

- Electrical loads issued from the process equipment list
- Utility loads (Air compressor, HVAC, UPS's, etc.)
- Packages auxiliary loads
- Lighting and small power
- Any other miscellaneous loads not included in the above categories.

All the loads, including standby units, shall be listed under the switchboard/motor control centres/bus section to which they are connected so that the load and size of each switchboard/MCC can be determined.

All the loads shall also be listed per process unit and package so that the loads of each package can be determined.

One sheet per type of power source (normal, essential, emergency) shall be prepared.

This document shall include the following data:

- Revision index per item
- Tag number and designation
- System number
- Validity (power rating has been: Estimated, Confirmed or Final)

Note: The validity column does not appear in the example given in Appendix 1, however this column shall be added to the load list.

- Equipment service (continuous, intermittent, stand by)
- Diversity factor (for intermittent loads)
- Load type (motor, passive load, etc.)
- Service voltage
- Load demand (shaft power)
- Nameplate rating

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- Rated speed
- Power factor
- Efficiency
- Calculated active absorbed power (shaft power/efficiency)
- Calculated reactive absorbed power
- Loads required for main power restarting.

The total design load is defined below:

Total design load = Continuous load + intermittent loads (affected by diversity factor) plus the rated output of the largest stand by motor.

Main power generation sizing shall consider the total design loads plus the required power margin (20% as per **GS EP ELE 001**).

Summary sheets shall give for each type of power source, voltage level, bus bar and for each specific configuration (process, summer/winter, offloading, etc.) the following values:

- Global apparent power
- Global power factor
- Global active and reactive power
- Generators rating
- Spinning reserve.

The individual power transformer ratings shall also be included in the summary.

All the calculation formula shall be made available for Company review.

An example of electrical consumer list and load balance is shown in Appendix 1.

4.4 Electrical Equipment List

The Electrical equipment list shall include electrical equipment such as Switchgear, MCC, UPS, Transformers, panels, etc.

Item to be listed shall be:

- Tag number
- Designation
- Manufacturer
- Type (Manufacturer model or reference no.)
- Rating
- Supply voltage
- Location

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- Overall dimensions
- Weight.

4.5 Cable Schedule

During basic design, a main cable schedule shall be established (main feeders, main consumer supply).

For the detailed design, a complete cable schedule is required.

It shall include at least:

- Tag number
- Origin and destination (from/to)
- Length
- Number of cores and cross section area
- Type (this may be in the form of alpha-numeric references to denote cable characteristic data as appropriate)
- Service voltage
- Equipment rated current.

4.6 Project Particular Specifications

The project particular specifications shall determine the options to be selected, and shall include amendments/deletions to the Company General Specifications in order to scope with the specific project requirements.

4.7 Equipment Data-Sheet

The Company Data sheet related to the described equipment shall be used.

Any modifications to the Data Sheet shall be brought to the Company attention.

Wherever no Company data sheet exists, a new one shall be issued.

4.8 Long Lead Item Specifications, Data-Sheets, Requisition

Long lead items have been defined during basic engineering by Company.

Basic engineering Contractor shall issue relevant specifications, data sheets and requisition for Company approval.

A price break-down form shall be provided in order to compare and evaluate the Supplier's bids.

4.9 Long Lead Item Technical Bid Evaluation

The bid evaluation sheet shall include all technical characteristics, a description of the options/deviations/amendments given by each Supplier and the price break-down as required in the requisition.

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Recommendations highlighting positive and negative aspects of each bid shall be issued for Company review.

4.10 Electrical Equipment Requisition

Requisition shall be issued for Company technical approval.

4.11 Electrical Equipment Technical Bid Evaluation

The bid evaluation sheet shall include all technical characteristics, a description of the options/deviations/amendments given by each Supplier.

Recommendations highlighting positive and negative aspects of each bid shall be issued for Company approval.

4.12 Single line Diagrams

Minimum requirements are:

- One overall single line diagram with all generators, external power supplies, and main power distribution networks (HV, LV)
- Substation(s) single line diagram(s) if necessary
- Auxiliary typical single line diagram (UPS's, heat tracing, lighting, etc.).

Single line diagrams shall include the following:

- Switchgear:
 - Rated voltage
 - Nominal current
 - Short circuit current withstand values (kA - s).
- Main isolating equipment:
 - Rating
 - Normal operating position (NO/NC).
- Transformers:
 - Rated power kVA
 - Primary and secondary voltages
 - Zcc%
 - Vector group
 - Neutral system
 - Tapping range
 - Cooling method.

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- Generators:
 - Rated output kVA and PF
 - Driver mechanical power at minimum and maximum site temperature
 - Rated Voltage
 - Reactance (X''_d , X'_d and X_d).
- Main motors, packages, etc.
 - Rated power.
- For detailed substation single line diagrams, shall be drawn:
 - All HV motors
 - Low voltage network
 - UPS (AC and DC)
 - Emergency supply (Diesel, etc.)
 - Secondary low voltage switchboards (lighting, etc.).

These one line diagrams shall indicate:

- Tag number and designation of equipment
- Neutral systems (Earthing transformers and/or neutral impedances and surge protection devices)
- Frequency
- Mechanical interlock for incomers and bus tie
- Synchronisation devices
- Dotted lines shall be drawn to show buildings and area or boundary limits.

Single line diagrams shall be updated at each stage of the project.

4.13 Typical Protection Diagrams

Typical protection diagrams shall include:

- All protections and their ANSI reference numbers as per **GS EP ELE 001** (Appendix 3 to 6)
- Location of their actions (open, close, permission, information, alarm, etc.)
- Protection/measurement transformer
- Measurement and metering devices
- Auxiliaries.

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The following typical diagrams shall be provided:

- Typical generator incomer (HV & LV)
- Typical transformer incomer
- Typical line/cable incomer
- Typical line/cable feeder
- Typical HV transformer feeder
- Typical bus tie (HV and LV)
- Typical High voltage motor feeder (as many as needed)
- Typical Low voltage motor feeder (as many as needed)
- Typical LV transformer feeder
- Typical distribution feeder.

