DESIGN CRITERIA AND STANDARDS

Electrical DCS

Electrical General Requirements

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1 Introduction

a) This is the Design Criteria and Standard document for the electrical engineering and automation works shall apply to all electrical Equipment and systems.

b) The requirements in **the Particular Design Criteria and Standards overrule** the general requirements in the **Design Criteria and Standards**, in case of discrepancies.

c) This document shall be always applied together with the other Electrical DCS

d) Civil requirements related to electrical installation (electrical rooms and grounding) are specified in the Civil DCS

2 Definitions

The following words and expressions shall have the following meanings hereby assigned to them:

Term	Explanation
Contractor	Means the entity named as contractor, Supplier or Seller in the main contract.
Employer	Means the entity named as employer or Buyer in the main contract.
DCS	Or **"Design Criteria and Standards**" means the documents as referred to in Annex 5 or the Employer requirements hereof, and including any specifications and other Employer requirements in respect of the Works to be carried out by the Contractor, if any, and any Variation to such document.
PDCS	Or **"Particular Design Criteria and Standards**" means the documents as referred to in Annex 4 or the Employer requirements hereof, and including any specifications and other Employer requirements in respect of the Works to be carried out by the Contractor, if any, and any Variation to such document.
Site	Means the location as identified in the main contract where the Permanent Works are to be delivered or executed.
Works	Means all the work and design to be performed by the Contractor including temporary work and any Variation as specified in the Contract and the Employers Requirements.
CE	The CE mark is the official marking required by the European Community for all Electrical and Electronic equipment
FB	Function Block
CB	Circuit Breaker
CCR	Central Control Room
CT	Current Transformer
DC	Direct Current

Term	Explanation
I/O	Input / Output
DI	Digital Input
DO	Digital Output
EMC	Electromagnetic Compatibility
FC	Frequency Converter
GIS	Gas Insulated Switchgears
HMI	Human-Machine Interface
HV	High Voltage
IEC	International Electric Commission
LV	Low Voltage
MCC	Motor Control Center
MV	Medium Voltage
PLC	Programmable Logical Controller
PCS	Process Control System
PDIS	Process Data Information System
SCADA	Supervisory Control and Data Acquisition
UPS (=USV)	Uninterruptible Power Supply
VSD	Variable Speed Drive
VT	Voltage Transformer

Table 1

3 Codes and Standards

a) The design, manufacturing, installation and construction of all works, shall conform to the local Codes and Standards of the country of the works and shall conform to the Codes and Standards mentioned in the DCS.

b) The design and construction of the Works shall be carried out in accordance with the regulations and requirements of all relevant legal authorities.

c) The electrical engineering, equipment and installation shall be in compliance with the latest edition of the European Codes, ISO, CENELEC and local Standards.

d) If there is a statement in any detailed specification of this document which is against local and European Codes and Standards, the Contractor is to provide a similar solution which is in line with local and IEC Codes and Standards.

e) For areas, which are not regulated by any Codes and Standards, the design shall be in accordance with the International Electric Commission (IEC).

4 General Requirements

4.1 Main Objectives

The main objectives of the electrical design are to ensure the following:

a) Reliable and safe plant operation
b) Stable power supply with optional extension for the future
c) Minimum power costs
d) High power quality
e) Reliable and cost optimal process control system
f) Easy to maintain

4.2 Selection of Components

The selection of the components shall comply with the following:

a) All electrical equipment shall be of high quality and from well-known producers. References with applications in cement industry are preferable.
b) Only new electrical equipment shall be used
c) High efficiency devices and equipment shall be used
d) Total life-cycle costs shall be considered
e) State of the art components have to be used
f) The service lifetime shall be > 30 years
g) The service lifetime of HV components shall be > 50 years

4.3 Required Certifications

a) All components, devices, panels, panel-assemblies, systems and entire installations, shall have the required permits, passports or certificates at the place of installation.

