Base Load Power Hub (BLPH)

Technical Specification for Electrical Requirement in Packaged Units

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.1 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

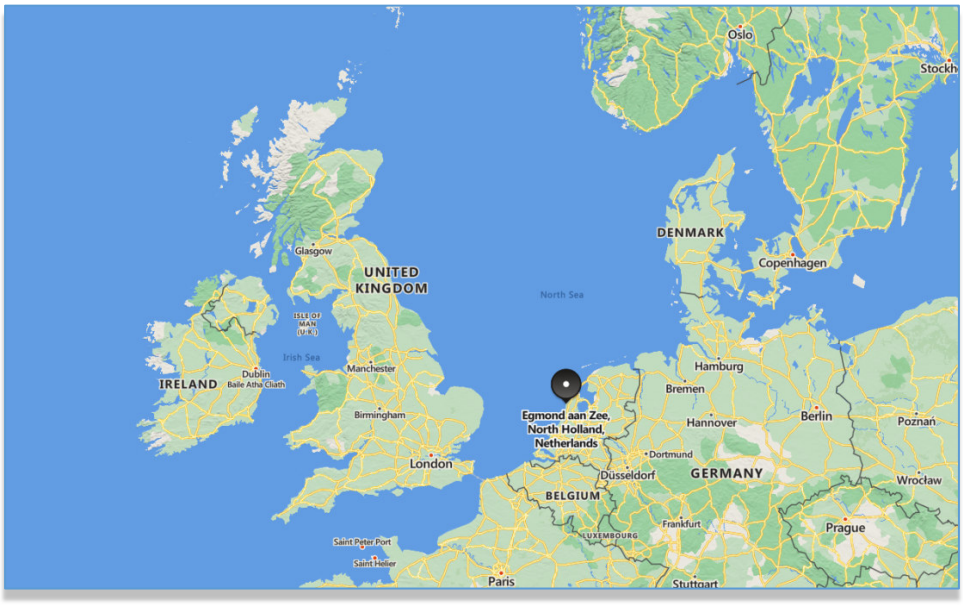


Figure 1 - HOLLANDSE KUST NOORD WIND PARK Location Map

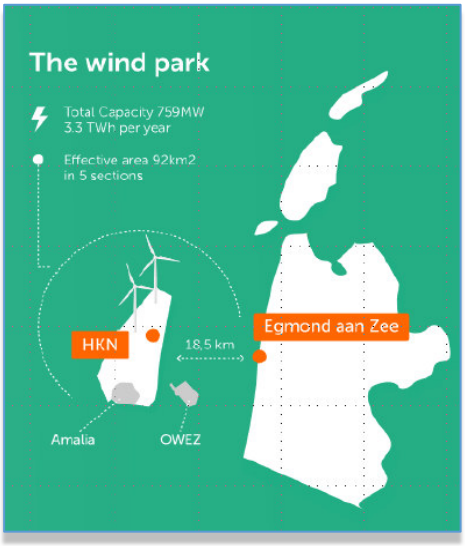


Figure 2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile located on coordinates E 590719.1, N 5841602.3 is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.1.2 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

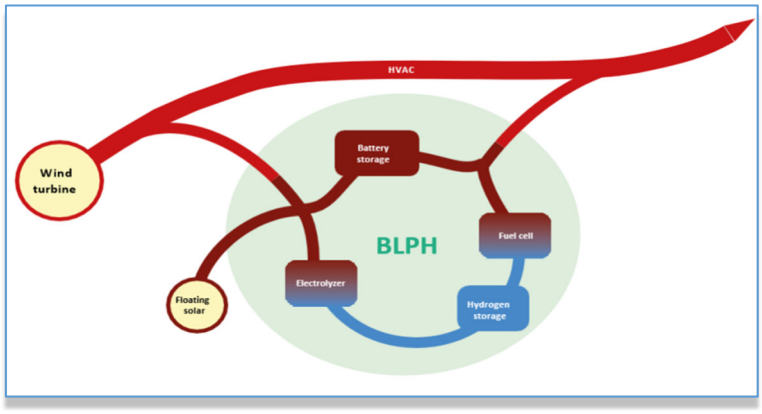


Figure 3 - BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH s to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

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2 DOCUMENT SCOPE

This specification defines the minimum requirements for the design, manufacture, inspection and testing of electrical equipment equipped with pre-assembled units.

This specification should be read in conjunction with the corresponding packaged unit Design specifications, drawings and data sheets, if any.

The technical definition of the package and relevant equipment or items shall be exclusive responsibility of the Vendor of the packaged unit. Any failure by the Vendor to take exception to any part of this specification in the initial bid proposal shall indicate complete compliance to the specification.

The objects of this specification are mainly the following:

- Electrical installations.
- Material selection.
- Electrical interfaces.
- Lighting systems (where required).
- Earthing system.

For a complete definition of the supply (i.e., process, mechanical etc.) reference shall be made to the other project documents of the package.

It shall be the Vendor's responsibility to be, or to become, knowledgeable of the requirements of the standards and codes referenced in section 4.

Related to the quality assurance and test shall be apply the "Inspection Data Sheet" in Annex II.

The Documents that shall be supply along with the technical proposal and during the manufacturing phase are indicated in the "Documents Data Sheet" in Annex III.

2.1 REFERENCES

Doc. No.	Description
123A90-DDL-EL-DG-20159	Electrical Single Line Diagram LV Systems
123A90-DDL-EL-DD-20090	Electrical Typical Installation details - Earthing System
123A90-DDL-EL-DD-20091	Electrical Typical Installation details - Lighting System
123A90-DDL-EL-DD-20092	Electrical Typical Installation details - Power System & Cable Installation
123A90-DDL-EL-DD-20093	Electrical Typical Installation details - Cable Routes System
123A90-DDL-IN-SP-40094	Instrumentation for Package Unit Specification
123A90-PML-DIG-PRO-00002	Equipment and System Tag Numbering