4.14 Interlocking and Intertripping Diagrams

Typical key interlocking diagrams shall be issued during basic engineering in accordance with **GS EP ELE 001**. For standardisation purpose, with existing facilities, key interlock symbols shall be subject to Company approval.

During detail engineering study, a complete key list shall be issued with the key numbers, their location and the typical interlock diagram to which the key is being referenced.

The key interlock procedures shall be issued before the pre-commissioning phase subject to Company approval.

4.15 Logic Diagrams (including Automatic Transfer Diagrams)

These documents are intended to facilitate an understanding of the system or scheme operation. They represent, by symbols and texts, a system with its inter-action.

These diagrams shall define:

- The successive status of a logic set
- The actions that cause status change
- The events which result from these actions.

Grafcet or logic block diagrams shall be used.

4.16 HV & LV Typical Schematic Diagrams

The typical diagrams consist of one booklet per function describing the detailed functionality required by all equipment and its location (switchgear, ICSS, ECS, Unit, substation, etc.).

Minimum functions required:

- High voltage switchgear
- HV generator, Incoming, Bus-tie, Transformer outgoer, Motor starter (as many as needed)

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- Low voltage switchgear
Incoming, Bus-tie, Transformer outgoer, Feeder outgoer, Motor starter (as many as needed)
- Auxiliary load centres
- Lighting and small power panels
- AC and DC Uninterruptible power supply distribution panels
- Diesel generator control panel.

Per function, the drawings shall include:

- Component list
- Power connections including earthing systems
- Auxiliary supplies
- Measurement and protection connections
- Control/command functionality
- Fault/Alarms/Status description
- Communication links.

4.17 HV & LV Schematic Diagrams

The complete diagrams shall be issued for all equipment (switchgear, panels and distribution boards, etc.). Each individual diagrams shall include:

- Polarities distribution
- Power circuit
- Protection and Control circuit
- Signalling and remote information's schematic
- Terminal blocks diagram with cross references (sources, auxiliaries, intertrip, etc.)
- Part list.

4.18 Switchgear and distribution board schedule

It shall include at least for each feeder of switchgear and distribution board (AC and DC):

- Tag number
- Location within the switchgear
- Apparatus (breaker, contactor, earthing switch, fuse, etc.)
- Meters
- Voltage and current transformers
- Protection relays with the setting range

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- Cable characteristics
- Typical schematic diagram.

4.19 Interconnection Wiring Diagrams

The interconnections drawings shall include:

- Control/command cables (hardwired stop, alarms, etc.)
- Protection cables (pilot lines, differentials, interlocks, etc.)
- Power cables
- Other cables (optic fibres, communication links, etc.).

Cables shall be identified with tag numbers and characteristics.

Whenever package units are present, the drawing shall clearly state the exhaustive interconnection wiring between packages and other equipment.

4.20 Trouble Shooting Diagrams

Trouble Shooting Diagrams shall be functional and not geographic.

Trouble Shooting Diagrams shall consist of one set of schematic diagrams related to equipment plus the associated cross referenced interconnecting and termination diagrams with a cover sheet, and gathered into one booklet.

Trouble Shooting Diagrams shall be issued prior to commissioning.

The minimum requirements are:

- All control, power and signalling circuits
- All terminal blocks
- Tag numbers for cable, terminal blocks, etc.
- Complete interconnecting drawings extracted from latest Manufacturer drawings.

4.21 Load Shedding specification

During basic engineering, a load shedding specification shall be established in co-ordination with process department.

It shall include:

- Conditions to initiate load shedding (Frequency drop, Voltage drop, Turbine high temperature, etc.)
- Required performance
- Load shedding schedule and number of steps.

During basic engineering, load shedding requirements shall be included in the Basis of electrical system design specification.

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4.22 Motor Starting Study

The purpose of this study is to confirm the feasibility of DOL starting without excessive network disturbance.

It shall establish the suitability of turbine/essential and emergency Generator rating (with known value of reactance's) when a large motor is started direct-on line and check the voltage dip with the lowest foreseen load already on the system as this will represent the worst case for the voltage dip. This study also identifies the limit of the transient reactance's of the machines.

Unless otherwise specified, when any large motor is started, the voltage drop shall not be more than 15% at generator terminals and 20% at motor terminals.

The study report shall be issued and shall include:

- Equipment design data
- Network configurations
- Calculation note (with formulas used)
- Calculation results (at each bus)
- Conclusion (feasibility, recommendations, etc.).

4.23 Black Start Specification / Procedure

This document shall define the sequence which shall be followed after a black out. It's a step by step procedure. It shall clearly state once the danger has been cleared, which equipment is necessary for the safe plant restarting (UPS, batteries, diesel generator, HVAC, etc.) and who is allowed to perform it.

This document shall follow and develop the guidelines given in specifications [GS EP ELE 001](#) and [GS EP ELE 021](#).

4.24 Electrical I/O list

An electrical I/O list shall be issued for interface with other systems such as ICSS, power generation packages, etc.

4.25 VDU Graphic Displays Requirements

Graphics displays requirements shall be defined for ICSS and for ECS.

For ICSS the requirements shall be according to [GS EP INS 134](#).

ICSS and ECS display lists shall be prepared during Basic Engineering in accordance with the specification [GS EP ELE 221](#).

Typical displays shall be issued during Detailed Engineering and approved by Company.

4.26 Electrical Control System Design Specification and relevant documents (exchange tables, Architecture, etc.)

During Basic Engineering the ECS project specification shall be issued in addition to the general architecture.

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4.27 Sizing of Equipment

All equipment sizing shall be justified with a calculation note. For instance, capacitive current calculation shall be performed on the HV network to validate the rating of the earthing transformers or transformer neutral impedance.

