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ELECTRICAL SYSTEM DESIGN CRITERIA

نگهداشت و افزایش تولید میدان نفتی بینک

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IFC: Issued For Comment
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AFD: Approved For Design
AFC: Approved For Construction
AFP: Approved For Purchase
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IFI: Issued For Information
AB-R: As-Built for Client Review
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PAGE	D00	D01	D02	D03	D04
1	X	X	X		
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3	X	X			
4	X	X			
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PAGE	D00	D01	D02	D03	D04
51					
52					
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87					
88					
89					
90					
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					

CONTENTS

1.0 INTRODUCTION 5

2.0 SCOPE 5

3.0 NORMATIVE REFERENCES 6

3.1 LOCAL CODES & STANDARDS 6
3.2 INTERNATIONAL CODES AND STANDARDS 6

4.0 ENVIRONMENTAL CONDITIONS 6

5.0 DESIGN BASIS 6

5.1 CONDITIONS OF OPERATION 7
5.2 UNITS OF MEASUREMENTS 7
5.3 NOISE LEVEL 7
5.4 VOLTAGE LEVELS & FREQUENCY 7
5.5 AREA CLASSIFICATION AND MATERIALS SELECTION 8
5.6 CERTIFICATIONS 9
5.7 THE MARKING REQUIREMENTS WILL INCLUDE THE FOLLOWING: 9
5.8 DEGREE OF PROTECTION 9

6.0 RELAYING AND METERING SYSTEM 10

7.0 OPTIMIZING ENERGY 10

7.1 LIGHTING CONTROL 11
7.2 SOLAR WATER HEATER 11
7.3 ENERGY AND DEMAND SAVINGS THROUGH SYSTEM IMPROVEMENTS 12

8.0 STUDIES AND CALCULATIONS 12

8.1 GENERAL REQUIREMENTS 12
8.2 SHORT CIRCUIT CALCULATION 13
8.3 LOAD FLOW STUDIES 14
8.4 MOTOR STARTING STUDY 15
8.5 HARMONIC CURRENTS AND VOLTAGES (IF NECESSARY) 15
8.6 VOLTAGE DRPOS 16
8.7 PROTECTIVE DEVICE COORDINATION STUDY 17
8.8 LIGHTING CALCULATION 18
8.9 CABLE SIZING 18
8.10 EARTHING CALCULATION 19

9.0 MEDIUM VOLTAGE SWITCHGEARS 19

10.0 LOW VOLTAGE SWITCHGEARS 21

10.1 GENERAL 21
10.2 POWER CENTERS 22
10.3 SUBSIDIARY LV SWITCHBOARDS 23

11.0 POWER TRANSFORMERS 24

12.0 EMERGENCY DIESEL GENERATOR 25

13.0 UNINTERRUPTIBLE POWER SYSTEMS 26

13.1 110 VDC for Electrical Substation Loads 26
13.2 AC UPS 26
13.3 F&G and Fire Alarm System 27

14.0 ELECTRIC MOTORS 27

15.0 POWER FACTOR IMPROVEMENT 30

16.0 CABLES 30

17.0 LIGHTING SYSTEM 33

18.0 GROUNDING AND LIGHTNING SYSTEM 38

19.0 CATHODIC PROTECTION SYSTEM 40

20.0 MISCELLANEOUS 40

20.1 Convenience Receptacles 40
20.2 Welding Receptacles 41
20.3 Local Control Station 42
20.4 Cable Termination 42
20.5 Cable Trays/Ladders 43
20.6 Conduits 43

21.0 ELECTRICAL MONITORING & CONTROL SYSTEM 44

21.1 Application of System 44
21.2 Signal Transfer to the Control System 44

22.0 ELECTRICAL SUBSTATIONS BUILDING 44

1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

<u>GENERAL DEFINITION</u>

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – General Facilities
EPD/EPC CONTRACTOR(GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR:	Joint Venture of : Hirgan Energy – Design & Inspection(D&I) Companies
VENDOR:	The firm or person who will fabricate the equipment or material.
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
THIRD PARTY INSPECTOR (TPI):	The firm appointed by EPC CONTRACTOR and approved by GC & COMPANY (in writing) for the inspection of goods.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by COMPANY rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

2.0 SCOPE

This document covers minimum necessary requirements for the design, manufacture, inspection, testing and delivery of Electrical Design Criteria that will be used in “Binak Oilfield

Development".

3.0 NORMATIVE REFERENCES

The equipment shall be engineered, designed, manufactured and tested in accordance with the latest edition of the following standards:

3.1 Local Codes & Standards

IPS Iranian Petroleum Standards

3.2 International Codes and Standards

IEC	International Electro technical Commission
BS	British Standard
IEEE	Institute of Electrical and Electronics Engineers
DIN	Deutsches Institut Für Normung
NACE	National Association of Corrosion Engineers
API	American Petroleum Institute

4.0 ENVIRONMENTAL CONDITIONS

The installation site is in south of Iran with corrosive, hot and high humid atmosphere. Therefore, all equipment shall be designed to fully comply with the performance specification in the environmental conditions. For more information refer to "Process Basis Design; section 11".

For the Ambient Conditions, Special Care should be paid to:

- Enclosures of Equipment for Outdoor Installation
- Painting and Coating of Metal Parts to Resist to the Severe Environmental Condition
- Any environmental derating factors shall be considered by vendor before design

5.0 DESIGN BASIS

The electrical system shall be completely redundant. The design of electrical system will be based on:

- Continuous and reliable service: the electrical system will be designed to isolate faults with a minimum of disturbance to the system and to give the maximum dependability consistent with the plant requirements.
- Safety of personnel and equipment
- Ease of maintenance

- Interchangeability of equipment

5.1 Conditions of Operation

The power distribution, control and instrumentation will be suitable for 24 hours, 7 days/week, and 365 days/year operation.

5.2 Units of Measurements

SI unit of measurements is used in the whole documents.

5.3 Noise Level

Under normal working conditions, no operator shall be exposed to a continuous noise level of more than 85 dB (A) for a period of 8 hours. The noise level in the central control room and office rooms shall not exceed 60 dB (A).
In any case the noise level shall be according to the requirement of OSHA (occupational safety and health administration) for relevant equipment and condition.

5.4 Voltage Levels & Frequency

The voltage variation shall be ± 10%. The frequency is 50Hz with variation of ± 5%.
Combined voltage and frequency variation is ±10%.

- Motors > 1000 kW — 11 kV – 3 ph.
- Motors ≥ 150 kW — 3.3 kV – 3 ph.
- Motors < 150 kW — 400 V – 3 ph.
- Heaters ≥ 3 kW — 400 V – 3 ph.
- Heaters < 3 kW — 230 V – 1 ph+n

Low voltage distribution — 400 V – 3 ph., neutral directly grounded
Welding receptacles — 400 V – 3 ph.
Lighting system:

- Normal main distribution — 400/230V–3ph, neutral directly grounded
- Emergency main distribution — 400/230V–3ph, neutral directly grounded
- Normal branch circuits — 230 V–1ph+n (for individual fixtures or sockets)
- Emergency branch circuits — 230 V–1ph+n (for individual fixtures)

- Socket for light and tools 230 V–1ph+n

Circuit Breaker tripping and closing circuit, alarm circuit, micro-processor based meters and relays auxiliary supply and C.B. motor charging supply circuit shall be supplied by 110 VDC

- Instrument control voltage 24 V dc and 110 VAC
- Communication power system 230 V – 1 PH+N
- Telephone system (PABX power voltage) 48 VDC

5.5 Area Classification and Materials Selection

Classification of hazardous areas and their extent will be in accordance with IEC 60079 and API-RP 505 codes as follows:

Substance characteristic identification as per IEC 60079-1

Hazardous areas and their extension as per IEC 60079-10

Recommended practice for classification of location for electrical installation at petroleum facilities classified as Zone 0, Zone 1, and Zone 2.