Table 1 - Reference Documents

2.2 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY):	CROSSWIND
CONTRACTOR (CTR):	ROSETTI MARINO S.p.A.
PROJECT:	HOLLANDSE KUST NOORD WIND PARK Project
INSPECTION AUTHORITY:	The organization representing the Owner or Vendor /Contractor that verifies that the equipment and facilities have been designed, constructed, inspected and tested in accordance with the requirements of this specification and the Purchase Order/Contract.
INSPECTOR:	A qualified individual representing the Owner, Vendor/Contractor or the assigned Inspection Authority, who verifies that the equipment and facilities have been designed, constructed, inspected and tested in accordance with the requirements of this specification and the Purchase Order/Contract.
VENDOR:	Individual, firm or manufacturer that provide Materials/Equipment to COMPANY in accordance with this specification and terms of the Purchase Order.
AC:	Alternating current
CB:	Circuit Breaker
DC:	Direct current
DOL:	Direct-on-Line (motor starter)
EMC:	Electromagnetic Compatibility
Ex:	Explosion Protection Technique
Ex dc	Explosion Protection Technique - Flameproof
Ex ec	Explosion Protection Technique - Increased Safety
Ex de	Explosion Protection Technique – combining Increased Safety and Flameproof approach in design
GRP:	Glass Reinforced Plastic
HVAC:	Heating, Ventilation and Air Conditioning
ICSS:	Integrated Control Safety System

IE:	Instrument Earth
IEC:	International Electro-technical Commission
IP:	Ingress Protection
IS:	Intrinsically Safe
LED:	Lighting Emitting Diode
LCS	Local Control System
LV:	Low Voltage (<1000V)
MCB:	Miniature Circuit Breaker
MCC:	Motor Control Centre
MCCB:	Moulded Case Circuit Breaker
PE:	Protective Earth
PO:	Purchase Order
RCU	Remote Control Unit
THD:	Total Harmonic Distortion
TN-S:	Three Phase and Neutral System (with separate neutral and earth)
UCP:	Unit Control Panel
UPS:	Uninterruptible Power Supply
UV:	Ultraviolet
V:	Volts
VSD:	Variable Speed Drive
VT:	Voltage Transformer

Table 2 - Definitions and Abbreviations

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3 GENERAL CONDITIONS

3.1 LANGUAGE

All correspondence, engineering documents and manuals shall be in the English language.

4 APPLICABLE CODES AND STANDARDS

The following documents list shall constitute an integral part of this specification.

IEC - International Electro-technical Committee (latest edition shall be applied).

- IEC 60034 Rotating electrical machines
- IEC 60072 Dimension and output series for rotating electrical machines
- IEC 60079 Electrical apparatus for explosive gas atmospheres
- IEC 60085 Electrical Insulation - Thermal evaluation and designation
- IEC 60092 Cables for offshore installations, halogen-free or mud resistant
- IEC 60255 Measuring relays and protective equipment
- IEC 60269-4 Low voltage fuses - supplementary requirements for fuse links for protection of semiconductor devices
- IEC 60331-11 Test for electric cables under fire conditions – circuit integrity – apparatus – fire alone at a flame temperature of at least 750 degrees Celsius
- IEC 60331-21 Test for electric cables under fire conditions – circuit integrity – procedures and requirements –cables of rated voltage up to and including 0.6/1 kV
- IEC 60364 Low voltage electrical installations
- IEC 60445 Basic and safety principles for man-machine interface, marking and identification
- IEC 60502 Extruded solid dielectric insulated power cables for rated voltages from 1 kV up to 30 kV
- IEC 60228 Conductor of insulated cables
- IEC 60529 Degrees of protection by enclosures
- IEC 60623 Secondary cells and batteries containing alkaline or other non-acid electrolytes - vented nickel-cadmium prismatic rechargeable single cells
- IEC 60751 Industrial Platinum Resistance Thermometers and platinum temperature sensors
- IEC 60754 Test on gases evolved during combustion of electrical cables

- IEC 60896 Stationary Lead Acid Batteries
- IEC 60909 Short Circuit Currents in Three Phase AC Systems
- IEC 60947 Low-voltage switchgear and control gear
- IEC 61000 Electromagnetic compatibility
- IEC 60439 Low voltage switchgear and control gear assemblies
- IEC/TR 61641 Enclosed low-voltage switchgear and control gear assemblies – Guide for testing under conditions of arcing due to internal fault
- IEC 61869 Instrument Transformers
- IEC 61892 Mobile and Fixed Offshore Units - Electrical Installations
- IEC 62259 Secondary cells and batteries containing alkaline or other non-acid electrolytes – nickel-cadmium prismatic secondary single cells with partial gas recombination
- IEC 60598 Luminaries
- IEC 61347 Lamp control gear

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5 ENVIRONMENTAL AND OPERATING CONDITIONS

The Metrological and Oceanographic Data are as given below (source: HKN2018 data @ 1979-2018)

Description	Value	Unit
Ambient Conditions		
Ambient Temperature (min/nom/max) – hourly @ +10m	-8.4 / 10.5 / 25.0	° C
Atmospheric Pressure (nominal) – hourly @ +10m	1013.7	mbar
Specific Humidity (min/nom/max) – hourly @ +10m	4.2 / 6.5 / 9.5	x 10^{-3}
Wind conditions		
Annual average wind speed (at 100m)	9.56	m/s
Extreme Wind Speed for 1-Year Recurrence Period (at 100 m)	33.1	m/s
Extreme Wind Speed for 50-Year Recurrence Period (at 100 m)	41.0	m/s
Marine conditions		
Sea Water Temperature (min/max)	1.2 / 20.2	° C
Average Sea Water Density	1025	Kg/m^3

Table 3 - Metrological and Oceanographic Data

6 POWER SYSTEM DESIGN

The power system shall be designed to satisfy the electrical power requirements of the offshore facility, focusing the following:

- Personnel safety during operation, inspection and maintenance
- Good operability and easy maintenance
- Equipment protection and safety
- Plant reliability and availability

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6.1 VOLTAGE LEVELS

The A.C. main power supply characteristics (e.g. voltage, frequency, and voltage and frequency variation) shall be defined in the relevant data sheet.