For HV subsea power transmission system, the voltage insulation sizing of the transmission system shall be justified in accordance with [IEC 60071-1](#) and [IEC 60071-2](#). In particular the study shall verify for the power cable that its voltage insulation level is in accordance with the voltage level seen by the cable all over its length whatever are the operating conditions.

The calculation note shall clearly state the principles and input data used for the calculation. All coefficients shall be clearly described.

4.28 Load Flow and Short-Circuit Calculation

Load flow analysis shall be carried out for various conditions of operation and a validation of the power generation and distribution network equipment sizing shall be done.

The different operating conditions, including no-load conditions, shall be clearly identified and described.

Short circuit calculation shall be carried out in line with [IEC 60909](#) (all parts) with a description of the network configuration:

- Minimum short circuit values
- Maximum short circuit values.

Network configuration for short circuit calculation shall be:

- N+1 turbine
- N turbine + 1 essential generator
- N turbine + 1 emergency generator
- All essential generator + 1 turbine (if essential and main switchboard are not at the same voltage level).

When the network is connected to an external grid, the previous network configurations shall be considered with and without the external grid.

The short circuit rating of LV switchboards shall be determined with one transformer in operation (bus tie normally open) and all the LV consumers in service.

A summary table shall be done for each bus bar with:

- Rated current
- Maximum Balanced short circuit values:
 - Initial symmetrical short circuit current I''_k , and for thermal withstand of switchgear. If a more accurate value is required Contractor shall use [IEC 60865-1](#) and [IEC 60865-2](#) or appendix A of [IEC 60909-0](#) to calculate the thermal equivalent short-time current I_{th}
 - Steady state short circuit current I_k

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- Peak short circuit current used for electrodynamics' stresses and making capacity of circuit breakers: I_p
- Symmetrical short circuit breaking current used for breaking capacity of circuit breakers: I_b @100 ms.
- Minimum short circuit values:
 - Initial symmetrical short circuit current I''_{k3}
 - I''_{k2} Line to line short circuit current without earth connection or I_{k2E} Line to line with earth for network with earth connection
 - I''_{k1} Line to earth short circuit current.

In addition minimum short circuit values shall be calculated at the equipment end terminals to verify proper tripping conditions.

For long step-out (>10km) cable transmission line, short circuit current calculation shall take into account the short circuit current contribution of the cable.

The Complete electrical network data in the software configuration shall be given to Company at the end of the calculation for future use (upgrading, new simulation, etc.).

On project request, the software to be used might be imposed.

4.29 Dynamic Stability Study

This study models the dynamic response of an electrical power system and monitors the ability of the network to give stable responses to transient conditions and disturbances such as short circuits, generator tripping, starting of large motors, large power transformers and harmonic filter inrush current, tripping of large load, Automatic Transfer System (ATS) sequence, power plants interconnection or public grid connection.

The results will be used to:

- Verify selection of equipment and system configuration
- Determine the need for load shedding following a fault and or loss of generation and maximum acceptable load shed times
- Confirm the protection plan
- Confirm stability of the system and maximum acceptable fault clearance times
- Verify motor starting capability
- Verify motor reacceleration and restart capability and develop restart sequences.

The Complete electrical network data in the software configuration shall be given to Company at the end of the calculation for future use (upgrading, new simulation, etc.).

Simplified models of transfer function block diagrams for main and essential power generation shall be used for calculation (governor and AVR).

For long step-out (>10km) cable transmission line, the transient condition shall also assess the dynamic response to the trip at full load of the circuit breakers at each end side of the cable transmission line.

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If the electrical power system encompasses equipments such as: Synchronous condenser, Static Var Compensator and On Load Tap Changer; the dynamic stability study shall also model their dynamics responses.

Simplified models of transfer function block diagrams for these equipments and the control philosophy described in the Basis of Electrical System Design shall be used for calculation.

The document shall verify the performance requirements for load acceptance and rejection.

4.30 Governor and AVR Models and transfer function block diagrams

Governor and AVR models and transfer function block diagrams shall be drawn for main and essential power generation.

Block diagram shall be in accordance with IEEE standards.

Each value within the model shall be given with its available range.

4.31 Start-up and ramp-up simulation

For HV subsea power transmission system, based on the sequence described in the Black Start Specification and the control philosophy described in the Basis of Electrical System Design, this study shall simulate the start-up and ramp-up of the power transmission system (including: transformers, power cable and if any: SVC, Harmonic filter, compensation reactors) from black start to full load.

The simulation shall in particular study for the power transmission system: the voltage and current variations, grid power factor and the reactive power flow.

4.32 Cable Sizing Calculation note and Charts

This document shall be in accordance with **GS EP ELE 061**.

4.33 Harmonic Distortion studies

For installations which contain a significant percentage of non-linear loads (e.g. variable speed drives, large thyristor controlled heaters, etc.), harmonic studies shall be produced.

These studies shall verify that any harmonics on the system are in accordance with acceptable limits as per IEEE 519, taking full account of the various harmonic sources in the network.

Supplier data shall be used for calculation.

The calculation shall describe various scenarios in the most stringent condition with different network configuration. When filters are used, a calculation shall be carried out without filters and another with filters.

Clear conclusions and recommendations shall be given.

The Complete electrical network data in the software configuration shall be given to Company at the end of the calculation for future use (upgrading, new simulation, etc.).

In case of use of large VSD (>15 MW) with an islanded power plant, Sub Synchronous Torsional Interaction (SSTI) study of the power plant shall be done by a third party in cooperation with the VSD's supplier under the supervision of the contractor.

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For long step-out cable transmission line:

- The study shall calculate and display its impedance versus frequency (up to harmonic 50)
- The study shall calculate the current and voltage harmonics due to transformer inrush current (Harmonic 2).

4.34 Selectivity Study and relay setting booklets for AC and DC systems

Preliminary protection and co-ordination diagrams shall be proposed when loads are tentatively sized and before major equipment is placed on order, to ensure that all the HV, LV and DC systems will be ultimately selective.