    1. For example: if the installation place is located in countries, which are EU members, CE standards and CE certifications are binding. In Russia Gost certification, in China the CCC certification are mandatory, etc.

b) The Work shall in any case be in accordance with the objectives of the directives (i.e. CE-directives) and shall under no circumstances be an obstruction for certification of the overall installation.

4.4 EMC Compliance

All equipment shall meet the Electromagnetic Compliance (EMC) regulatory requirements.

4.5 Safety

a) All components shall be capable to withstand the dynamic, thermal and dielectric stresses resulting from prospective short-circuit currents without damage or injury of personnel.

b) The installation shall be designed to ensure safe operation under all operating conditions and during inspection and maintenance.

c) Overpressure caused by short-circuits shall easily flow-out by pressure relieve purposes without any danger to the staff.

4.6 Standardization

a) In order to limit the procurement of spare parts, the contractor shall use, wherever feasible, the same brand, standard sizes and capacities of equipment throughout the entire plant, unless the standardization gives a considerable impact on the nature of manufacturer's standard design or patent.

b) With respect to electrical motors or distribution transformers, the number of different types and sizes utilized throughout the plant shall be kept as low as possible.

c) There shall be only one common key type for panel doors, connection box doors, cabinets, switches and other enclosures.

4.7 Sub-Control Panels

a) The use of Sub-Control Panels (Black Boxes) and local operation panels are not allowed.

b) PLC's and operator stations of the process control system shall be used in place of Sub-Control Panels.

c) Black Boxes may be approved by the Employer if there are the following advantages:

1. Overall cost savings
2. Extended diagnostic possibilities
3. Better access with a special programming tool
4. Special or protected technology

4.8 Underground Channels

a) Long supply and cable channels shall be avoided and are only accepted with the approval of the Employer.

b) Early-warning fire detection is to be installed and are to be connected with a central signaling unit.

c) Extensive channels, shafts, stories and floors for cables should in addition be divided into smaller sections using fire resistant sealant. A fire protection section shall not exceed the length of 60 m.

d) Cable channels and shafts are to be laid out in such a way that no combustible materials, such as; oil, bitumen, lacquer, floor cleaning material nor sparks, glowing ash, liquid metal, slag, and similar substances can enter.

4.9 Cable and Wire

a) In order to ensure that heat is extracted from cables and wires, it is required to provide sufficient aeration and ventilation. In particular if heat extraction is impaired by fire prevention measures, e.g. by placing sealant, or installing covers.

b) Cable sizing shall consider all factors such as: location, routing, distance, ambient temperature and the distances between cables and wires

c) Bare cable bundles in the buildings are to be protected against quantities of combustible materials, e.g. pulverized coal, saw dust, from accumulating.

4.10 Tag Numbering System

a) One common numbering system for all disciplines has to be used. The Numbering System has to be used for all buildings, equipment, devices and related documents.

b) The DCS Equipment Naming & Tags defines the common numbering system to be used.

4.11 Contractor Proposals

a) The DCS are based on Employer's concepts and long term operation experiences. However, they shall give the Contractor the opportunity to propose alternative solutions based on Proven Technology and Proven Suppliers.

b) Deviating solutions, concepts, component suppliers, and sub-suppliers have to be approved by the Employer.

5 Basic Conditions

5.1 Voltage Drop

The following maximum voltage drop limits shall be applied:

Location	max voltage drop
At motor terminals during full load	5 %
At bus-bars during start or restart of the largest motor	10 %
At lighting and sockets terminals	5 %

Table 2

5.2 Cable Type Definitions

5.2.1 Cable Types

Cable insulation grade shall be as it is shown in the table 3:

Related voltage:	Insulation Voltage	Insulation material	No. of Cores	Sheath	Conductor
230 V	600/1000	PVC	3,4,5, etc.	PVC	Cu
400 V	600/1000	PVC	1,4,5.	PVC	Cu
690 V	600/1000	PVC	1,4,5	PVC	Cu
6 kV motors	3,6kV/6kV	XLPE	3 cores steel armored	PE	min 95mm² Cu
6.3 kV interconnections	6kV/10kV	XLPE	1	PE	min 120 mm² Cu min 185 mm² Al
10 kV motors	6kV/10kV	XLPE	3 cores steel armored	PE	min 120mm² Cu
10.5 kV interconnections	6kV/10kV	XLPE	1	PE	min 120 mm² Cu min 185 mm² Al
>11 kV interconnections	12kV/20kV or higher	XLPE	1	PE	min 120 mm² Cu min 185 mm² Al

Table 3

a) The color of the cable shells shall be standardized throughout the plant to distinguish between high, medium and low voltage cables.
b) Only flexible cables shall be used between the motor and the associated local disconnect switch.
c) All cables shall be clearly and permanently marked at both ends of the cable.

5.2.2 Cable Sizing

Cable shall be dimensioned according to:

a) National Codes and Standards
b) Rated load multiplied by 1.25
c) Short circuit conditions of the plant's power network (1sec short circuit current)
d) De-rating factors due to ambient temperature, number of cables installed and method of laying
e) Voltage drop at the terminals of consumers shall be lower than the limits given in item 1.2.2.
f) Control circuit cables shall have color coded wires
g) Minimum conductor size shall be:

1. 1 mm² for control circuits
2. 1.5 mm² for power and lighting circuits
3. 4 mm² for UPS distribution between two circuit-breakers if the length of the cable is < 100m

4. 6 mm² for UPS distribution between two circuit-breakers if the length of cable is > 100m

h) The cross section of cables shall not be reduced at its point of termination, junction, joints, etc.

5.2.3 Cable Wire Colors

Cable type color codes shall comply with local standards. The following definitions for low voltage cables are based on EU standards HD 308 S2-2001.

Wire / conductor	Color	Abbr.
3 phase power circuit or signals	brown, black, grey	bn, bk, gr
N potential or signal	light blue	lbl
PE potential	green/yellow	gn/ye

Table 4

5.2.4 IT and Telephone Cabling inside Buildings

Cables shall be Cat 5e or Cat 6 quality inside buildings. The design shall be according the “structured design criteria” for IT installations, with the use of T-Base 10 sockets and T-Base 10 patch panels.

5.2.5 Fiber Optic Cables

a) The assemblies and associated equipment shall conform to:

1. IEC 304
2. IEC 793 & 794
3. ISO/IEC 11801 Performance Categories.

b) All fiber optic cables shall be reinforced. The routing and type of cable shall be approved by the Employer.
c) The complete installation and all junctions shall be tested.
d) All fiber optic cables ends shall be protected, each cable shall provide at least 2 core reserve.
e) All inter-building data connections have to be done by optical cables.

6 Engineering and Design

6.1 General Lighting Requirements

a) Lighting installation shall be supplied either from technology related transformers or from dedicated transformers with capacity of 250 KVA or 400 KVA. The design has to be approved by the Employer.

b) The transformers shall be of three phases; the voltage: 400 VAC and 230 VAC.

c) The lighting switchboard shall be supplied from two sources with an automatic switch over to a life supply in case of a single loss of power.

d) Type of power distribution TN-S

e) Throughout the plant lamps shall have long rated life, high efficiency, and require low maintenance such as i.e. high-pressure sodium, fluorescent lamps or LED lamps.

f) All lighting and small power equipment and fittings shall be of heavy duty, industrial type to a minimum protection of IP54. All lighting fixtures shall be complete with lamps available from local sources.

6.2 Outside Lighting

a) Outside lighting, where possible will be from adjacent buildings. All outside lighting and lighting in areas not needed in the daytime shall be on circuits controlled by contactors. There will be a photocell mounted in a clean area and it will control lighting contactors.

b) All metal components susceptible to corrosion shall be galvanized.