The following voltage levels shall generally be used where technically possible:

Service	Rated AC Voltage (Volts)	Phase / Wire	System Earthing
HV supply	66000	3ph+PE	Solid (TN-S)
MV supply	6600	3ph+PE	Solid (TN-S)
Normal LV supply	400	3ph+N+PE	Solid (TN-S)
Solar farm in-feed LV supply	800	3ph+N+PE	Solid (TN-S)
Emergency LV supply	400	3ph+N+PE	Solid (TN-S)
Low voltage distribution	400/230	3ph+N+PE / 1ph+N+PE	Solid (TN-S)
63A welding (power) sockets	400	3ph+PE	Solid (TN-S)
Motor loads	400	3ph+PE	Solid (TN-S)
Luminaires	230	1ph+N+PE	Solid (TN-S)
Emergency luminaires	230	1ph+N+PE	Solid (TN-S)
Convenience sockets	230	1ph+N+PE	Solid (TN-S)
AC UPS	400 (In) 400/230 (Out)	3ph+N+PE 3ph+N+PE / 1ph+N+PE	Solid (TN-S)
DC UPS	400 (In) 110 (Out)	3ph+N+PE 2+PE	Solid (TN-S)

Table 4 - System voltage levels and Earthing arrangements

6.2 SYSTEM VOLTAGES AND FREQUENCY

1. Voltages should be selected from IEC 60038. On 50 Hz systems the nominal LV power supply voltage shall be 400/230 V three phase and neutral.
2. Nominal system voltage(s) and frequency and the positive phase sequence of three phase systems shall be indicated on the key single line diagram.
3. The phase sequences shall be specified in the order L1, L2, L3, each phase reaching its maximum in time sequence in that order.

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6.3 DEVIATIONS IN SUPPLY VOLTAGE AND FREQUENCY

1. During normal system operation and under steady-state conditions, both of the following shall be accomplished:
   a. The voltage does not deviate from the rated equipment voltage by more than 5%.
   b. The system frequency does not deviate from the rated frequency by more than 2%.
2. The combined voltage and frequency deviations shall lie within Zone A as described in IEC 60034-1.
3. All loads should be distributed (i.e., balanced) so that the negative phase sequence components of voltage and current at any point in the system do not exceed the values quoted in IEC 60034-1.
4. During starting or reacceleration of direct-on-line motors, either singly or in a group, the voltage at the motor terminals shall not deviate by more than +10% or –20% from rated equipment voltage.
5. Voltage deviations occurring at switchgear busbars during motor or group motor starting/reacceleration shall be such as to maintain a minimum of 85% voltage on switchgear busbars, and at least 80%, but not more than 110%, of rated equipment voltage on all other consumers.
6. Equipment having tolerances higher than those specified in (6.3, Item 4) (6.3, Item 5) with respect to variations in voltage or waveform shall be provided with a power supply that is adequately stabilized or filtered.
7. Voltage dips resulting in consumer terminal voltages down to 80% of rated equipment voltage shall not impact plant operations.
8. Voltage dips resulting in consumer terminal voltages below 80% of rated equipment voltage for a duration of not more than 0.2 s shall result in the ride-through of selected consumers performing a vital or essential service.
9. Voltage dips resulting in consumer terminal voltages below 80% of rated equipment voltage for a duration between 0.2 s and 4 s shall, on voltage restoration, result in a sequential re-start of selected consumers.

6.4 DEVIATIONS AND VARIATIONS IN SUPPLY WAVEFORM

1. Electrical loads having non-linear characteristics such as to produce voltage and current waveform distortion of a magnitude detrimental to the lifetime or performance of system electrical equipment shall not be utilized unless appropriate measures are taken to render harmless the effects of such distortion, e.g., by filtering or phase displacement.

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2. For new projects and new facilities, the planning levels for Total Harmonic Distortion (THD) and individual harmonic voltage defined in IEC 61000-3-6 Table 2 shall be followed:
   a. THD for system voltages up to 36 kV shall not exceed 6.5%;
   b. THD for system voltages higher than 36 kV shall not exceed 3%.
3. For extensions to an existing electrical system, the Total Harmonic Distortion (THD) and individual harmonic voltage distortions at any point of the system up to a voltage of 36 kV shall not exceed the levels defined in IEC 61000-3-6 Table 1.
4. Equipment which produces a continuous DC component in the AC supply system shall not be utilized.

7 ELECTROMAGNETIC COMPLIANCE

7.1 ELECTROMAGNETIC COMPLIANCE

The specification, design, testing, installation, operation and maintenance of all electrical power systems, electrical / electronic instrumentation and control equipment / system shall comply with EMC directives. This is to ensure that the requirements for electromagnetic compatibility are considered during the various stages of design, construction, and installation.

All as aspects of the control system shall be certified to 2014/30/EU. The VENDOR shall provide a Declaration of Conformity for their package stating as such.

8 ELECTRICAL EQUIPMENT SELECTION

8.1 DESIGN LIFE

Electrical equipment must have an operational life of 2 years, but the standard design life of the supplier's materials must be provided.

8.2 HAZARDOUS AREA CLASSIFICATION

Latest edition of IEC 60079-10 Codes cover the mandatory requirements governing the classification of areas where there is danger of fire or explosion due to flammable liquids, gases, vapours and dusts, handled, processed or stored.

An area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precaution for the construction, installation and use of equipment, is non-hazardous (on account of explosive gas atmosphere)

Rooms where inlet of flammable gases or formation of explosive atmospheres is continuously excluded by means of pressurization with forced air ventilation from "Non-Hazardous" locations and adequate safeguards against loss of pressure and ventilation, are classified as "Artificially Non-Hazardous" areas.

All electrical equipment, suitable to be installed in "Hazardous" classified area, and relevant installation system, shall be in compliance to the relevant IEC 60079 specific manufacturing rule and shall be certified according to the European Directive 2014/34/UE (ATEX Directive), by Certification Notified Bodies. Self-certifications of the Manufacturers of the equipment will not be accepted.

The IEC has defined three types of hazardous areas:

- Zone 0 An area in which an explosive atmosphere is present continuously or for long periods.
- Zone 1 An area in which an explosive atmosphere is likely to occur in normal operation.
- Zone 2 An area in which an explosive atmosphere is not likely to occur in normal operation but if it does occur, will persist for a short period only.

Minimum design for classification for all equipment's installed in the upper deck shall be Temperature group T1, Gas group IIC or IIB + H2, Equipment protection level EPL Gc, Classification EX ec.

8.3 GENERAL REQUIREMENTS

All electrical equipment and materials shall be suitable for the environmental and installation conditions stated in the chapter 5 "ENVIRONMENTAL AND OPERATING CONDITIONS"

In particular all materials installed outdoor shall be suitable for the direct exposition to rain, wind, snow and possibility of ice formation.

Moreover, the direct exposition to UV radiation shall be duly kept in consideration.

All electrical equipment and materials shall be new, of current design and production, suitable for the service conditions specified in the specific project documents and free for any type of defect.