The final electrical co-ordination study shall include the following:

- Detailed Electrical protection diagrams showing the protective devices and associated current and potential transformers
- Manufacturer's name, type, designation and ranges as applicable, for all protective devices
- Selected relay settings, circuit breaker trip settings and fuse sizes
- Time-current diagrams showing the co-ordinated minimum and maximum clearing time curves for the selected settings and sizes of the protection devices
- Supporting data, such as motor starting and running currents, calculated fault currents, equipment protection requirements, inrush currents (such as transformer) and references that were used in establishing the setting and sizes of the protective devices
- Copies of the Manufacturer's characteristic curves for all relays, circuit breaker trips and fuses used for equipment protection
- Manufacturer's instruction manuals for all protective devices.

Final study shall be completed when the loads and electrical system are adequately defined and the equipment types and ratings are firm.

Selectivity Study and relay set booklets for all AC and DC systems (set of curves with settings, tripping time, etc.) shall be prepared by the Contractor.

The high voltage network selectivity study shall be carried out.

For low voltage, switchgear incomers and the most stringent cases shall be studied (with an explanation of the chosen verified elements-Longest cable, smallest transformer, etc.).

Protection relay documentation shall be annexed to the selectivity study.

One booklet should be established per technical room.

The protection setting shall be issued to set and test the protection devices during the Factory Acceptance Tests (FAT).

4.35 Earthing Grid Sizing Note

The purpose of this note is to define the material and the minimum cross section of all earthing conductors.

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The document shall clearly indicate:

- The network characteristics (voltage, earthing system, short circuit values, protection philosophy, etc.)
- Mode of routing (underground, cable trays, cable ladders, etc.)
- Environmental conditions (soil resistivity, etc.)
- Hypothesis (standards, etc.).

4.36 Lightning Protection study & Risk analysis

Preliminary evaluation for lightning protection shall be done at basic engineering stage by an independent third party specialised in lightning protection and never by an equipment Supplier.

The Engineering Contractor shall assist the third party in providing all necessary information required for the studies.

The purpose of this study (isolation co-ordination calculation, etc.) is to define the minimum requirement to protect the equipment.

The document shall clearly indicate:

- Hypothesis (keraunic level)
- The lay out (lightning protection zones LPZ, earthing grid, equipotential mesh, etc.)
- Check list of the most sensitive equipments
- Risk analysis (refer to [IEC 62305-2](#))
- Coordination calculation note of surge protective devices and equipment characteristics
- Typical installation drawings.

4.37 Substation location drawings and main cable routings

Following drawings shall be provided:

- Overall drawing showing all the plant substations and main cable routings
- For each process area, lay-out of electrical consumers and all cable routings.

Whenever it is necessary, details on a larger scale or detail drawings in appendix shall be provided to determine delicate points and/or heavy concentrated areas.

For cable routings, the drawings shall include supports and the section with the name of the cables.

All clearway zones shall be clearly indicated as well as space reserve for future extensions.

4.38 Substation Layout

This drawing shall show all the equipment to be installed inside or adjacent to the substation.

All clearway zones shall be clearly indicated as well as space reserve for future extensions.

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4.38.1 Electrical lay out:

It shall show at least:

- Electrical equipment
- Earthing network
- Transformer bays
- Cable openings (internal and external)
- HVAC equipment, piping and duct runs
- Equipment and personnel access
- Lifting and handling equipment if any
- The lighting location and controls
- Electrical Safety devices.

4.38.2 General arrangement

It shall show where applicable:

- Foundations
- Earthing mesh/underground network
- Trenches
- Wall/floor openings
- Equipment anchoring
- Water/oil drainage system
- Pulling chambers/Inspection covers
- The material used (wall, roof, door, floor, finishing, etc.).

4.39 Cable routings and routing cross sections including cable transits schedule/arrangement

Those drawings shall show:

- Separation of cables (HV LV Instrument, etc.)
- Cable routings avoiding crossings and entanglements
- Cable trays dimensions
- Cable allocation
- Cable identification for cable transits and cross section drawings
- Key references to standards installation drawings.

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4.40 Typical Installation standard drawings (Earthing, Power, Lighting, Control)

Usual drawings concern:

- Buried cables (trench, duct bank, pulling concrete chamber, road crossings, etc.)
- Cable trays (support, etc.)
- Motor connection
- Earthing (main equipment, tank, truck loading, control station, structure, etc.)
- Earth bars, earth pits (different mounting system, etc.)
- Lightning protection
- Lighting (luminaires, floodlight, street lighting, level gauge, indoor, etc.)
- Socket outlets
- Heat tracing
- Etc.

4.41 Detailed Installation standard drawings (Earthing, Power, Lighting, control)

These drawings are based on the above typical drawings and shall include all the required accessories for proper installation (bolting, etc.).

4.42 Earthing and Lightning Layout

These drawings shall contain at least:

- General earth grid
- Internal loops
- Connecting points to earth pits and to lightning protection devices (cross section shall be indicated)
- Measuring points
- Connection points to frameworks, casing, cable routes conduits, etc.

4.43 Lighting and sockets layout

It shall contain all the luminaires, sockets and associated accessories. All equipment shall be referenced and tagged.

4.44 Lighting circuit diagrams

During detailed design, one booklet per substation shall be drawn with the complete description of each lighting circuit.

Each lighting circuit from the power source to the last luminaires of the line included supply lighting panel and feeder rating, luminaires type, cables, junction boxes, switches, location, shall be drawn. Any equipment shall be tagged.

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They shall be split between:

- Normal lighting (indoor and outdoor)
- Essential lighting
- Emergency lighting.

4.45 Lighting Calculation note

This calculation note shall give the required types and numbers of luminaires to provide the specified illumination levels. It shall only be made once the Manufacturer has been chosen and the plant lay out has been completely frozen.