The selection of electrical equipment to be installed in classified areas will follow the recommendation of IEC 60079-14.

No electrical equipment will be installed in hazardous areas classified Zone 0.

The following table summarizes the minimum safety execution of the electrical apparatus suitable to be installed in the classified area.

Electrical Equipment	Qualification of Zones	
Zone	**Zone 1**	**Zone 2**
L.V. motors	Ex-d	Ex-d or e
M.V. motors	Ex-d	Ex-d or e
Lighting fixtures	Ex-d	Ex-e
Plugs & sockets	Ex-d	Ex-d
Junction boxes	Ex-d	Ex-e
Pushbutton stations	Ex-d	Ex-d
Local boards	Ex-d	Ex-d

5.6 Certifications

All materials to be installed in hazardous area will be certified by recognized Authority. It is essential to provide certificate of conformity for all equipment installed in hazardous area zone I, II.

5.7 The marking requirements will include the following:

- Identification of the manufacturer;
- The name or type of designation of the apparatus;
- The number of the appropriate part of the certification specification for the type of protection used;
- Identification of the type of protection;
- The apparatus group, if applicable;
- The number of the certificate and the name or mark of the certifying Authority;
- The temperature class;
- Any other relevant information

5.8 Degree of Protection

The minimum degree of mechanical protection of electrical equipment, specified according to IEC 60529, will be:

- Switchboards, outdoors installation protected with canopy IP 54
- Switchboard, outdoors unprotected IP 65
- Switchboards, indoor installation IP 42
- Motors, outdoor installation IP 54
- Motors Terminal Box, outdoor installation IP 55
- Lighting fixture, outdoor installation IP 65
- Lighting fixtures, indoor installation IP 42
- Local Control Boxes IP 65
- Transformer, Protected IP 54
- Earthing resistor enclosure, Protected IP 55

6.0 RELAYING AND METERING SYSTEM

Metering and protection system shall be as per IPS-E-EL-100(1) para. 7.5.

A relaying and metering system will be designed for incoming and outgoing feeders.

Relays will provide adequate safeguards of equipment against electrical faults and a suitable action to discriminate and trip faulted lines in order to minimize troubles on the system and guarantee safety to personnel and equipment.

Indirect relays will be microprocessor type (unless specific protection is not available with this technology) with programming and communication (Mod bus) facilities (cable T software...).

They will be dust proof, flush mounted, easy removable heavy duty and provided with local and remote setting facilities and local facilities for connection of testing devices.

The relays will meet the requirements of IEC 60255.

Metering system will be provided to give consumption of utilities and process units.

Measurement instruments will be electric, electronic or microprocessor type and independent from multifunction protective relays.

The most common type instruments used in distribution system are as follows: ammeters, voltmeters, watt meters, var meters, power factor meters, frequency meters, synchroscopes, elapse time meters, including portable and recording.

For more information reference to be made to IEC 60051.

At least the requirements to IEC 60051 shall be considered during design stage, all equipment must be connected on the circuit side of the circuit breaker or motor starter (voltmeters are excluded).

Electrical device function number shall be as per IEEE std. C37.2 indicated in IPS-E-EL-100(1) para. 6.1.10.

7.0 OPTIMIZING ENERGY

Production Energy Optimization (PEO) is a solution for industrial facilities that:

- Reduces energy costs per unit of production output
- Increases asset utilization
- Optimizes both demand and supply side energy management initiatives
- Accelerates continuous improvement

The PEO solution offers sustainable savings by simplifying the collaboration and expertise of managers, operators, maintenance professionals and engineers, as well as the compatibility, synergy and capability between plant systems and energy systems.

Efficient Energy Management is critical as most energy intensive industries like petroleum, petro-chemicals, etc., depend upon primary energy resources. These industries are forced to explore ways and means for using energy judiciously and without much wastage.

It is important to examine the power consumption and reduce the power needs as much as possible

7.1 Lighting Control

Energy efficiency is gained by allowing the normal use of schedule, switch, and occupancy-sensor device controls to be shared on lighting circuits:

- Sensors and Wiring Devices that cause energy savings and energy code.
- The Lighting Control Relay Panel that combines ease of use, versatility and durability

7.2 Solar Water Heater

Solar water heating (SWH) or solar hot water (SHW) systems comprise several innovations and many mature renewable energy technologies that have been well established for many years.

SWH systems are designed to deliver hot water for most of the year. However, in winter there sometimes may not be sufficient solar heat gain to deliver sufficient hot water. In this case a gas or electric booster is normally used to heat the water.

Using solar water heating system will help to reduce harmful emission from fossil fuels.

The type, complexity, and size of a solar water heating system are mostly determined by:

- The temperature and amount of the water required from the system.
- Changes in ambient temperature and solar radiation between summer and winter.
- The changes in ambient temperature during the day-night cycle.
- The possibility of the potable water or collector fluid overheating.
- The possibility of the potable water or collector fluid freezing

7.3 Energy and Demand Savings through System Improvements

Capacitor Banks and Controls:

Installing capacitors on a system will lower losses by reducing reactive current. This loss reduction will minimize peak kW seen by system. In addition, because energy losses will be reduced, fewer kilowatt-hours (kWh) need to be generated.

Capacitors, controllers, communications, and centralized automation decrease system loses, improve energy efficiency, eliminate compliance penalties and improve grid stability during peak stresses. By releasing energy capacity through the installation of capacitors and controls, a utility may postpone the need for adding other and more expensive equipment and generation facilities.

Voltage Optimization Solutions:

Improving electric distribution system efficiency through voltage regulation can save energy, reduce peak demand and better manage reactive power.

Industry research indicates that the energy savings results from implementing voltage regulation programs are within the expected values of 1 to 3 percent total energy reduction, 2 to 4 percent reduction in kW demand, and a 4 to 10 percent reduction in kvar demand.

8.0 STUDIES AND CALCULATIONS

8.1 General Requirements

System studies and calculations referred to in this section will be submitted to the Employer for review and approval.

A suitable validated computer application, utilizing databases, will be used for recording and calculating the electrical loads. The load summary shall be updated at multiple stages during the detail design phase of the project as required to support the design of the distribution system and procurement of equipment. A final version of the study shall be issued for record purposes at the end of the detail design phase of the project.

To verify that no cable is under voltage, the load flow studies shall be followed considering the capacitor banks out of service and transformers tap changers in normal position.

Transformers secondary side's voltage shall be considered in no-load condition.

In modeling the electrical distribution system of a plant, the real short circuit current as well as the real X/R amount of the grid shall be considered.

The overall system power factor, inclusive of reactive power losses in transformers and other distribution system equipment, shall not be less than 0.95 lagging at rated design throughput of the plant.

System studies shall be performed during the detail design phase of the project in support of the electrical system design. Such studies shall be carried out using a validated software and shall include, but not necessarily be limited to:

- Load flow studies
- Fault level studies
- Dynamic performance studies under motor starting and/or loss of Generation/utility supply conditions
- Transient stability studies under three-phase fault conditions
- Power system harmonics study (only if necessary)

Reports shall be prepared for each of the studies carried out. The reports shall include a discussion of results and a list of recommendations and conclusions. All assumptions and estimated data shall be clearly identified. Preliminary studies shall be performed before equipment is ordered using typical data where actual data is not available and shall include recommendations for operating configurations.

Final studies shall be conducted after equipment supplier's data has been received. The studies shall confirm that the equipment has been properly selected and that the design meets the requirements that are specified herein.