Use of prototype solutions is not allowed. Specific cases, when strictly motivated, shall be subjected to written authorization by the Contractor/Company.

All materials shall be complete of CE marking in compliance to the laws and directives in force in the European Union.

For package with ATEX equipment, VENDOR should submit a complete ATEX equipment register and provide all the ATEX supporting documents, included Number of certificates, EU Declaration of Conformity and Quality Assurance Notification and calculation.

8.4 PROTECTION DEGREES (IP)

The protection degrees for enclosures of electrical equipment in packages to be followed as per IEC 60529:

Equipment type	Installation	
	Indoor	Outdoor
Power Generators	Not Applicable	IP44 (Alternator) IP54 (Terminal box) (see note 1)
Electrical motors and relevant junction boxes	IP 55	IP 56
Motor Control stations	IP 55	IP 56
Low Voltage switchgears Low Voltage motor control centre	IP 41 IP20 with doors open	Not applicable
Low Voltage distribution boards	IP41 for room with climate control IP20 with doors open	IP56 IP20 with doors open (see note 3)
Unit Control Panels	IP41 for room with climate control IP20 with doors open	IP56 IP20 with doors open (see note 3)
Cable Glands	IP 55 (see note 2)	IP 66 (see note 2)
Junction Boxes	IP 55 for technical room without climate control	IP 56
Lighting fixtures	IP56	IP56
General Equipment (Service Sockets, Lighting and Service switches, Emergency pushbutton etc.,)	IP 55 for room without climate control	IP 56

Notes:

(1) Enclosed in ventilation container
(2) Shroud and similar (shrink tubing) shall not be used on cable glands
(3) When directly exposed to weather or deluge they shall be provided with protective hood.

Table 5 - Protection Degrees (IP)

8.5 MATERIAL REQUIREMENTS

The materials of electrical equipment in packages are as listed below:

Equipment type	Installation	
	Indoor	Outdoor
Cable Trays & Cable Ladders	GRP / FRP	GRP / FRP
Cable Glands	Nickel plated brass	Nickel plated brass
Supports for Cable trays & Cable Ladders	Hot Dip Galvanized (HDG) Steel	Hot Dip Galvanized (HDG) Steel
Junction Boxes	GRP / FRP	GRP / FRP / AISI 316
Light Fixtures	GRP Aluminium alloy	GRP Aluminium alloy
Socket Outlets and plug	Polycarbonate	GRP
Local control units, command switch and other equipment	GRP Polycarbonate	GRP Aluminium or metal painted according to environmental condition

Table 6 - Material Requirements

9 BATTERY LIMITS OF ELECTRICAL CONNECTION

The battery limits for the connection of the packaged units with the platform electric system shall be considered as following listed:

9.1 POWER SUPPLY CONNECTION

- Terminal blocks into the Unit Control Panel (UCP) (for indoor).
- Terminal blocks into interface Junction Boxes at the edge of the skid / package (for outdoor).

In case of motors or consumers directly fed from MCC switchboards, the relevant feeding cable shall be connected directly to their terminal boxes. In this case Vendor shall provide only the cable trays from the edge of the skid to the consumers.

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9.2 CONTROL SIGNALS AND ALARMS

- Terminal blocks into the Unit Control Panel (UCP) (for indoor).
- Terminal blocks into interface Junction Boxes at the edge of the skid / package (for outdoor).
- Hardwired signals to trip package equipment shall be from the safety system.
- Hardwired Digital Output from Safety System to UCP shall be installed inside UCP, powered 24V dc by Safety system.
- Hardwired Digital input from UCP to Safety System shall be installed inside UCP, powered 24 V dc by UCP (free voltage contact to safety system).
- Hardwired Digital input from UCP to PCS shall be through relays, installed inside UCP, powered 24 V dc by UCP (free voltage contact to PCS).

9.3 EARTHING CONNECTION

- Earthing plates on the base frame of the skid in cross angles.
- Earthing bus bar into Unit Control Panel (for Protective Earth (PE) included in the supply cable)

Both connections should be performed.

All earthing terminations shall be made with compression cable lugs.

Two suitable earthing lugs shall be provided on the exterior of all equipment (typically base frames) for bonding connections to be made to the platform structure. The earth lugs shall be unpainted stainless-steel having 16mm diameter hole ready for the connection of a lug that extends beyond the applied insulation.

For packages where there are not installed electrical consumers, only the earthing connections of the base frame is required.

Vendor shall indicate when the package requires or include separate earthing system for the connection of instruments (IE) or (ISE).

9.4 EARTHING (GROUNDING) AND BONDING

1. The Instrumentation earthing (grounding) systems shall be split as follows:

   a) Protective Earth for personnel safety

   b) Functional Earth, for surge suppression and EMC
   - Instrument Earth (IE).
   - Intrinsically Safe Earth (IS).

   c) The instrument earth/intrinsically safe earth shall be connected at a single point only.

2. Instrument earth cables shall connect the instrument earth bar of the marshalling and instrument cabinets.
3. Looping of instrument earth cables between cabinets shall not be applied.
4. Connections of instrument earth cables shall be made using cable lugs and not terminals.
5. Dedicated earth rods should not be applied.
6. Manufacturers/Suppliers' recommendations on the arrangement of functional earthing (grounding) and maximum allowable resistance to earth shall be followed.
7. The star point earthing shall be connected to the overall plant earth grid inside equipment rooms.
8. For Insulation colours refer to the below Table:

Description	Colour
Protective Earth	Green (RAL 6018) and Yellow (RAL 1021)
Instrument Earth	Green (RAL 6018)
Intrinsically Safe Earth	White (RAL 9010)

Table 7 - Earthing and Bonding

10 MATERIALS

Materials and equipment shall be designed and manufactured in compliance to the applicable technical rules and the additional requirements (if any) specified in the technical specifications of the package.

Following is listed a general description of the main equipment included in the Supply.

10.1 ELECTRICAL EQUIPMENT

The electrical equipment included in the package shall as minimum comply with the following requirement.

10.1.1 CIRCUIT BREAKERS

Detailed I/O lists shall be prepared for all systems required to exchange data through the serial links and via "Hard Wired" connections.

Circuit breakers shall comply with IEC 60947 series and IEC 60898.