4.46 External grid connection study

This document shall be made when Company electrical grid is connected to an external grid. The document shall indicate:

- Frequency variations data(at steady and transient state)
- Voltage variations data (at steady and transient state)
- Voltage unbalance
- Existing background voltage THD (at steady and transient state)
- Minimum and maximum short circuit power available at grid connection point
- Number of power outage per year with their duration
- Number of voltage dips(depth >20% and duration>1 sec) per year
- The power factor required at grid connection point
- The current harmonic emission requirements
- The use of a tariff frequency signal (e.g. 175 Hz)
- Upstream protection relay settings
- Earth system configuration and earth fault current.

4.47 Material Take Off

It shall include at least:

- List of reference documents and their revision number
- Recapitulative sheets per equipment stating length, number, weight and any other characteristics needed for purchase orders.

4.48 Inspection and Test Plans

Inspection and test plans are part of the Supplier quality assurance/quality control.

A project FAT schedule shall be established and updated during the detailed engineering.

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4.49 Electrical system Operating Manual

The purpose of this document is to describe the whole electrical networks and allow proper operation in all configurations.

It shall include:

- Brief description of all equipment: main characteristics of power generation, HV/LV switchgear, transformers, UPS, Diesel generator, etc.
- Brief description of the electrical control system (ECS) and the links with ICSS
- The normal and downgraded network configurations and corresponding operating procedures to be performed
- The black start procedure
- Key interlock procedures
- Particular operations (electrical and mechanical interlocking, intertripping, transfer sequences, etc.).

4.50 Verification Dossier

This Verification Dossier shall be prepared for the installation in line with the requirements of the [IEC 60079-14](#) § 4.2.

In order to correctly install or extend an existing installation with hazardous area the following information are required:

- Area classification documents (see [IEC 60079-10](#)) with plans showing the classification and extent of the hazardous areas including the zoning
- Optional assessment of consequences of ignition
- Instructions for erection and connection
- Documents for electrical equipment with conditions of use, e.g. for equipment with certificate numbers which have the suffix 'X'
- Descriptive system document for the intrinsically safe system
- Manufacturer's/qualified person's declaration.

Note: The manufacturer's/qualified person's declaration is applicable to situations where uncertified equipment (other than simple apparatus in intrinsically safe or energy-limited circuits) is used.

- Necessary information to ensure correct installation of the equipment provided in a form which is suitable to the personnel responsible for this activity (see [IEC 60079-0](#) Instructions)
- Information necessary for inspection, e.g. list and location of equipment, spares, technical information (see [IEC 60079-17](#))
- Details of any relevant calculation, e.g. for purging rates for instruments or analyser houses

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- If repairs are to be carried out by the user or a repairer, information necessary for the repair of the electrical equipment (see [IEC 60079-19](#))
- Where applicable, gas or vapour classification in relation to the group or subgroup of the electrical equipment
- Temperature class or ignition temperature of the gas or vapour involved.
- External influences and ambient temperature.

4.51 Electrical Equipment Obsolescence Dossier

The obsolescence shall be managed as per [GS EP TEC 007](#).

O&G facilities are usually design with an expected design life ranging from 20 to 25 years. On the other hand the electrical equipment have shorter life cycle in particular for electronic and software based ones, which might result in one or more upgrading during the design life of the facility.

This dossier shall develop equipment lifecycle management strategy focusing on product obsolescence, support options and further software migration, components or equipment replacement or upgrades.

Strategy for managing obsolescence starts at the pre-project phase and needs to be regularly updated as an integral part of the core functions

- Design and development
- Sourcing and production
- In-service sustainability
- Vendors support.

A project specific dossier shall be developed during basic engineering stage and shall address all obsolescence requirements and data.

The obsolescence dossier will consider the complete life cycle including:

- Design phase
- Project delivery phase
- Operation & maintenance phase.

The contents of the dossier shall include as a minimum:

- Equipment Inventory
 - Bill Of Material (BOM)
 - . Comprehensive list with identification of all components up to the card, relay, fuse, CB level
 - Software releases, when applicable
 - Obsolescence status of all main equipment, components and softwares, if any.

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- Dates
 - End of spare parts availability,
 - End of support (i.e. design engineering support, technical after sale support)
 - Product Change Notice (PCN)
 - Product Discontinuance Notice (PDN)
 - End of Life (EOL).
- Vendor support
 - Availability
 - Location.
- Replacement strategy of all components and associated softwares, if any
- Replacement schedule.

All above data shall be tabled in a database or spreadsheet application.

The obsolescence dossier shall be further complemented during the detailed engineering stage and shall detail all aspects of equipment life cycle.

Obsolescence database ought to be required from Contractor/Vendor at CFT stage.

5. Other requirements

All documents shall comply with IEC standards [IEC 60027](#), [IEC 60050](#) and [IEC 60617](#) for letter symbols, vocabulary and graphical symbols.