8.2 Short Circuit Calculation

Short-circuit calculations shall be executed using the following criteria:

- The method of IEC 60909 for Onshore shall be adopted for calculating short-circuit currents.
- IEC tolerances shall be used for transformer and generator impedances, unless otherwise agreed with the Company.
- Both resistance and reactance shall be taken into account for all impedances.
- The DC component of the asymmetric short-circuit current shall be shown to have decayed sufficiently by the time that the circuit breaker contacts open to enable the arc to extinguish.

One-phase and three-phase short-circuit studies shall be performed in:

- Normal case: one transformer can be out of service and whole load feed from the other transformer by closing the bus-tie breaker.
- Worst case: two transformers can be parallel with each other for a short time by closing the bus-tie breaker.
- The results of the short-circuit study shall be used to confirm the following:
- Busbar Ratings
- Switchgear and Distribution Equipment Ratings
- Cable Ratings
- Bus-duct Ratings

Protective Earthling Systems

8.3 Load Flow Studies

Load flow studies shall be carried out to calculate all bus voltages, branch power factors, currents and power flows throughout the plant electrical system. The load flow reports shall tabulate the magnitude of active (real) power and reactive power supplied by each generator, transformer, feeder and busbar with the total connected plant load. Load flow diagrams shall be prepared for both main and essential systems and shall indicate MW and MVAR figures, busbar volts and voltage phase angles.

The load flow studies shall include the preparation of calculations and diagrams showing the distribution of loads under predicted abnormal operating conditions, such as loss of one generator, feeder or transformer due to fault or maintenance conditions. System losses shall also be determined and indicated on the diagrams.

Voltage drop and voltage regulation calculations shall be carried out as part of the load flow studies. These calculations shall determine the voltage profile of the network under full load and light/no load conditions.

The load flow and motor starting studies shall be performed in:

- Normal case: bus-tie breaker is normally open, and each section is fed by its own transformer.
- Worst case: one transformer can be out of service and whole load feed from the other transformer by closing the bus-tie breaker.

The results of the above load flow studies shall be used to check the following:

- System voltage profile and phase angles
- Transformer ratings/loadings
- Power losses

Transformer taps settings/ratings

8.4 Motor Starting Study

A motor starting study shall be carried out to determine the voltage profile of the system when starting under minimum supply conditions with the rest of the plant operating at full load:

- The largest rated motor connected on the main system
- The largest rated motor connected on the essential systems

Transient stability studies shall be performed during detail design to study the effects of three phase faults and partial loss of generation and/or the utility supply.

8.5 Harmonic Currents and Voltages (if necessary)

A harmonic study shall be carried out during detail design in case of several adjustable speed drives provision and thyristor controlled large heaters are a part of the electrical network.

The selected systems shall ensure minimum harmonics under the specified operating conditions.

The magnitude of the harmonics and the total voltage distortion shall be calculated for all main bus bars. Harmonics acceptance limits shall comply with IEC 61000-2-4.

Ratings of transformers and generators shall be checked against actual network harmonics contents.

Actions to attenuate harmonic disturbances shall be evaluated case by case.

8.6 Voltage Drpos

Cable voltage drops shall be limited to the following values:

Bus duct or cable between:

- transformer secondary and switchgear: 5% at rated load
- Main Feeders: 2% at rated load:

Motor cables at rated load:

- For LV: 5% (at terminals)
- For MV: 3.25% (at terminals)

Motor cables at motor starting:	15% (at terminals)
Process heater circuits:	5% at rated load
	1% to heater panels
	4% from panel to heater
Process lighting circuits:	5% at rated load
	2% to lighting distribution panels
	3% for lighting branch circuits
Socket outlet circuits:	5% at rated load
	2.5% to distribution panels
	2.5% for branch circuits
Trace heating circuits:	5% at rated load
	2% to distribution panels
	3% for branch circuits
DC supply circuits:	5% at rated load (at the end user)

UPS circuits 5% at rated load (at the end user)

Greater voltage drops may be permissible under special circumstances, subject to approval by the Employer.

The transient voltage dips shall be limited as is noted below, with the exception of motors that are supplied by captive transformers, unless otherwise approved by the Employer. For motors that are supplied by captive transformers, transient voltage dips at the motor terminals shall be limited to the minimum value for which the motor is specified and designed.

- Main Distribution Switchgear Bus: 10%
- Secondary Distribution Switchgear Bus 15%
- At Motor Terminals 15%

The voltage drops shall be calculated for the worst operating conditions (i.e. with the system operating at minimum short-circuit conditions) unless otherwise approved by the Employer

8.7 Protective Device Coordination Study

A protective device coordination study shall be carried out during detail design to provide correct discrimination between all protective devices, for the minimum and maximum prospective fault currents, from the point of power utilization up through the circuit towards the source of power. The thermal effects of fault currents shall not exceed the thermal withstand capability of any circuit component.

Appropriate settings shall be calculated for each relay and the characteristics of all the protective devices on the circuit branch under consideration compared to ensure discrimination. The following data shall be used:

- A one-line diagram of the power system, showing the type and rating of the protective devices and their associated current transformers.
- The impedance of the local grid system.
- The impedances of all power transformers, rotating machines and feeder circuits.
- The maximum and minimum values of short-circuit currents that are expected to flow through each protective device.

- The starting current requirements of motors and the starting and stalling times of induction motors.
- The maximum peak load current through protective devices.
- Decrement curves showing the rate of decay of the fault current supplied by generators.
- Performance curves of the current transformers.
- Approved software will be used for recording and plotting characteristics of time over current relays for the coordination study.
- On completion of the study, a relay setting schedule shall be prepared, which will include settings for all adjustable electrical protective devices.

8.8 Lighting Calculation

Illumination calculations shall be developed for typical installations to determine the minimum number and locations of luminaries required to provide levels and uniformity of illumination as defined in API RP540 table 4 and IPS-E-EL-100(1) table 15.

8.9 Cable Sizing

Cable sizes shall be specified in the units of the SI System with conductor cross sectional areas in mm^2.

Cables shall be sized in accordance with document “Cable Sizing Calculation”.

In general, cables shall be selected in order to satisfy the following conditions:

Thermal Short Circuit capacity

- Continuous current carrying capability
- Voltage drops

Furthermore, proper de-rating factors will be properly applied basing on the installation conditions (i.e. underground, aboveground in covered cable tray, aboveground in conduits etc.) as per document “Cable Sizing Calculation”.

8.10 Earthing Calculation

Calculations and studies as required by IEC standards shall be carried out to determine the minimum requirements for conductors and materials of the power system earthing and lightning protection systems. Calculations and studies shall include, but not necessarily be limited to:

- Calculation of minimum conductor cross sectional area, which shall be selected to withstand the maximum prospective short-circuit current for a period not less than the maximum fault clearing time, as determined by the power system studies.
- Calculations to show that the required resistance to earth values can be achieved for all earthing and lightning protection systems.
- Studies shall be conducted for all units to design an earthing system which shall protect structures against lightning strikes.

9.0 MEDIUM VOLTAGE SWITCHGEARS

MV switchgears shall be according to IPS-M-EL-144(4).

The switchgears will consist of metal clad Air insulated freestanding units, assembles together in single row, suitable for indoor installation. Switchgears will be arranged for future extension at both ends.

Units will be equipped with necessary current and potential transformer, relays, instruments and other ancillary equipment.

Potential transformers will have draw out type primary current limiting fuses. Secondary will be rated 110VAC.

Current transformers will have secondary rated 5A for local protective relays and for remote indication or metering it shall be 1A.

Bus bars system will be insulated copper.

Circuit breakers will be vacuum type with suitable rupturing capacity.