They shall be of the following type:

- Moulded case circuit breakers (MCCB) for incomers protection (where required) and for consumers where is required a nominal current ≥ 63 A.
- Miniaturized circuit breakers (MCB) for all other outgoing feeders or for the protection of internal auxiliary circuits.

Circuit breakers shall include built-in thermomagnetic relays sized in compliance to the absorbed power and to the cross section of cable connected.

All outgoing feeders, if not otherwise specified, shall be provided with Residual Current relays as following specified:

- Class A – Idn ≤ 300 mA for generic consumers and electronic equipment.
- Class B – for equipment that could have DC current to earth.
- Class AC – Idn ≤ 100 mA for heating resistors.

Circuit Breakers inside UCPs shall be for fixed installation.

When installed in "Ex-d" certified panels their operability from the front of the panel is mandatory requested.

They shall be provided with a rated short-circuit breaking capacity larger than the maximum value of the expected short-circuit current.

In particular the circuit breakers selection criteria will be:

- I_{cs} = 100% I_{cu} for MCCB
- Breaking capacity referred to I_{cu} for MCB.

At least: I_{cu} = 25 kA r.m.s. have to be taken into account.

Circuit breakers shall be provided with auxiliary contacts to signal "Open/close and protection trip". They shall be wired up to the interface terminal strips.

10.1.2 CONTACTORS

Contactors shall be in accordance with IEC 60947-4-1

They shall be for industrial type. Use of miniaturized contactors for power circuits is not allowed.

They shall be fully coordinated with the associated protection device against short circuits and overloads.

The "Utilisation" categories for the motor starters shall comply with the IEC 60947-4-1:

- AC-3 for cage rotor motors in CONTINUOUS, DISCONTINUOUS service, etc.;
- AC-4 for cage rotor motors in INTERMITTENT services

10.1.3 DISCONNECTOR SWITCHES

Switch disconnectors shall comply with the applicable Code IEC 60947-3.

The rated short-time withstanding current "Icw" and rated short-circuit making capacity "Icm" shall be higher than the maximum short-circuit current foreseen at each switching point included in the package unit's "Scope of Supply".

Utilization category shall be:

- AC circuits AC-23A
- DC circuits DC-22A

One auxiliary contact shall be available on interface terminals to signal "disconnector open".

10.1.4 MOTOR STARTERS

Motor starters shall as minimum comply with IEC 60947-4-1.

They shall be composed as following indicated:

- Moulded Case Circuit Breaker with magnetic built-in relay
- Contactor
- Thermal relay

The devices shall be of the same manufacturer and shall be fully coordinated against the short circuits and overloads. "Type 2" coordination as per 60947-4-1 is required.

Thermal relays shall be installed in all phases and shall include protection against single phasing. The trip class (10; 20 or 30) shall be selected under vendor responsibility accordingly to the starting current and time of the relevant connected motor.

The coordination shall be demonstrated by tables of the manufacturer selected.

Motor starters control philosophy shall be agreed during the development of the supply.

Space heaters shall be rated for operation at the heater supply AC 200-240V. It shall be controlled by thermostats and protected against short-circuit and earth faults by automatic magneto-thermal MCB.

10.1.5 CONTROLS, INSTRUMENTS, INDICATIONS AND ALARMS

Refer to Doc.no. 123A90-DDL-IN-SP-40094 – "Instrumentation for Package Unit Specification", for requirements of controls, instruments and meters, status indications and alarm to be provided both locally and remotely for the various types of plant and equipment.

10.1.6 CURRENT AND VOLTAGE TRANSFORMERS

Current Transformers (CT) shall comply with IEC 61869-1: "Instrument Transformers – Part 1: General requirements and conditions" and IEC 61869-2: "Instrument Transformers – Part 2: Additional requirements for current transformers".

Busbar and circuit Voltage Transformers (VT) shall comply with IEC 61869-1: "Instrument Transformers – Part 1: General requirements and conditions" and IEC 61869-3: "Instrument Transformers – Part 3: Additional requirements for inductive voltage transformers".

10.1.7 AUXILIARY RELAYS

The auxiliary relays shall comply with the IEC applicable rules.

They shall be provided with auxiliary contacts ("SPDT" type) in quantity as requested by the schematic diagrams.

Auxiliary relays shall be industrial type designed for heavy and intensive duty and for resistance to vibrations and shocks.

They shall be fitted with holding spring and LED indication for energized condition.

They shall be mounted on plug-type socket provided with screwed connection terminals.

Use of relays with connection by direct welding or by "faston" connectors is not allowed.

10.1.8 PUSH BUTTON AND SELECTOR SWITCHES

Push buttons and selector switches shall be of heavy duty, dust construction.

Switch contacts shall have a minimum continuous rating of 10A, 230V - 50Hz unless specified otherwise in the package specifications and shall be in accordance with the applicable parts of IEC 60947-5.

Push buttons shall be complete with proper facilities in order to avoid unintentional activations.

The push buttons, when required, shall be positioned and shall have colour in accordance with their specific functions as per IEC 60073.

Emergency stop pushbutton shall be mushroom type, red colour, provided with facilities for unintentional use is required by vendor.

10.1.9 SPACE HEATERS

Space heaters shall be provided when required in the project documents.

In particular, they shall be required for enclosures installed outdoor with internal electronic components.

They shall be controlled by thermostats and protected against short-circuit and earth faults by automatic magneto-thermal MCB.

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11 LOW VOLTAGE MOTORS

Electrical motors will generally be delivered as part of a package and be mounted on the same skid or base plate as the driven equipment.

Motors shall be designed in compliance to IEC 60034 series of rules.

When installed in hazardous area they shall comply also to IEC 60079 series of rules.

Minimum design for classification for all LV motors shall be Temperature group T1, Gas group IIC or IIB + H2, Equipment protection level EPL Gc, motor classification EX ec.

They are generally for direct on-line starting. Exceptions to this will be reviewed and approved on a case-by-case basis.

All low voltage motors shall be continuously rated with class F insulation (class B temperature rise) and shall be able to make two starts in quick succession, from hot, three from cold and another two starts shall be allowed after 30 minutes cool down.

Torque characteristics shall be selected such that the motor can accelerate (or re-accelerate) a fully loaded driven load with a terminal voltage of 80% applied.

12 VSD AND VSD MOTORS

VSDs shall be used for loads for which either of the following apply:

a) Where the load varies more than 20% from full load in normal operation or

b) Where use of a VSDs will eliminate the need for additional equipment (e.g. a gearbox).