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Appendix 1

			ELECTRICAL CONSUMER LISTS AND LOAD BALANCES SUMMARY SHEET									
Client:												
Project:												
Doc. No:						Rev:		Date:				
NORMAL OPERATING CONDITIONS												
REV	TAG. NO	DESIGNATION	ELECTRICAL LOAD			SPARE CAPACITY (%)	ELECTRICAL LOAD WITH SPARE CAPACITY			REMARKS		
			kW	kVAR	kVA		kW	kVAR	kVA			
			L PD 981-1	6.6 kV MAIN SWITCHBOARD Largest motor to start	9719 1414		5086 715	10920 1589				
TOTAL LOAD FOR MAIN POWER GENERATION:			11133	5801	12509	20	13360	6961	15011			
TOTAL LOAD FOR MAIN TURBINE GENERATOR:			kW	kVAR	kVA	p.f.						
			13360	6961	15011	0,89						
USING 3 x 50% RATED TURBINE GENERATORS :						8045 kW						
RATED OUTPUT POWER AT MAX. AMB. TEMP.:						16090 kW	ACTUAL CONTINGENCY IS:			30,80%		
TOTAL POWER AVAILABLE WITH 2 GENERATORS RUNNING IS:												
ESSENTIAL OPERATING CONDITIONS												
REV	TAG. NO	DESIGNATION	ELECTRICAL LOAD			SPARE CAPACITY (%)	ELECTRICAL LOAD WITH SPARE CAPACITY			REMARKS		
			kW	kVAR	kVA		kW	kVAR	kVA			
			L PD 981-2	6.6 kV MAIN SWITCHBOARD Largest motor to start	3000 355		1596 179	3371 399				
TOTAL LOAD FOR ESSENTIAL POWER CASE:			3355	1775	3770	20	4026	2130	4524			
TOTAL LOAD FOR ESSENTIAL POWER DEMAND:			kW	kVAR	kVA	p.f.						
			4026	2130	4524	0,8839689						
EMERGENCY OPERATING CONDITIONS												
REV	TAG. NO	DESIGNATION	ELECTRICAL LOAD			SPARE CAPACITY (%)	ELECTRICAL LOAD WITH SPARE CAPACITY			REMARKS		
			kW	kVAR	kVA		kW	kVAR	kVA			
			L PD 982-4	400V EMERGENCY SWITCHBOARD Largest motor to start	399 70		271 40	487 80				
TOTAL LOAD FOR EMERGENCY CONDITION:			469	311	567	20	563	373	681			
TOTAL LOAD FOR EMERGENCY DIESEL GENERATOR SIZING:			kW	kVAR	kVA	p.f.						
			563	373	681	0,9						



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ELECTRICAL CONSUMER LISTS AND LOAD BALANCES - 6,6 kV MAIN SWITCHBOARD L PD 981-1															
6,6 kV L-PD 981-1 ON NORMAL															
		Client:													
		Project:													
		Doc. No:										Rev:		Date:	
Rev	TAG. No.	DESIGNATION	SYSTEM NUMBER	SERVICE	DIV FACTOR (%)	LOAD TYPE	SERVICE VOLTAGE (V)	LOAD DEMAND (kW)	MOTOR RATING (kW)	RATED SPEED tr/min	POWER FACTOR	EFFCY. (%)	ABSORBED POWER		REMARKS
													kW	KVAR	
	L GX 303 A	CRUDE OIL EXPORT PUMP		C		M	6600,0	1414,0	1600,0	1500,0	0,89	95,8	1476,5	753,6	RELOCATED TO PD-981-1 AS DRY OIL CIRC.
	L GX 303 B	CRUDE OIL EXPORT PUMP		S		M	6600,0	1414,0	1600,0	1500,0	0,89	95,8			RELOCATED TO PD-981-1 AS DRY OIL CIRC.
															PUMPS ARE REINSTATED
	L GX 304 A	DRY OIL CIRCULATING PUMP A		C		M	6600,0	355,0	400,0	1500,0	0,89	94,6	375,5	191,0	TWO LOOPS RUNNING FOR PRESERVATION
	L GX 304 B	DRY OIL CIRCULATING PUMP A		C		M	6600,0	355,0	400,0	1500,0	0,89	94,6	375,5	191,0	TWO LOOPS RUNNING FOR PRESERVATION
	L GX 304 C	DRY OIL CIRCULATING PUMP C		S		M	6600,0	355,0	400,0	1500,0	0,89	94,6	0,0	0,0	
	L GX 704 A	UPSIDES WATER INJECTION MAIN PUMP		C		M	6600,0	1800,0	1980,0	1500,0	0,89	95,8	1878,6	948,2	
	L GX 702 A	SRU FEED PUMP		C		M	6600,0	420,0	475,0	3000,0	0,87	94,0	446,8	252,3	
	L GX 893 A	METHANOL INJECTION PUMP		C		M	6600,0	188,0	250,0	1500,0	0,92	93,0	202,0	86,0	
	L GX 893 B	METHANOL INJECTION PUMP		C		M	6600,0	188,0	250,0	1500,0	0,92	93,0	202,0	86,0	
	L GX 893 C	METHANOL INJECTION PUMP		S		M	6600,0	188,0	250,0	1500,0	0,92	93,0			
	M GX 901 A	SEAWATER LIFT PUMP		C		M	6600,0	471,0	500,0	1500,0	0,93	93,0	506,5	207,73	NON SIMULT. WITH TWO DRY OIL PUMPS
	M GX 901 B	SEAWATER LIFT PUMP		C		M	6600,0	471,0	500,0	1500,0	0,93	93,0	506,5	207,73	NON SIMULT. WITH TWO DRY OIL PUMPS
	M GX 901 C	LP SEAWATER LIFT PUMP		S		M	6600,0	220,0	250,0	1500,0	0,93	93,0			
	501	400 V ESSENTIAL SWITCHBOARD		I	50		6600,0	2802,0			0,88	100,0	1401,0	756,0	
	502	400 V PROCESS/UTILITIES SWITCHBOARD		I	50		6600,0	1574,0			0,84	97,0	787,0	427,0	VIA 2500 kVA TRANSFORMER
	L PD 981-2 A	6.6 kV ESSENTIAL SWITCHBOARD		I	50		6600,0	1696,3			0,88	100,0	515,0	325,0	
	L PD 982-1 A	400 V PROCESS/UTILITIES SWITCHBOARD		I	50		6600,0	1481,4			0,86	97,0	740,5	439,0	VIA 2500 kVA TRANSFORMER
	L PD 300	400 V EMERGENCY SWITCHBOARD		C			6600,0				0,85	97,0	306,0	215,0	VIA 1600 kVA TRANSFORMER
TOTAL LOAD													9719,2	5085,5	
6.6 kV NORMAL SWITCHBOARD L PD 981-1															
LOAD FOR BUSBAR SIZING:															
				<u>kW</u>	<u>KVAR</u>	<u>p.f.</u>	<u>kVA</u>	<u>In (A)</u>							
Total:				9719	5086	0,89	10920	955							
Total with 20% spare:								1146							