Earthing switch will be provided for all incomings and outgoings of MV switchgears.

A remote control panel (RCP) shall be installed in LV switchgear room (Substation), near the MV switchgear for open/close of non-motor type circuit breakers of medium voltage switchgear.

MV switchgear shall be capable of carrying the Prospective symmetrical fault currents for specified short time duration of 1 second without deleterious effect.

The back-up fault current protection clearing times shall always be less than the equipment short time current rating.

The closure of MV switchgear on to a balanced or unbalanced fault shall not result in shock load damage to healthy parts of the system as a result of peak asymmetrical make currents following.

The selection of circuit breakers shall be dependent on the make and break duty which the breaker is required to cater for switching devices that may be closed on to fault will have the necessary fault making capability.

Plant protected by fault current limiting HRC type fuses need not be designed to sustain the prospective shock or thermal loads obtained by calculating system fault currents.

Basically the protective relays for the incoming and outgoing feeders shall be as follows:

MV switchgear incoming feeders:

- 50/50N
- 51/51N
- 50G (if applicable)
- 50 BF
- 47
- 27 & 27r

MV switchgear bus tie:

- 50/50N
- 51/51N
- 27 & 27r
- 25

MV switchgear outgoing feeders:

- 50/50N
- 51/51N
- 50 BF

MV switchgear outgoing Motor type feeders (150KW<P<1000KW):

- Fuse protection
- 66
- 51L
- 50G
- 50 BF

- 49, 49T
- 48
- 46
- 27

Note: Lock out relay (86) will be provided separately.

10.0 LOW VOLTAGE SWITCHGEARS

10.1 General

LV switchgears shall be according to IPS-M-EL-143(3).

Low voltage switchboards will include Power and Motor Control Center (PMCC), Auxiliary Service Panels (ASP) and subsidiary switchboards feeding all low voltage users. Unless otherwise indicated, the switchboards will be for indoor installation.

The ASP, if required will feed small users other than motors, Lighting Panels, Air Conditioning units, Welding Receptacles, Heaters and so on. ASP can be deleted, if the above mentioned loads are few.

LV switchboards will be designed with adequate rupturing capacity; the bus bar will be solid copper insulated.

All boards except lighting panels will be sized to withstand a short circuit current of 50 kA, 1 second as a maximum.

Low voltage switchboards at least will be equipped with 10% of outgoing feeders as spare for future needs plus 10% spare space.

LV switchgear shall be capable of carrying the Prospective symmetrical fault currents for specified short time duration of 3 second without deleterious effect.

The back-up fault current protection clearing times shall always be less than the equipment short time current rating.

The closure of LV switchgear on to a balanced or unbalanced fault shall not result in shock load damage to healthy parts of the system as a result of peak asymmetrical make currents following.

The selection of circuit breakers shall be dependent on the make and break duty which the breaker is required to cater for switching devices that may be closed on to fault will have the necessary fault making capability.

Plant protected by fault current limiting HRC type fuses need not be designed to sustain the prospective shock or thermal loads obtained by calculating system fault currents.

Basically the protective relays for the incoming and outgoing feeders shall be as follows:

LV switchgear incoming feeders:

- 64R
- 50/50N
- 50 BF
- 51/51N
- 49
- 27 & 27r

LV switchgear bus tie:

- 50/50N
- 51/51N
- 27 & 27r
- 25

LV switchgear outgoing Motor type feeders:

P<18.5KW: Fuse or MCCB

49

18.5KW<P<150KW: Fuse or MCCB

27

47

49

50G

Note: Lock out relay (86) will be provided separately.

10.2 Power Centers

They will be of self-supporting, metal enclosed compartmented type structure consisting of vertical sections assembled in a single row with common bus bars.

Incomings and bus-tie compartments will be equipped with draw out air circuit breakers, electrically and manually controlled.

Outgoing feeders above 400A shall be draw out and provided with manually operated air circuit breakers.

Outgoing feeders up to 400A can be draw out MCCB type by client confirmation.

Motor starters will be withdraw able and equipped with fuse load break switch, air contactor, over load relay, indicating lamps for motor operation signal (running, stopped, tripped) and with reset button for thermal relay. Earth leakage relay with core balance CT will be provided for motors include and above 18.5kW.

Equipment coordination will be according to IEC 947.4.1 type 2.

The direct on line motor starters will be designed of utilization category AC-3.

The bi-metallic overload thermal protection will be 3 poles device, compensated as to operating temperature, will be provided with protection devices against phase failure and with external manual reset. Earth fault protection will have an adjustable setting current and adjustable time setting to assure protective co-ordination requirements.

Starters will be housed in modular compartments and will be interchangeable.

Starters for motors larger than and equal to 4 kW shall have a current transformer with secondary rated 1A feeding ammeter installed on remote push button control station and a current transformer with secondary rated 5A for ammeter installed on starter.

The motors smaller than 4 KW that are not seen from the LCS, also require an ammeter on local control station fed from a current transformer with secondary rated 1A.

Each motor starter/feeder will have a feeding compartment equipped with a fuse load break switch, contactor, suitably sized, a 400/230 V isolating transformer for control circuits, voltmeter and ammeter for local measuring as necessary.

MCC part will be filled with 10% equipped spare feeders and 10% spare space.

Motors operating equipment with same function will be fed from two different bus of MCC part

10.3 Subsidiary LV Switchboards

Other boards as lighting panels, auxiliary panels, local motor controller, motor operated valves and so on, suitable for indoor or outdoor installation will consist of self-supporting structure, cast-iron or aluminum enclosure for Zone 1 , 2 & industrial ones.

Incoming feeders will be equipped with on-load switches, outgoings in separate or common compartment will consist of on-load switches and HRC fuses combination or automatic circuit breakers depending on the required interrupting capacity.

Buses will be copper made with sufficient capacity and arranged to facilitate cable connections.

Switch-racks enclosures will be according to the classified area.

For lighting and convenient outlets panels, each 230 V outgoing circuit will be equipped with two poles automatic circuit breakers with internal fault trip relay and 30mA differential built in protection and 400V outgoing circuits by 4-poles with internal fault trip relay and 30mA differential built in protection. 25 % spare circuits will be foreseen. For all other boards outgoings will be equipped with automatic circuit breakers.

11.0 POWER TRANSFORMERS

Power Transformers shall be according to IPS-M-EL-152(3).

Power Transformers will be oil filled type self-cooled suitable for outdoor installation. Transformers up to 2500KVA shall be sealed type.

Voltage ratio will be determined in related data sheet.

Transformers will be sized each one for the total power demand in the normal operating conditions.

An over sizing of 20% will be foreseen for each transformer.

Starting of large motor may require an over sizing of the transformer, for this reason the starting current of motors and the starting method will be considered.

Windings will be copper made. Cooling oil will be mineral type. Protective devices and additional accessories will be as per manufacturer standard if special features are not required.

An off-load tap changer, manually operated, will be provided on primary side, with at least five taps, two above and two below the rated primary voltage (±2x2.5 %Vn).

Neutral point of secondary MV side of transformers will be earthed through earthing resistor if any.

Neutral point of LV side of transformers will be solidly earthed.

Earthing resistors will be designed to carry continuously 10% of maximum earth fault current and to withstand it for 10 seconds, without exceed the permissible overheating. For transformer with rated current up to 630A; earthing resistor will be restricted to the earth fault current equal to transformer rating current and for transformer with rated current above 630A; earthing resistor will be restricted to the earth fault current up to 630A.