If required, VSDs, including transformers, converters and motors, shall be supplied from one Vendor with proven capability of similar rated systems. The Vendor's standard design voltage shall be acceptable. The motor and drive combination shall have been fully type tested. The motor shall have thermistors embedded in the stator windings to provide thermal protection.

The motor shall be converter rated with all speed duty parameters (speed range, power range, load type, etc.,) shown on a second nameplate to maintain Ex certification compliance. Depending on motor size and duty, additional design features shall be employed such as insulated bearings.

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13 MOTOR LOCAL CONTROL STATIONS

All motors shall be provided with emergency stop pushbuttons of the stay-put lockable type, adjacent to the motor. Motors to be controlled locally shall be provided with start/stop control stations mounted local to the motor. For ATEX areas the control stations shall be as a minimum Ex ec IIC or IIB + H2, T1 type.

Motors both automatically controlled from the ICSS and having local start/stop facilities shall have stop/auto/on selector switches mounted local to the motor.

This functionality shall interface with the motor protection relay directly and shall be repeated in the ICSS control logic. The unit shall have facilities for locking in the "OFF" position.

Control stations shall be heavy duty type, high impact, and flame retardant, ultraviolet resistance with lock-off stop feature which is lockable in "OFF" position. These shall be as a minimum Ex ec IIC or IIB + H2, T1 type for ATEX areas as applicable.

Control stations shall normally be installed on suitable steel supports close to the motor they control and shall be wired directly to the motor starter in the switchgear.

Stay-put lockable type stop pushbuttons shall be located adjacent to the motor where the control station is remote from the motor.

Local control station (LCS) field push button (standard or mushroom cap) with momentary & maintained action for multiple functions or emergency stop. Remote control unit (RCU) shall be having three position selector switch "STOP" "AUTO" "START". Refer the diagram given below.

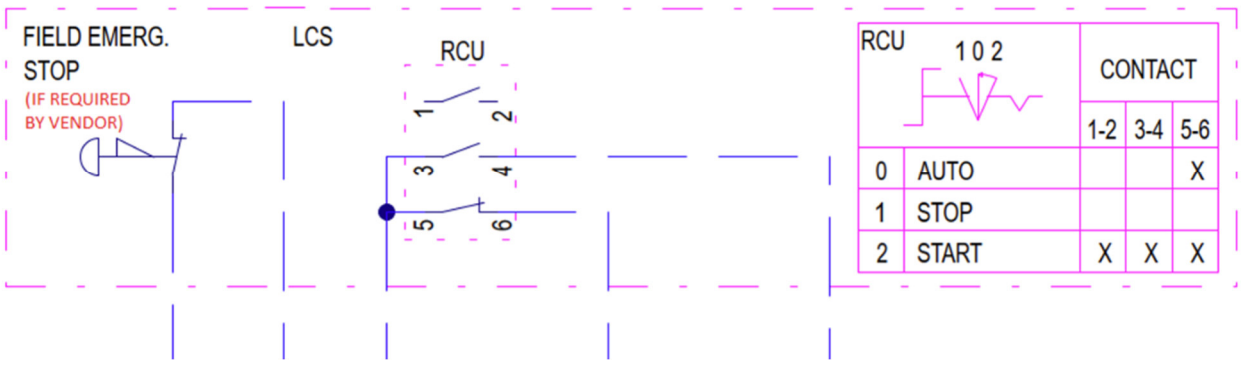


Figure 4 - LCS Diagram

14 ELECTRICAL HEAT TRACING

Trace-heating shall be designed and installed in accordance with IEC 62395, ATEX and VENDOR instructions / recommendations. Trace-heating shall be provided to all piping, fittings, valves, instruments and vessels as shown on the P&IDs and piping isometrics / piping line-lists.

The trace-heating shall be suitable for use in a hazardous area should this be applicable.

A single trace-heating sub-circuit shall only supply one process system.

Sub-distribution boards for heat tracing shall operate at 230VAC, 1-Phase from a 400V 3ph+N+PE distribution board. Each outgoing circuit shall be protected by a suitably sized MCB and 30mA RCD to provide sensitive earth leakage protection.

Trace heating shall be applied to external water pipes, liquid lines and level bridles of the Vent Drum, gas process instrumentation impulse lines and instrument enclosures for frost protection and to prevent the formation of hydrates within impulse lines.

Adequate tracing of impulse lines in the metering systems shall be ensured. Preference is for valves not to be insulated or trace heated.

Supplier should as a standard offer Heat Tracing and provide a junction box on Skid boundary for Contractor's power cable hookup for powering up Heat Tracing circuits.

In case the packaged units will include electrical heat tracing for frost protection, condensation prevention and for maintaining process temperature, it shall be designed and installed in accordance with IEC 60079-30-1, IEC 60079-30-2 and the Vendor instructions and recommendations.

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15 CABLES

15.1 GENERAL REQUIREMENTS

Cables shall have, as a minimum, the following cross-sections:

- Low voltage power distribution circuits : 2,5 mm^2
- Control and signaling circuits : 1,5 mm^2

The wiring colour code shall be as follows:

- For AC power or lighting use, the cores shall be colour coded using the following convention in accordance with IEC 60445:

Core	Colour
No.1 (L1)	Black to represent U phase
No.2 (L2)	Grey to represent V phase
No.3 (L3)	Brown to represent W phase
No.4	Blue to represent N (Neutral)
Protective Earth	Green / Yellow or Yellow / Green
Control cables	Black

- For DC systems:

Core	Colour
No.1 (L+)	Red (+)
No.2 (L-)	Blue (White) (-)
Control cables	Black

Use of other colours shall be submitted to Contractor/Company approval.

15.2 INSULATION LEVELS

The minimum insulation levels for the cables (including the relevant termination fittings) are following detailed:

Uo/U: 0,6/1 kV

This insulation level shall be applies to:

- Power distribution circuits to all "Normal" and "Emergency" classified consumers;
- Power distribution circuits to all "Safety" classified consumers fed by AC UPS;
- Earthing cables

Uo/U: 0,45/0,75 kV

This insulation level applies to:

- Internal cabling (power and auxiliary) of UCP and equipment.
- Relay based control circuits (for wiring and components).