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ELECTRICAL CONSUMER LISTS AND LOAD BALANCES - 6,6 kV MAIN SWITCHBOARD L PD 981-1															
6,6 kV L-PD 981-1 ON ESSENTIAL															
		Client:													
		Project:													
		Doc. No:										Rev:		Date:	
Rev	TAG. No.	DESIGNATION	SYSTEM NUMBER	SERVICE	DIV FACTOR (%)	LOAD TYPE	SERVICE VOLTAGE (V)	LOAD DEMAND (kW)	MOTOR RATING (kW)	RATED SPEED tr/min	POWER FACTOR	EFFCY. (%)	ABSORBED POWER		REMARKS
													kW	kVAR	
	L GX 303 A	CRUDE OIL EXPORT PUMP		S		M	6600,0	1414,0	1600,0	1500,0	0,89	95,8	0,0	0,0	RELOCATED TO PD-981-1 AS DRY OIL CIRC.
	L GX 303 B	CRUDE OIL EXPORT PUMP		S		M	6600,0	1414,0	1600,0	1500,0	0,89	95,8			RELOCATED TO PD-981-1 AS DRY OIL CIRC.
															PUMPS ARE REINSTATED
	L GX 304 A	DRY OIL CIRCULATING PUMP A		C		M	6600,0	355,0	400,0	1500,0	0,89	94,6	375,5	191,3	TWO LOOPS RUNNING FOR PRESERVATION
	L GX 304 B	DRY OIL CIRCULATING PUMP A		C		M	6600,0	355,0	400,0	1500,0	0,89	94,6	375,5	191,3	TWO LOOPS RUNNING FOR PRESERVATION
	L GX 304 C	DRY OIL CIRCULATING PUMP C		S		M	6600,0	355,0	400,0	1500,0	0,89	94,6			
	L GX 704 A	UPSIDES WATER INJECTION MAIN PUMP		S		M	6600,0	1800,0	1980,0	1500,0	0,89	95,8	0,0	0,0	
	L GX 702 A	SRU FEED PUMP		S		M	6600,0	420,0	475,0	3000,0	0,87	94,0	0,0	0,0	
	L GX 893 A	METHANOL INJECTION PUMP		S		M	6600,0	188,0	250,0	1500,0	0,92	93,0			
	L GX 893 B	METHANOL INJECTION PUMP		S		M	6600,0	188,0	250,0	1500,0	0,92	93,0			
	L GX 893 C	METHANOL INJECTION PUMP		S		M	6600,0	188,0	250,0	1500,0	0,92	93,0			
	M GX 901 A	SEAWATER LIFT PUMP		S		M	6600,0	471,0	500,0	1500,0	0,93	93,0	0,0	0,0	NON SIMULT. WITH TWO DRY OIL PUMPS
	M GX 901 B	SEAWATER LIFT PUMP		S		M	6600,0	471,0	500,0	1500,0	0,93	93,0	0,0	0,0	NON SIMULT. WITH TWO DRY OIL PUMPS
	M GX 901 C	LP SEAWATER LIFT PUMP		S		M	6600,0	220,0	250,0	1500,0	0,93	93,0	0,0	0,0	
	501	400 V ESSENTIAL SWITCHBOARD		I	50		6600,0	2802,0			0,88	100,0	1401,3	756,0	
	502	400 V PROCESS/UTILITIES SWITCHBOARD		S			6600,0	1574,0			0,84	97,0	0,0	0,0	VIA 2500 kVA TRANSFORMER
	L PD 981-2 A	6.6 kV ESSENTIAL SWITCHBOARD		I	50		6600,0	1696,3			0,88	100,0	848,2	457,0	
	L PD 982-1 A	400 V PROCESS/UTILITIES SWITCHBOARD		S			6600,0	1481,4			0,86	97,0	0,0	0,0	VIA 2500 kVA TRANSFORMER
	L PD 300	400 V EMERGENCY SWITCHBOARD		S			6600,0				0,85	97,0	0,0	0,0	VIA 1600 kVA TRANSFORMER
TOTAL LOAD													3000,4	1595,6	
6,6 kV NORMAL SWITCHBOARD L PD 981-1															
LOAD FOR SWITCHBOARD SIZING:															
				<u>kW</u>	<u>kVAR</u>	<u>p.f.</u>	<u>kVA</u>	<u>In (A)</u>							
Total:				3000	1596	0,89	3371	295							
Total with 20% spare:							4045	354							