Basically the protective relays for the transformer shall be as follows:

Primary side:

- 50/51
- 50N/51N
- 50 BF

Secondary side:

- 49
- 50/51
- 50N/51N
- 51G
- 50 BF
- 64R (for all transformers with MV secondary side)

Overall transformer protection:

- 87T (Over 5MVA)
- 71
- 63B (Conservator Type)
- 63P
- 63S
- 26D
- 26W (Over 2.5MVA)

12.0 EMERGENCY DIESEL GENERATOR

Synchronous generator shall be according to IPS-M-EL-138(1).

The generator shall be suitable for continuously operating. If the generator is used as a prime, its rating power shall be 1.15 times the continuous power.

A generator set consist of a synchronous AC generator, an diesel engine driving the generator, their control, protection and relay panels, auxiliary equipment and a base plate. Drivers applied to these generator sets shall be diesel engines.

The generator set shall be designed to minimize any risk of internal short circuits and to ensure personnel and plant safety under all prescribed conditions of operation, inspection and maintenance.

Generator shall be equipped with automatic voltage regulation (AVR) that maintain output voltage within ±0.5% of rated voltage between no load & full load.

Generator shall have minimum nine resistance type temperature detector in stator windings.

Insulation class of generator shall be “F“ with temperature rise class “B”.

Anti-condensation space heaters (400/230 V, 3/1 phase, 50 Hz) shall be installed inside the generator.

Maximum noise level should not exceed 81 db (A) at one meter.

Basically the protective relays for the low voltage diesel generator shall be as follows:

81

64R (S>500 KVA)

59

50/50N

51/51N

49, 49T (S>500 KVA)

47

27

Note: Lock out relay (86) will be provided separately.

13.0 UNINTERRUPTIBLE POWER SYSTEMS

13.1 110 VDC for Electrical Substation Loads

DC system shall be according to IPS-M-EL-174(2).

DC distribution system in substation will be used in order to feed:

- Control, signal and protection circuits of MV & LV switchgears، outdoor substation equipment's including spring loading motors of their circuit breaker relays,
- Auxiliary supply of MV and LV protection relay & signaling;
- Some low voltage circuit breaker control circuit

The DC distribution system will consist of:

- A double three phase rectifier fed at 400 V with two separate cables;
- A 110 VDC charging and distribution panel, realized with an automatic circuit breaker for every circuit, with auxiliary contact for remote alarm.
- A double accumulators battery bank composed by Ni-cd type, maintenance free for 20 years operation life batteries. Each bank shall be rated for 50 percent of the load.

The batteries will be charged by the battery charger and will be automatically switched to supply, without interruption, the 110 VDC distribution panel in case of AC supply failure. Capacity of the battery bank will be sized for 8 hours operation.

The batteries will be installed in a separate ventilated room within the substation building.

13.2 AC UPS

Uninterruptible power supply shall be according to IPS-M-EL-176(2).

Uninterruptible power supply system will be used in order to feed:

- Critical instrumentation and electrical consumers (according to the opinion of the company representative)

The AC distribution system will consist of:

- 2x100% three phase rectifier fed at 400 V;
- 2x100% 110 VDC charging, realized with an automatic circuit breaker, with auxiliary contact for remote alarm.
- 2x100% accumulator battery bank composed by Ni-cd type, maintenance free for 20 years operation life batteries.
- 2x100% inverter, transistor control
- An AC distribution board
- A bypass line with 100% load capacity and AC stabilizer.

When duplicate unit configuration is selected, the units shall operate in parallel, to share the load, and shall energize a single distribution panel according to IPS-M-EL-176(2)-appendix “D”. Both units are to be fed from synchronized AC supply.

The batteries will be charged by the battery charger and will be automatically switched to supply, without interruption. Capacity of the battery bank will be sized for 120 minutes operation.

The batteries shall be M type and will be installed in a separate ventilated room within the substation building.

13.3 F&G and Fire Alarm System

Power supply of F&G system shall be 400/230V AC that is fed by 2 separate feeders, one from primary normal bus and the other one from the emergency bus.

Separate 24VDC charger system and batteries for F&G system shall be inquired from OWNER. In case of approval by OWNER if needed, designing and procurement of this system shall be completely carried out by EPC Contractor in compliance with project approved technical documents.

14.0 ELECTRIC MOTORS

MV and LV motors shall be asynchronous, squirrel-cage type, suitable for direct-on-line starting unless otherwise specified. Motors shall be according to IEC-60034, IPS-M-EL-131(2) and IPS-M-EL-132(2).

Insulation class of motors will be “F“ with temperature rise of class “B”.

Low voltage motors will be selected in the range of the IEC series.

Medium voltage motors if applicable, will be equipped with space heaters (230 V, 1 phase+ neutral for < 3KW and; 400 V, 3 phase+ neutral for > 3kW) to prevent condensation inside motors when not in operation.

Anti-condensation heater/s is not required for low voltage motors unless otherwise specified in electrical motor data sheet.

Degree of protection and execution of the motors will be according to the area classification.

Motors will able to operate at rated load and with the voltage, frequency and combined variation indicated in para.5.

MV motors will be equipped with main terminal box (for power cables) and with separated terminal boxes for anti-condensation heater, winding and bearing temperature detectors.

Terminal boxes and other fittings will be according to the execution of motors.

Stator winding temperature detectors will be provided for all MV motors and LV motor (upper than 150 kW). Three resistance type temperature detectors (RTD) for each phase will be wired in a separated auxiliary terminal box.

Motors larger than 1000 kW will be provided with current transformers for differential protection installed in a separate terminal box.

2 Bearing temperature detectors will be provided for all MV & HV motors. One resistance type temperature detector (RTD) for each bearing will be wired in a separated auxiliary terminal box.

Inside each terminal box an earthing stud of adequate dimensions will be fitted for connection of a cable earthing conductor.

In addition all motors will be provided with an external earthing screw of at least 8 mm diameter, metric thread, tapped into frame foot for equipment earthing, located at the box side of the motor, at the opposite end to drive shaft

Maximum noise level will be 85 db at 1 (one) meter.

The vibration severity for a complete assembled motor will be equal to zone “A” Group III as per ISO Standard 10861-1.

The rotor will be dynamically balanced with half key in the shaft extension.

Motor bearings will be defined by Supplier on the basis of forces involved, speed, operating conditions and fabrication standards.

Bearings of low voltage motors shall be grease lubricated anti-friction rolling element type (ball and/or roller bearing) as proposed by the motor manufacturer. All rolling element bearings shall be with metallic cage.

Bearings shall be in metric sizes with maximum interchangeability and shall comply with ISO recommendations (ISO 15 and ISO 1132).

Motors with re-grease able bearing will be capable of operating for at least 2000 hours without require complete change of grease.

Only motors up to 7.5kW shall have pre lubricated bearings with more than 20,000 guaranteed working hours.

Generally motors will be designed for operating conditions which correspond to continuous service.

Moreover they should be capable of ensuring a minimum number of starts under full voltage, in the following conditions:

- When cold: 3 consecutive starts for low voltage motors
  3 consecutive starts for medium voltage motors
- When hot: 2 consecutive starts for low voltage motors
  2 consecutive starts for medium voltage motors

Unless otherwise specified they will be capable of two successive starts with the motor already at running temperature under the following conditions:

Motor terminal voltage: 80 % of rated voltage

- Load torque: varying with square of speed from zero to rated motor torque
- Inertia: 125 % of own motor inertia

One other starting sequence under the same conditions, after a cooling period of 30 minutes should be allowable.

All motors will be suitable for restarting against full residual voltage.

API 610 power ratings for motor drives centrifugal pumps are as follows:

Motor Nameplate Rating		Percentage of Rated Pump Power
KW	HP	
< 22	< 30	125%
22~55	30~75	115%
> 55	> 75	110%

15.0 POWER FACTOR IMPROVEMENT

Power factor improvement capacitors shall be according to IPS-M-EL-181(2).