6.3 Interior Lighting

a) Interior lighting shall be switched from a central lighting control panel. Local switches shall be used only where needed for convenience.

b) Common spheres should be switch-able at all entrances of these areas. For example doors or entrances to stairs. The local recommendations about that shall be observed. It is not accepted to switch illumination by hand at distribution panels. The switching of illumination should be usable by any personal, not only electricians.

6.4 Special Requirements

a) In hazardous locations, explosion proof fixtures shall be provided.

b) Fluorescent fixtures using four-foot, rapid-start lamps shall be used in all applicable areas such as electrical equipment rooms, control room and offices.

c) Spot lights shall be High Pressure Sodium or LED to light up general yard or plant entrance areas.

Photo 1: Lighting Junction box

d) Emergency Lighting

1. Emergency lighting shall be placed that in an emergency case a safe passage of personnel throughout the plant is ensured.
2. Emergency lighting will consist of self-contained and maintained type battery operated units with built-in battery chargers.
3. Power source shall automatically be switched from normal power to battery power at the loss of the power supply.

6.5 Lighting Intensity Levels

a) Lighting intensity levels are indicated in the following table. These intensities are European based examples. The national codes and standards have to be observed. Furthermore the actual requirements have to be taken into account. The lighting intensity is measured in lx (Lux), given in table below, will be maintained.

b) The impact of dust and aging process shall be taken into account so that the design of new installations shall consider a safety factor 1,25

c) For existing installations the safety factor shall be at least 0.8.

d) The lighting intensity for all continuously occupied working rooms, which are not mentioned in table 5, shall be as of 200 lx.

Area	Lighting Intensity	Method of Lighting
Plant Roads	20 lx	High Pressure Sodium
Open Yard	30 lx	High Pressure Sodium
Conveyors, Platforms	30 lx	High Pressure Sodium
Remote controlled process areas	50 lx	High Pressure Sodium
Stores for similar or large goods	50 lx	
Staircases, walkways	50 lx	
Dispatch Platforms	100 lx	High Pressure Sodium
Electrical Equipment Rooms	100 lx	Fluorescent
Remote controlled process areas with sporadically manual activities	100 lx	High Pressure Sodium
Stores for various diverse goods	100 lx	
Changing rooms, Toilets	100 lx	Surface or troffer fluorescent
Continuously occupied working places in process area	200 lx	High Pressure Sodium
Workshops	250 lx	Fluorescent
Offices, Laboratories	300 lx	Surface or troffer fluorescent
Control Rooms	300 lx Adjustable/ or graduated	Luminous ceiling or troffer fluorescent

Table 5

6.6 Maintenance Power Supply

a) Socket outlets suitable for the local standards shall comprise of:

1. Five pole outlets for welding machines as well as for portable machine applications, 3 phases + N + PE, rated for 1 x 63 A CEE type and 1 x 32 A CEE
2. Two single phase outlets, 2 pole + PE, each rated for 16A
3. 24V socket for lighting for hazardous area (SELV)

b) All single phase circuits shall be provided with residual-current circuit breakers.

c) All sockets shall be fitted with circuit identification labels.

6.7 Emergency Stop Concept

The emergency stop is a vital safety function. Employer follows the concept to de-energize large sections or even complete plant areas. The concept is defined as follows:

a) Emergency stop switches off the main in-feed and the control voltages (by means of emergency-stop relays). MV transformers and drives, LV in-feed panels and large LV drives, which are supplied directly from the distribution switchgear, shall be equipped with under-voltage coils which are integrated in the emergency stop circuits to switch off the consumers in a safe way.

b) A selective protection shall be built so that in case of the failure of the respective breaker the superior breaker can disconnect the circuit.

c) Emergency push buttons shall be located at least at:

1. Escape exits of buildings and as necessary
2. In each electrical room, close to the exit doors. If different systems are supplied from that room, each system will get an own clearly marked emergency switch.
3. At the front panel of each in-feed section
4. Each production system shall have its corresponding emergency push button in the Central Control Room. Maximum 4-6 emergency stop push buttons for the whole plant.

d) The locations of the emergency stop switches shall be discussed and agreed upon by the Employer.

e) The emergency stop switch shall be colored according to the local Codes and Standards. Generally a yellow housing and a red colored push button is used. This color combination shall not be used for any other switching functions.

f) Emergency stop cancels all start commands in the PLC, and returns to stand-by status

g) Emergency stops are indicated individually with the name and location of the control circuit.

h) Function "Quick stop" will be realized by means of the PLC in the software for a controlled fast stop of a production line without de-energizing the complete switchgear.

i) Every local main switch functions as an individual emergency stop switch for that particular drive.

j) The emergency stop switch shall be fitted with protection around the push button to prevent accidentally activation. Site installations of emergency stop push buttons shall be installed in closed boxes covered with a glass window. A kind of hammer has to be installed to break the glass in case of an emergency.

k) One reset push button with telltale lamp shall be fitted on the front panel of the cabinet in which the emergency relay is installed.

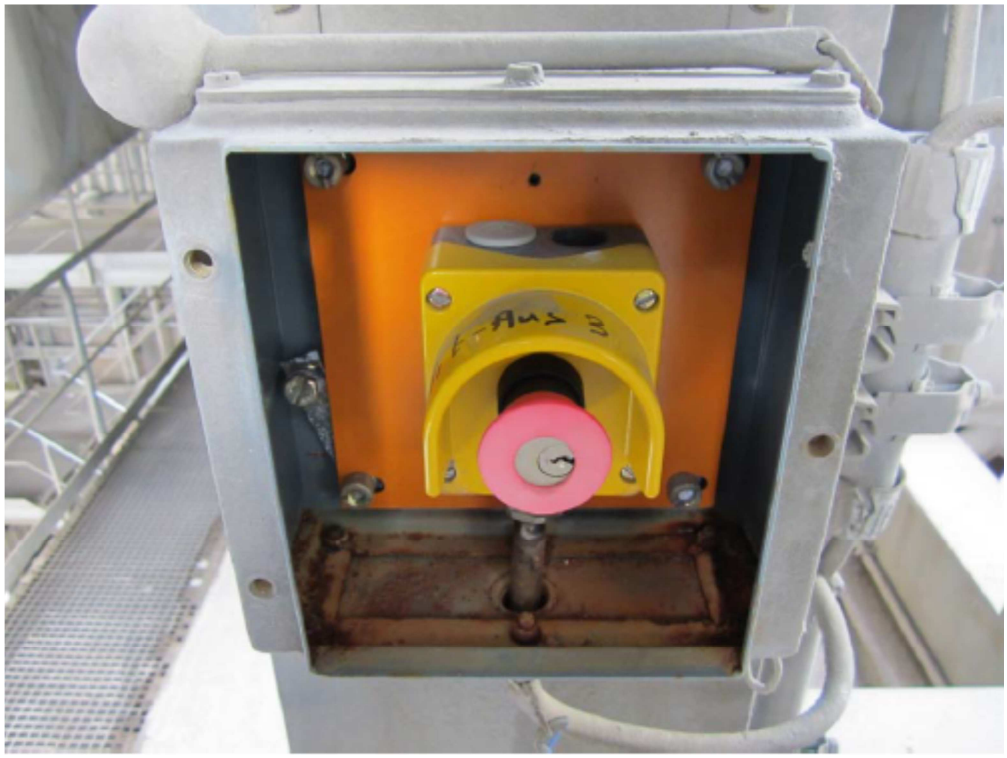

Photo 2: Emergency stop

7 Local Disconnect Switch

a) Local disconnect switches are an essential part of the lock-out, tag-out concept as described in the Health & Safety DCS.