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ELECTRICAL CONSUMER LISTS AND LOAD BALANCES - 400V EMERGENCY SWITCHBOARD L PD 982-4															
400 V L-PD 982-4 ON EMERGENCY															
Client:															
Project:															
Doc. No:															
Rev:															
Date:															
REV	TAG. No.	DESIGNATION	SYSTEM NUMBER	SERVICE	DIV FACTOR (%)	LOAD TYPE	SERVICE VOLTAGE (V)	LOAD DEMAND (kW)	MOTOR RATING (kW)	RATED SPEED t/r/min	POWER FACTOR	EFFCY. (%)	ABSORBED POWER		REMARKS
													kW	kVAR	
	M GX 0170 A	BILGE TRANSFER PUMP (STERN MACHINERY ROOM)		C		M	400	51.0	60.0	1500.0	0.85	76.5	54.0	33.40	
	M GX 0170 B	BILGE TRANSFER PUMP (STERN MACHINERY ROOM)		C		M	400	51.0	60.0	1500.0	0.85	76.5	54.0	33.40	
	M GX 004 A	AUX BILGE TRANSFER PUMP		I	50	M	400	1.3	1.5	1500.0	0.56	76.5	0.7	0.51	
	M GX 003 A	BILGE PUMP (STERN MACHINERY ROOM)		I	30	M	400	13.0	15.0	1500.0	0.80	90.0	3.8	2.80	
	M GX 003 B	BILGE PUMP (STERN MACHINERY ROOM)		I	30	M	400	13.0	15.0	1500.0	0.80	90.0	3.8	2.80	
	M GX 003 C	BILGE PUMP (BOW MACHINERY ROOM)		C		M	400	11.5	15.0	1500.0	0.80	90.0	12.8	9.5	
	M GX 003 D	BILGE PUMP (BOW MACHINERY ROOM)		S		M	400	11.5	15.0	1500.0	0.80	90.0			
	M GX 902	EMERGENCY SEA WATER LIFT PUMP		S		M	400	31.9	37.0	3000.0	0.80	90.7			EMERGENCY CONDITION FOR HVAC COOLING DUTY
	M GY 960 A	DIESEL FIRE WATER PUMP PKGE. (STERN M/C ROOM)		I	50	M	400	8.0			0.90	95.0	4.2	2.0	
	M GY 960 B	DIESEL FIRE WATER PUMP PKGE. (BOW M/C ROOM)		I	50	M	400	8.0			0.90	95.0	4.2	2.0	
	M GX 961 A	FIRE WATER JOCKEY PUMP		C		M	400	47.0	55.0		0.76	89.5	54.0	46.72	
	1361	START AIR COMP		I	10	M	400	4.7	5.5		0.93	93.0	0.50	0.20	
	M GX 962 B	FOAM INJECTION PUMP		S		M	400	58.0	75.0		0.86	91.5	0.0	0.0	
	L KX 920 A	HYDROGEN DILUTION FAN (ELECTROCHLORINATOR)		C		M	400	1.5	2.0		0.69	78.0	1.9	2.0	PART OF L UB 920
	L KX 920 B	HYDROGEN DILUTION FAN (ELECTROCHLORINATOR)		S		M	400	1.5	2.0		0.69	78.0			PART OF L UB 920
	M UA 928	SEWAGE TREATMENT PACKAGE		I	50		400	8.0	11.0		0.79	86.7	4.6	3.6	
	M GX 931 A	TREATED DIESEL OIL (TRANSFER) PUMP		I	50	M	400	4.3	5.5		0.72	84.7	2.5	2.44	
	M JD 940	CRANE - PORT SIDE (HYDRAULIC CHARGE MOTOR)		I	50	M	400	70.0	90.0		0.87	92.0	38.0	21.33	
		HVAC - MAIN CABINET - EMERGENCY SUPPLY		C			400	55.0	65.0		0.82	90.0	58.0	35.00	
	L GA 062 A	HVAC - CONDENSER COOLING PUMP (EMERGENCY)		C			400	8.8	11.0		0.81	87.2	10.1	7.3	
	L GA 062 B	HVAC - CONDENSER COOLING PUMP (EMERGENCY)		S			400	8.8	11.0		0.81	87.2	0.0	0.0	
	L GA 064 A	HVAC - CHILLED WATER PUMP (EMERGENCY)		C			400	6.0	7.5		0.81	85.0	7.1	5.2	
	L GA 064 B	HVAC - CHILLED WATER PUMP (EMERGENCY)		S			400	6.0	7.5		0.81	85.0	0.0	0.0	
	L KA 058 A	HVAC - EMERGENCY SYSTEM AHU FAN		C			400	29.6	37.0		0.81	91.0	32.5	23.5	
	L KA 058 B	HVAC - EMERGENCY SYSTEM AHU FAN		S			400	29.6	37.0		0.81	91.0	0.0	0.0	
	L KA 066	HVAC - FIRST AID EXHAUST FAN		C			400	0.44	0.55		0.60	67.2	0.7	0.9	
	AM 375 K 1090 A	HVAC - BATTERY ROOM EXHAUST FAN		C			400	0.44	0.55		0.60	67.2	0.7	0.9	
	AM 375 K 1090 B	HVAC - BATTERY ROOM EXHAUST FAN		S			400	0.44	0.55		0.60	67.2	0.0	0.0	
	L KA 070 A	HVAC - ESSENTIAL DIESEL GEN. ROOM EXHAUST FAN		C			400	14.8	18.5		0.86	89.0	16.6	10.0	
	L KA 070 B	HVAC - ESSENTIAL DIESEL GEN. ROOM EXHAUST FAN		S			400	14.8	18.5		0.86	89.0	0.0	0.0	
	L PY 981	EMERGENCY DIESEL GENERATOR - AUXILIARIES		C			400	10.0	12.0		0.98	100.0	10.0	7.00	GEN. COOLING FANS RUNNING FOR EMERG CASE
	M PY 982 A	ESSENTIAL DIESEL GENERATOR A - AUXILIARIES		C			400	10.0	12.0		0.98	100.0	10.0	7.2	GEN. COOLING FANS RUNNING FOR ESSNTL CASE
	M PY 982 B	ESSENTIAL DIESEL GENERATOR B - AUXILIARIES		I	50		400	10.0	12.0		0.98	100.0	5.0	1.2	GEN. COOLING FANS RUNNING FOR ESSNTL CASE
		COLD STORE 1 - REFRIG. COMPRESSOR		I	50		400	4.0	5.0		0.72	83.0	2.4	2.3	
		COLD STORE 2 - REFRIG. COMPRESSOR		I	50		400	4.0	5.0		0.72	83.0	2.4	2.3	
		NAVIGATION AIDS SYSTEM		I	50		400	8.5	10.00		0.90	95.0	4.5	5.7	
TOTAL LOAD ON EMERGENCY BUSBAR:															
TOTAL LOAD:															
400V EMERGENCY SWITCHBOARD															
LOAD FOR SWITCHBOARD SIZING (EMERGENCY LOAD CASE):															
Total:								kW	kVAR	kVA	In (A)	p.f.			
Total with 20% spare:								399	271	487	610	0.84			
											732				