Power factor improvement capacitors will be foreseen on each MV motor feeders (if required) and 400 V panels in order to maintain the Plant power factor not lower than 0.95, as per IPS requirements. Each automatic power factor improvement panel boards, 5 steps, will be connected to the 400 V Power center bus bars.

Sizing of the LV capacitor banks shall be calculated based on the maximum load with 20% spare capacity for future development.

Connecting cables and switching device shall have a continuous current rating of 1.5 times the nominal current rating of the capacitor bank.

In a redundant electrical system, each capacitor bank shall be calculated based on connected bus bar and shall be regulated by a current transformer on related incomer.

16.0 CABLES

Cables will be according to IEC-60502, IEC-60840, IPS-M-EL-271(2), IPS-M-EL-272(2), and IPS-E-EL-100(1).

MV cables will be stranded copper conductor, XLPE insulated, screened, single core and multi-core, lead sheathed, single wire armored, hydrocarbon resistant PVC outer jacket.

LV cables will be stranded copper conductor, XLPE insulated, single core and multi-core, lead sheathed, single wire armored, hydrocarbon resistant PVC outer jacket.

Single wire armor shall be steel for multi-core cables and shall be non-magnetic materials (such as aluminum) for single core cables.

The PVC outer jacket will be flame retardant type as per IEC 332-3 Cat. C.

The insulation level will be:

- MV (33 kV system) 18/30 (36) kV
- MV (11 kV system) 12/20 kV
- MV (6 kV system) 6/10 kV
- MV (3.3 kV system) 3.6/6 kV
- LV (400/230 V system) 0.6/1 kV

Cables will have colored cores for easy identification. Color coding of individual cable cores and wiring conductors will be as follows:

- Phase conductors Red-Yellow-Blue

- Neutral — Black
- DC positive conductor — Red
- DC negative conductor — Black
- Control conductor cables — Black (whit white numbering)
- Earthing conductors — green / yellow

Cable sizes shall be determined after short circuit and voltage drop study. Minimum wire size for 400 volt motors (according to IPS-E-EL-100(1)) will be:

- 0 to 3.7 KW 4 mm^2
- 3.8 to 7.5 KW 6 mm^2
- 7.6 to 15 KW 10 mm^2
- 15.1 to 22 KW 16 mm^2
- 22.1 to 37 KW 25 mm^2
- 37.1 to 55 KW 35 mm^2
- 55.1 to 75 KW 70 mm^2
- 75.1 to 90 KW 95 mm^2
- 90.1 to 150 KW 120 mm^2

Minimum wire size for lighting and power circuits will be 2.5 mm^2.

Wire size for motor control will be 2.5 mm^2 and 10% spare wire for control cable should be considered.

Generally power and control cable in process area will be laid in concrete cable trench and in accordance with area classification requirements. The cables will be laid underground, in a cable trench in according to IPS-D-EL-210 (Maximum 2 layer of cables shall be laid in trenches; if MV and LV cables are laid in one trench, they shall have min. 600mm distance from each other or segregated by a precast concrete divider).

Single core cables will be laid in cable trenches in Trefoil formation.

Markers will be used to indicate the buried cables routes in unpaved areas.

The cables will cross the roads underground through heavy duty PVC pipes encased in concrete block. A 20% of spare pipes with a minimum of 1 will be foreseen for future need.

The cables will search the loads leaving the cable tray through steel conduits rigidly supported or crossing the paving vertically, protected by steel conduits extending above grade against mechanical damages. For single core cables non-magnetizing conduits shall be used.

Above ground lighting and small power cables will be fire resistance type in hazardous and/or process areas, lighting tower and where high temperature are expected , PVC wires for substations and control rooms and underground ones need to have PVC insulation, lead cover and single wire armouring.

They will be laid in the same cable trench of LV power distribution system, if they will be under ground.

The cable network design will be carried out to minimize the number of cables joints required. The power cables will be sized for their duty, taking into account the following factors:

- Continuous duty
- Ambient temperature (air or soil temperature)
- For buried cables depth and soil thermal resistivity
- Grouping derating factor
- Rated current of users
- Voltage drops

The MV cables will be sized to withstand the stresses due to expected short circuit current and tripping time of protective devices (0.3 sec.). Maximum short circuit current will be considered. Minimum wire size for MV cables feeders which are protected by Fuse will be 50 mm^2.

Single core cables shall be used for cables with up to 400mm2 cross section area and multi core cables shall be used for cables with up to 240mm2 cross section area.

The electrical power system will be so designed to limit voltage drop (base on nominal voltage in the feeder cables) to the following values:

- Feeders to area substation 1%
- Feeders from area substation 1%
- LV Motors branch circuit (at full load) 5%
- Power source to panel board 2%
- Lighting circuits from panel board to last lighting fixture 3%
- Motor feeder cable during motor starting 15%
- MV motors at full load 3.25%

Summary of cables to be used:

- Single phase users 1 PH+N+E (3 cores cables)
- 400/230 V lighting panel feeders 3 PH+N (4 cores cables)
- 400 V lighting branch circuits 3 PH+N+E (5 cores cables)

• 230V lighting branch circuits	1 PH+N +E (3 cores cables)
• Lighting receptacle 230 V	1 PH+N+E (3 cores cables)
• Power receptacle 400 V	3 PH+N (4 cores cables)
• LV Motors	3 PH (3 cores cables)
• MV connections	3 PH (single core / multi core)
• 400 V emergency diesel generator	3 PH+N (single core cables)

17.0 LIGHTING SYSTEM

The Lighting System will be designed in accordance with IPS-E-EL-100(1).

Lighting system will provide uniform and adequate light distribution in all working areas.

The lighting system is divided in:

- Normal
- Emergency
- Security

The normal Lighting System (Panels) will be fed from PMCC switchgear.

The incoming feeder of lighting panels will be three phases, four wires plus neutral, controlled by means of four poles automatic circuit breakers having an adequate breaking capacity.

External lighting will be automatically controlled by astronomical photo-electric cell and a bypass for manual operation.

The lighting branch circuits will be single phase, three wires, distributed in process areas or where advisable through local lighting panels and controlled by automatic circuit breakers having an adequate breaking capacity and 30mA differential protections built-in; 20 % spare circuits will be provided on each panel.

The emergency lighting system will be fed from Emergency Switchgear.

According to IPS-E-EL-100(1) clause 7.10.3, the number of emergency luminaries as part of the total number of fittings shall be determined as follows:

• Utility area	20%
• Process area	10%
• Administrative area	5%

- Control room and auxiliary rooms 50%
- Substation, field auxiliary rooms 30%
- Compressor and generator buildings 30%

The emergency lighting incoming feeder and branch circuits' distribution and control will be as per the normal lighting system.

The security lighting, consisting of fixtures equipped with back-up battery (discharge capacity at least half an hour), will be used as anti-panic lights in control room, other buildings and critical points of the plant for safety. The security lighting system will be fed from the emergency system.

Type and installation of lighting facilities will be as follows:

- For process area and structures, lighting fixtures equipped with 40/36 W fluorescent lamps, suspension or stanchion mounting. If necessary floodlights equipped with mercury vapor lamps can be used.
- For machinery house, lighting fixtures with metal halide lamps. Sufficient florescent luminaires shall also be used for basic lighting requirements also as emergency lighting.
- For substation, lighting fixtures, industrial type, equipped with 40/36 W or 20/18 W fluorescent lamps, suspension or ceiling mounting.
- For Control Room and similar, lighting fixture, civil type, equipped with 20/18 W fluorescent lamps, recessed type mounting
- For streets, lighting fixture equipped with metal halide lamps Installed in 15 meter lighting tower
- For general area, floodlights equipped with metal halide lamps
- For outdoor substation, floodlights equipped with metal halide lamps Installed in 15 meter lighting tower
- For general area, floodlights equipped with metal halide lamps

Aircraft Warning Lights will be provided according to the International Civil Aviation Organization (ICAO), IPS-E-EL-100(1) clause 7.10.5.2, and the FAA for structures higher than 45 m.