15.3 CABLE SELECTION

Power and control normal distribution (indoor installation):

- Cross Linked Poly Ethylene (XLPE)
- Annealed copper class 2 conductor
- Not propagating fire (only for vital supply)
- Not propagating flames
- Low emissions of opaque smokes.
- Halogen free

Power and control normal distribution (outdoor installation):

- Cross Linked Poly Ethylene (XLPE)
- Annealed copper class 2 conductor
- Not propagating fire (only for vital supply)
- Not propagating flames
- Steel Wire Armour (SWA) (only for ATEX location)

15.4 CABLE SIZING

The sizing of the power and control cables within the battery limit of the packaged unit is specific responsibility of the Supplier.

LV cable sizing shall be carried out in compliance to the criteria indicated in the standard IEC 61892-4
In particular the sizing calculation philosophy is based on the following criteria:

Current rating
The standard gives the base cable carrying capacity referred to 45°C ambient temperature for a single cable considering a conductor temperature of 90°C (XLPE).

The current rating of the cables will be defined applying the relevant correction factors "K" to the nominal carrying capacities in continuous service.

Two correction factors will be considered:

- Correction factor for ambient temperature different from 45 °C;
- Correction factor of 0.85 for cable grouping for more than six loaded cables bunched in a group shall be applied.

Voltage drop
The circuit's voltage drop, at maximum load foreseen by design, it must not higher to the maximum limits specified in the paragraph 6.3 of this document.

Overload protection
The calculated cable carrying capacity shall be coordinated to the nominal rating of the related protection circuit breaker.

Short circuit withstand
The cables must be able to withstand the thermal effect of the maximum short circuit current calculated at the level of their installation.

In particular it shall be verified that the let through energy (Joule integral) tolerable to cable will be higher than the energy the let through energy of the protection device.

15.5 CABLE TERMINATIONS

For all LV power cables terminal lug shall match the connecting equipment terminals and shall be long barrel type. Terminal lugs shall be double crimped to stranded conductor using hexagonal compression dies.

For all other LV and control cables, depending on requirements, either appropriate terminal lug shall be crimped to the stranded conductor using hexagonal compression dies or compression connection shall be crimped to the stranded conductor using an appropriate tool.

All spare cable cores shall be individually terminated at the spare terminals.

All power cable cores shall have a phase colour identifier over the cable core (IEC 60445).

It is the responsibility of the CONTRACTOR to define each individual cable type and length.

An adequate percentage shall be allowed for slack, jointing, wastage, etc.

Application of grease if the connections are exposed to humidity shall be done; COMPANY shall approve quality of grease.

Checking of cleanliness and good contacts of conductive joint parts shall be performed.

Aluminium-copper connections shall be done with bimetallic lugs.

Unless otherwise specified, cable armour shall be earthed at both ends.

15.6 CABLE IDENTIFICATION

All cables shall be identified at each termination and each side of any obstacle (e.g. cable transit, ducting extremities, etc.) if any, by their respective tags/numbers, as indicated on the cable schedule.

Cable core ferrules shall be fitted at every termination. These ferrules shall be of engraved plastic slip on, interlocked and self-grip type.

Cable Identification shall be also done before entry to the switchboard and also in the switchboard cable compartment.

On cable trays or ladders, cables shall be identified at each end, at each change of direction and every 50 meters by 316L stainless steel embossed labels held by two 316L stainless steel ties. However, engraved plastic slip on characters onto plastic tie are acceptable indoor, only.

The method of cable marking shall be submitted to COMPANY for approval before to be used.

15.7 PANEL WIRING AND TERMINATIONS

All low voltage control wiring inside the cabinet shall be enclosed in cable duct. Cable ducts shall not be filled to more than 90% of their capacity. All wiring in the cable duct shall be insulated for the highest voltage in that cable duct and shall have a minimum 90 degree thermosetting temperature.

All wiring connections shall be made using insulated crimp connectors. Connections relying solely upon solder are not acceptable.

The minimum conductor sizes shall be as follows:

- Electrical Low voltage power wiring 2.5mm^2
- Electrical Control wiring 1.5mm^2

All spare and unused auxiliary contacts shall be wired to terminal blocks.

Wires shall be numbered at each end with the wire numbers shown on the Supplier's approved schematic and wiring diagrams. Wires shall be marked using indelibly printed ferrules in clear plastic ferrule holders. Ferrules and holders shall be unaffected by moisture or oil. Hand printed ferrules are not acceptable.

Ferrules shall require disconnection of the wire to remove the ferrule.

Equipment inter-panel wiring between transport units shall terminate at a row of marked terminals located on one side of the break between transport units to facilitate assembly on site. All wiring between transport units shall be bundled together and marked or identified ready to terminate into terminal blocks located in the adjacent transport unit.

When core numbers change, e.g. at connections between equipment, a clear system of coding is to be used at the change point and details shall be clearly marked on drawings.

All wiring shall be terminated in approved non-loosening terminals, one conductor per terminal. Cross-connecting links shall be used where more than one conductor per terminal is required.

The terminal blocks shall be located in such a way that easy access for termination, testing and maintenance is available. Terminations shall be arranged in functional groups each group being clearly labelled. As a minimum, 20% spare terminals shall be provided.

All power terminations shall be shrouded and segregated from the marshalling and control terminations. Complete segregation shall be maintained between power and signal circuits to avoid induced noise. Terminals operating at different voltages or performing different functions shall be adequately segregated from each other.

The spacing may be relaxed at entries to equipment, and where due to physical constraints these spacing's cannot practically be achieved. All such cases shall be highlighted in the design documentation and be subject to approval by the Contractor.

All cable cores shall be terminated. Only one core or screen shall be terminated in a terminal.

Field wiring shall be fully terminated onto rail-mounted terminals. Cores shall not be taped or tied back.

Terminals shall be of the pressure clamp type. Pinch screw terminals where the screw is in direct contact with the conductor are not acceptable. All terminations shall be of the crimped pin type. No external cables shall connect directly into equipment.

Terminal strips and blocks shall be in single layers. A minimum distance of 50 mm shall be maintained between a terminal strip and its associated ducting.

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If more than one conductor has to be terminated at the same point the required number of terminals shall be linked together. Within Control Panels proprietary comb type links inserted on the panel side of the terminal strip shall be used. Looping wire shall not be used for this purpose.

Unused cores in cables shall be terminated such that there is single path continuity from the field to the safe area termination panel where they shall be bonded to earth.