Red lighting will be foreseen with enclosure according to area classification.

The normal lighting system will provide a uniform and adequate light distribution in all working areas, the minimum average illumination levels will be as per IPS-E-EL-100(1). Major areas indicated in the below table:

AREA OR ACTIVITY	ILLUMINANCE LUX	ELEVATION MILLIMETER
I PROCESS AREAS		
A) General process units		
Pump rows, valves, manifolds		
Heat exchangers	50	Ground
Maintenance platforms	30	Ground
Operating platforms	10	Floor
Cooling towers (equipment areas)	50	Floor
Furnaces	50	Ground
Ladders and stairs (inactive)	30	Ground
Ladders and stairs (active)	30	Floor
Gage glasses	50	Floor
Instruments (on process units)	50	Eye level
Compressor houses	50	Eye level
Separators	200	Floor
General area	50	Top of bay
	10	Ground
B) Control rooms and houses		
Ordinary control house		
Instrument panel	300	Floor
Console	300	1700
Back of panel	300	760
Central control house	100	760
Instrument	500	Floor
Back of pane	500	1700
	100	900
C) Specialty process units		
Conveyors		
Conveyor transfer points	20	Surface
	50	Surface
II NONPROCESS AREA		
A) Loading, unloading, and cooling water pump houses, Pump area		
General control area	50	Ground
Control panel	150	Floor
	200	1100
B) Boiler and air compressor plants		
Indoor		
Outdoor equipment 50	200	Floor
	50	Ground
C) Tank fields (where lighting is required)		
Ladders and stairs		
Gating area	5	Floor
Manifold area	10	Ground
	5	Floor
D) Loading racks		
General area		
Tank car	50	Floor
Tank trucks, loading point	100	Point
	100	Point
E) Tanker dock facilities		

F) Electrical substations and switch yards		
Outdoor switch yards		
General substation (outdoor)	20	Ground
Substation operating aisles	20	Ground
General substation (indoor)	150	Floor
Switch racks	50	Floor
	50	1200
G) Plant road lighting (where lighting is required)		
Frequent use (trucking)		
Infrequent use	4	Ground
	2	Ground
H) Plant parking lots		
	1	Ground
I) Aircraft obstruction lighting		
III Buildings		
A) Offices		
	500	
B) Laboratories		
Qualitative, quantitative and physical test	500	900
Research, experimental	500	900
Pilot plant, process and specialty	300	Floor
Glassware, washrooms	300	900
Fume hoods	300	900
Stock rooms	150	Floor
C) Warehouses and stock rooms		
Indoor bulk storage	50	Floor
Outdoor bulk storage	5	Ground
Large bin storage	50	760
Small bin storage	100	760
Small parts storage	200	760
Counter tops	300	1200
D) Repair shop		
Large fabrication	200	Floor
Bench and machine work	500	760
Crane way, aisles	150	Floor
Small machine	300	760
Sheet metal	200	760
Electrical	200	760
Instrument	300	760
E) Change housed		
Locker room, shower	100	Floor
Lavatory	100	Floor
F) Clock house and entrance gatehouse		
Card rack and clock area	100	Floor
Entrance gate, inspection	150	Floor
General	50	Floor

G) Cafeteria		
Eating	300	760
Serving area	300	900
Food preparation	300	900
General, halls, etc.	100	Floor
H) Garage and firehouse		
Storage and minor repairs	100	Floor
I) First aid roomed	700	760

18.0 GROUNDING AND LIGHTNING SYSTEM

The earthing protection system will be designed to protect against indirect contacts (due to failure of insulation), electrostatic discharges and lightning. The system will be designed according to IPS-E-EL-100(1) and IPS-C-EL-115 standard specification.

Grounding system type is TN-S as defined by IEC 364-3. It will be designed considering equipotentialization of all ground connection according to IEC-1024 and IEC 1312,

The grounding network shall consist of the following systems which are connected to each other at one point with surge barrier:

- Substation building earthing system with resistance less than 1 Ohm
- Instrument earthing systems (separated for IS and NIS) with resistance less than 0.5 Ohm
- Earthing system for transformers neutral points (with OR unless resistance) less than 1 Ohm
- Lightning protection system resistance less than 5 Ohm
- Plant earth main ring with resistance less than 4 Ohm

Network will consist of main cable loops, earthing electrodes (diameter of 16mm and length of 2x1.5m) and equipment conductors.

At the point of entering/exiting cable trenches, earth conductors will be protected by rigid galvanized steel conduit stub-ups, extending by at least 500mm above grade.

Underground splices will be made using exothermic welding (Cad weld or Thermo weld).

Single core cable armoring shall be earthed using cable glands at one end (in hazardous area if any) and multi core cable armoring shall be earthed using cable glands at two ends.

Connections between electrodes and grounding loops will be arranged into pits with covers to allow maintenance and testing of individual electrodes.

Marshaling points installed at suitable locations, connected to the main grounding loop will collect protective insulated copper conductors coming from loads.

Grounding connections will be made to apparatus with bolted connections. Foundations or base bolts will not be used for earthing.

In general the following equipment will be connected to earthing system:

- Star point of power transformer
- Electric boards
- Motors
- Metallic structures such as vessel, pipe racks
- Outlets
- Cable trays
- All metallic enclosures with electrical devices

A separated earthing system will be considered for neutral earthing resistor of MV side of transformers.

Neutral earthing for each transformer should be connect to separated earth pits with resistance less than 1 Ohm

In general the highest metallic structures will be provided with lightning rod connected to main grounding system.

For buildings that will need lightning protection system, a ring of bare copper conductors will be placed on the top, connected to rods placed to the opposite corners. These rods will be connected with PVC cables. All this system will be connected to the general grounding system.

All other buildings and structures, totally enclosed in the area, will not need its own lightning protection system.

19.0 CATHODIC PROTECTION SYSTEM

Cathodic protection system shall be according to IPS-M-EL-155(1), IPS-M-TP-750, and IPS-M-TP-760 & IPS-E-TP-820 (1).

An impressed current cathodic protection system will be provided in order to protect from the corrosion the underground pipes, the bottom of metallic tanks of the Oil Plant and the grounding network system, where necessary.

Dielectric joints to isolate piping inside the Plant from external pipes will be installed and suitably protected against any kind of over voltages.

The cathodic protection system will be designed to maintain the structure at a potential of - 0.85 V with respect to a copper - copper sulfate electrode located at grade level above the structure.

Anodes will be designed for 20 years operation.

20.0 MISCELLANEOUS

20.1 Convenience Receptacles

The convenience socket outlets and the corresponding plugs shall be 230V single phase and neutral, 16 amps 3 pins (phase, neutral and earth). The earthing pin of the plug shall be made before the plug is fully inserted, and shall be disconnected after the plug is withdrawn.

Installation of socket outlets in zone 1 areas is not recommended unless absolutely necessary and approved by the Engineer. The convenience socket outlets and plugs for use in zone 2 areas shall be Exd type with a degree of protection IP 65. Unless otherwise specified in requisitions the gas group classification and the temperature class shall be group IIBT3. In areas where hydrogen is present the gas group classification and the temperature class shall be IICT3. For ease of interchangeability, similar socket outlets shall be used in safe areas of industrial plants (Exd IIBT3, Exd IICT3).

The enclosure of convenience socket outlets shall be metallic and corrosion resistant. The metal shall be specified in vendor proposal. Glass Reinforced Plastic (GRP) is acceptable for installation in safe indoor areas.

In addition to the earthing connection inside the socket, an earthing stud shall be provided outside the metallic enclosure.

20.2 Welding Receptacles

The welding socket outlets and the corresponding plugs shall be 400 volt, 3 phase, 63 amps 4 pins (3 phase and neutral) complete with means for earthing connection. The earthing connection (e.g. pin) shall be made before the plug is fully inserted and shall be disconnected after the plug is withdrawn.

Installation of socket outlets in zone 1 areas is not recommended unless absolutely necessary and approved by the Engineer. The welding socket outlets and plugs for use in zone 2 areas shall be Exd type with a degree of protection IP 65. Unless otherwise specified in requisition the gas group classification and the temperature class shall be group IIB, T3. In areas where hydrogen is present the gas group classification and the temperature class shall be IIC, T3. For ease of interchangeability, similar socket outlets shall be used in safe areas of industrial plants (Exd IIB, T3, Exd IIC, T3).

The enclosure of welding socket outlets shall be metallic and corrosion resistant. The metal shall be specified in vendor proposal.

In addition to the earthing connection inside the socket, an earthing stud shall be provided outside the metallic enclosure.

The welding socket outlets shall be equipped with a 4 pole ON-OFF switch .It shall not be possible to insert or withdraw a plug when the switch is in ON position. Socket outlet can only be energized when the plug is fully inserted. Means shall be provided to padlock the switch in OFF position.

A cap, connected to the welding socket outlet by means of a chain, shall be provided to close the entrance of the socket when no plug is inserted.

Power entry to the welding socket outlet will be minimum via 4 core 16 mm2 cable in metallic conduit. The cable will be copper conductor, PVC insulated, lead covered, with single wire armour. The armour will be used as earth conductor. Internal terminals of the socket outlets shall have looping facility.

Cable or conduit entries to the welding socket outlets shall be with metric threads of ISO form according to IEC 60423.

Welding socket feeder shall be connected to main LV switchgear and maximum two number of welding socket shall be supplied by each feeder.

20.3 Local Control Station

Local Control Station system shall be according to IPS-M-EL-161(2) and IPS-M-EL-143(3).

Control station with start-stop push-button switches will be provided for motors control. A Manual/off/Automatic hand selector switch will be added for the motors automatically controlled.

The control station will be installed adjacent to the motor, except for air coolers and will be provided with “off” position locking device.

Ammeters will be provided for motors larger than or equal to 4 kW fed by a current transformer with secondary rated 1A

The motors smaller than 4 KW that are not seen from the LCS, also require an ammeter on local control station fed from a current transformer with secondary rated 1A.

The enclosures of motor control stations for use in areas classified as zone 1 and zone 2 shall be Exd type with a degree of protection of IP65. Unless otherwise specified in requisitions the gas group classification shall be group IIB and the temperature class shall be T3. In areas where hydrogen is present the gas group classification shall be IIC with temperature class of T3. For ease of interchangeability similar motor control stations shall be used in safe areas of industrial plants (Exd IIB, T3, Exd IIC, T3).

20.4 Cable Termination

Cable termination and joints shall be supplied in kit form and shall include all insulating and setting material, conductor fittings and all required consumables.

The straight cable joint kits shall be suitable for jointing underground buried cables. The cables are with lead sheath and single wire armour. The size of conductors will be indicated in requisition and/or purchase order. Unless otherwise indicated in requisition and/or purchase order, the insulation of 400 volt low voltage cables is PVC and the insulation of medium voltage and high voltage cables is XLPE.

Cable accessories for medium and high voltage cables (6 Kv to 30 Kv) shall fulfill the test requirements of IEC 60502-4.

20.5 Cable Trays/Ladders

Cable trays/ladders shall be according to IPS-M-EL-161(2).

Cable trays/ladders will be hot dip galvanized, but in corrosive areas, corrosion resistant material such as stainless steel will be considered.

20.6 Conduits

Conduits for use in zone 1 areas shall be rigid steel, hot dipped galvanized heavy gauge, solid drawn (seamless) with metric threads of ISO form according to IEC 60423.

Conduit fittings shall be Exd type for zone 1 and zone 2 areas.

Minimum size of exposed conduits (surface mounted) shall be 20 mm.

In cooling towers area aluminum conduits shall be used. Copper free aluminum fittings shall be used with aluminum conduits.

Concealed conduits for use in offices, buildings etc. can be rigid steel black enameled (or galvanized). PG thread for black enameled conduits in accordance with DIN 40430 is acceptable.

Where flexible conduits are to be used to connect vibrating equipment to instruments or conduit fittings, they shall be suitable for the hazardous areas where they are to be installed.

Sealing fittings shall be supplied, to be installed where conduits run between safe and hazardous areas and also as close as possible to the equipment or components to which the conduits will enter. The required numbers of such fittings will be specified in requisition or purchase order.

The supplier of conduit system shall quote for all necessary conduit accessories including couplings, caps, U bolts, clamps etc.

21.0 ELECTRICAL MONITORING & CONTROL SYSTEM

21.1 Application of system

The electrical monitoring and control system shall be positioned within switch room and applied for the performance of control and supervisory functions in order to operate and supervise the switchgears properly.

Its function shall be reduced as a minimum to operate the main incoming circuit breakers and to indicate the most important fault and status signals, such as circuit breaker position, overload, short-circuit, earth fault, summary alarms, transformer fault, upstream under voltage, etc.

Some important electrical signals in addition to those which are anyway process relevant and hence are indicated in the DCS/PLC shall be transferred. Summary alarms of switchgears, UPS systems and other essential equipment belong to this group of signals.

21.2 Signal Transfer to the Control System

The following signals shall be transferred to CCR (Central Control Room):

- Operational status and common fault alarms as required for the process monitoring.
- Ready run, stop, trip and fault indication of each motor, motor actuator and electric resistance heater as required for the process monitoring.

22.0 ELECTRICAL SUBSTATIONS BUILDING

Substation building shall be as per IPS-E-EL-100(1) para. 7.2.5 and 7.2.6.

Plant substation will be located in no hazardous area and shall consist of transformer bays and switch rooms. The location shall be, if possible, close to the load centers in order to reduce, voltage drop, size and length of cables.

Transformer bays shall be enclosed within sidewalls, blast and fire proof; approximately two meters high with a wire mesh front containing access gates. Concrete pads extending min. 200mm above grade shall be provided for transformers and any other equipment in the transformer bay. A sunshade above the bay shall be provided to protect against direct sunlight.

The transformer room shall be built based on the physical dimensions of transformers and neutral grounding resistor (if any) located on it. The dimensions of the transformer room shall provide at least 1.2m free space around the transformers.

Gates and doors shall be provided with key operated locks and high voltage warning signs. Gates, doors or removable sections shall be properly and adequately sized for easy entrance of personnel and related equipment. Doors should have a height of at least 3m.

Switch rooms should have a height of at least 4.2m.

Generally, substations shall include two separate switch rooms for MV and LV switchgear(s). Switch rooms shall be provided with two doors at opposite ends. One of the doors shall be used for equipment transit. Generally the switch rooms shall be designed to be clean and dry.

All cable entries connecting the switch room to the transformer bay shall be via cable transits if they pass through common walls.

Sufficient space shall be provided for construction and maintenance activities including the removal and transportation of all initial and phased development electrical equipment. The minimum clearance around equipment will be:

- Behind switchgear 1000 mm
- Between equipment ends and/or wall 2500 mm
- For operating aisle 2500 mm

Transformers will be provided with oil pit receiver.

Substation will be equipped with fire detection system.