All panel wiring and trunking shall be flame retardant, low smoke, zero halogen type. Wiring shall be labelled as specified within this document.

All wiring shall be separated by duty and by voltage level. The respective terminal blocks shall be similarly grouped.

Wiring shall be clearly labelled and identified at both ends. Cable core identifiers must be indelible and permanently marked.

Terminals carrying voltages higher than 48 Volts shall be protected against accidental contact with removable cover plates and be labelled to indicate high voltage. Covers shall bear warning notices indicating that the equipment should be isolated before the cover is removed.

Where the packaged equipment involves several discrete items, such as a skid and a UCP, the supplier shall be totally responsible for the complete design of the interconnections between the component parts. The interconnecting cables shall be supplied and installed by the Contractor in accordance with the design documents provided by Supplier.

15.8 JUNCTION BOXES

Junction boxes should be designed for one multicore cable and segregated.

The minimum degree of protection for junction boxes (containing terminals only) shall be IP 56.

Junction boxes shall be made of fiberglass reinforced polyester (GRP) or AISI 316 with 316 or 316L stainless steel screw fastenings and shall be AISI 316 or AISI 316L Junction boxes shall not be painted.

All outgoing electrical connections from the package shall be grouped and wired to a Junction Box(es) located in an accessible position, close to the package edge, with adequate space for routing and connection of outgoing cables, allowing for Supplier's minimum bending radii.

Where GRP junction boxes are used, the cable armour of all cables shall be bonded to a metallic gland plate, an internal metallic back plate and/or an earth bar.

Bonding wires shall have a maximum length of 0.15m (0.5 ft).

Junction boxes should be located close to or under metallic structures in order to avoid exposure to direct lighting strikes.

"Electrical" junction box terminals to be marked L, N, PE / E using pre-marked plastic letters.

Certified drain plugs shall be installed in all JB's mounted outdoors.

16 LIGHTING

16.1 GENERAL

The supplier shall be responsible for the design, purchasing and installation of lighting system installed on the packaged unit (where required in the purchase order).

Lighting system shall be provided indoor the containerized room included in the package.

The lighting system of the package follows the same criteria and the same manufacturer of which installed on the platform. In particular it will be divided in LED light fitting without internal battery for general lighting and LED light fitting with 3 hours for emergency and escape lighting (the latter with 1 h internal battery back-up).

The following areas shall be provided with escape lighting:

- Package vendor rooms
- The top deck where hydrogen related equipment and storage vessels are located
- Every stair, ladder and platform

16.2 ILLUMINATION LEVELS

The required illumination levels, measured at the working plane or 1m above the floor level in a horizontal plane, shall be as given in the table below:

Location	E_{mean} (LUX)	Notes
Control Rooms		
General, including front of panel	300 - 500	See note 1
Rear of panels	50	
Auxiliary rooms	150 / 300	See note 2
Outdoor near entrances	150	
Plant Areas		
Operating areas requiring operator intervention (pumps, compressors, valves, manifolds, loading arms)	150	
Local control and monitoring points (Indicating instruments, gauges and control devices)	75	
Level gauges (see-through) to be lit from behind by single tube fluorescent luminaries	75	
Access ways (walk ways, platforms, stairways, ladders, module roofs)	25	
Non-operational areas with limited attendance, e.g. tank farms without equipment requiring regular operator intervention	0.5	

Table 8 - Required Illumination Levels

The illumination level indicated in the above table shall be used as a basis for the design of new installations unless higher illumination levels are required by national or local regulations in the country of installation.

The emergency lighting luminaires shall comprise up to 25% of the total number of luminaires.

The illumination levels apply when the luminaries are dirty: i.e., after taking account of the following fouling factors:

- Fouling factor of 0.80 for all plant areas and for outdoor non-plant areas;
- Fouling factor of 0.85 for indoor non-plant areas.

Note:

1. For control rooms, control of the illumination level should be possible either by switching off rows/groups of luminaires, or by use of electronic dimmers, or both.
   - 300 lux applies at night and 500 lux during the daytime.
2. For auxiliary rooms, the illumination level should be controlled by switching each lamp in a twin fitting from separately controlled circuits or by switching alternative fittings.
   - 150 lux applies for normal access and 300 lux for maintenance activities

17 EARTHING AND BONDING

All skid mounted equipment packages shall have two earthing studs installed diagonally opposite from each other as per Approved for Construction documents. All non-electrical metallic equipment such as vessels, tanks and skids, unless welded to the deck, shall be bonded by an earth cable to two steel earth bosses welded to the structure steelwork or main module framing at diagonally opposed locations. Separate earth conductor connections shall be made from the equipment external PE connection stud to steel earth bosses welded to the structure. The minimum cross-sectional area of the earth cable to be used for the bonding of this equipment shall be 25 mm^2.

The VENDOR shall check that a suitable earth connection point is provided on motors, panels, junction boxes and gland plates before cable glanding is started. If no connection point is provided, an earth tag and/or star washer shall be installed with the cable gland.

All armour clamp type glands shall have the cable braid terminated in the gland. Continuity between cable glands and other metallic equipment with threaded entries shall be achieved via the threaded entry to the enclosure. A minimum of five threads of contact is required. Where five threads cannot be achieved a suitable gland earthing ring tag shall be used.

The VENDOR shall be responsible for ensuring continuity between all glands, gland plates, doors, equipment housings and other associated equipment.

18 LABELS

All equipment shall be provided with nameplates indicating the tag number and the service description of the equipment.

All junction boxes, cabinets, panels and ancillary equipment shall be provided with nameplates indicating the tag number.

Tag numbers and service descriptions shall be aligned with the equipment database and equipment data sheets.

The text on nameplates for manual selector switches shall repeat the switch position markings and describe what each switch position represents.

The text on nameplates for push buttons shall describe what action results when the push button is activated. Where abbreviations are necessary, they shall be standardised and consistent for all nameplates.

19 TOOLS

All special tools necessary for the maintenance of electrical system included in the package shall be included in the supply.

20 EQUIPMENT TAGGING AND IDENTIFICATION

All equipment shall be tagged as per the project equipment and system tagging philosophy, 123A90-PML-DIG-PRO-00002 .

For all the components which are part of the Main Item to be supplied, as applicable like: control relays, measurement instruments, cables, terminal blocks, heaters, etc., the manufacturer tagging procedure shall be submitted for approval prior the construction.