b) The local disconnect switches contain also control switches for local start or local control.

c) The basic requirements and stipulations are as follows:

1. Local stop shall be operable in any situation, so that it can be used as a single local emergency stop for this drive.
2. Local disconnect switches shall be designed, so that they can be securely locked in the off position by up to three padlocks.
3. The color of the local disconnect switch shall be designed like an emergency stop switch.
4. A status indication for every control unit shall be provided.
5. Generally, local disconnect switches shall not be lockable in the “On” position. However, there are particular applications, where it is required. For instance earth switches and earth positions of circuit breakers have to be locked in the “on” position. Also drives that shall not be switched off by interrupting the motor in-feed like I-Type frequency converters can be locked in the “On” position. However, in this case an individual emergency stop switch has to be installed close to the drive.

6. Local start may be inhibited by means of the process control system.
7. All local disconnect switches shall be unambiguously labelled. The drive itself shall be marked identically so that there is a clear reference between the local disconnect switch and drive.
8. The nameplate has to be fitted to the not removable part of the local disconnect switch.
9. The nameplate shall be designed that it can stand the hard environmental conditions in a cement plant.
10. Labels shall be engraved and be of white/dark or color/white design.
11. Push buttons for start/stop, position, etc., shall be clearly and permanently marked equally in entire plant.
12. The nameplate shall contain the following information:

    i. Tag name
    ii. Description (text)
    iii. MCC Room
    MCC Field

13. A local disconnect switch has to be installed at the following objects:
    i. Motors (drives)
    ii. Dedusting filter's controllers
    iii. Flaps, also if controlled by solenoid valves
    iv. Control gates.
    v. For heaters or solenoid valves, which are used for aeration, shut off, etc., a local disconnect switch is not required.
    vi. For de-dusting filter controllers it is recommended to integrate the local disconnect switch directly at the local control boxes.

14. Other than for testing purposes by skilled persons, access to the internals of any local disconnect switch in the energized position shall be prevented.
15. All enclosures shall be suitable for the installation's environment, and in no case they shall have a protection rating of less than IP55.
16. It is preferred to use a handle lock instead of key lock for switch's enclosure
17. The Contractor is obliged to submit a proposal of local switch design to the Employer for discussion and approval.

7.1 Normal Motors, Damper Actuators

Local disconnect switches have to be installed at every drive and damper actuators. Disconnect switches shall be designed to cut off the full load without any damage and danger to the maintenance staff. This includes the higher load during a motor start up. Local disconnect switches are usually available up to 630 A for IC23 usage.

7.2 Large Motors

a) Large drives (>315 kW, >630 A) or variable speed drives (>315 kW, >630 A), where the local disconnection is not possible, shall be equipped with a local control switch and hardwired security interlocking. A secure under-voltage disconnect function of the main circuit breaker in the switchboard must be provided.

b) Status indication with a clear connect and disconnect indication shall be installed and additional safety instructions shall be fitted at the drive.

c) All drives which do not have a local disconnect shall be equipped with clear indication function at the main switch. Only a green “Off” indicates the safe condition. A not illuminated red “On” indication is not sufficient.

d) The function of the switch shall fulfil the following criteria:

Indication	Status	Criteria
Green light on	safe maintenance work is possible	Power switch in test position and power switch OFF, or load disconnect earthed and local master switch OFF
Red light on	maintenance work is not permitted, for safety reasons	Power switch in operating position, or power switch ON, or local disconnect switch ON, or earth disconnect not ON
No light on	Maintenance work is not permitted, for safety reason	Unclear condition, broken connection or broken lamp

Table 6

7.3 Bucket Elevator

a) The disconnect switch for bucket elevator drive(s) shall be located:
   1. Close to the drive
   2. For the auxiliary drive at every revision gate (bucket’s replacing door).

b) The disconnect switch shall have:
   1. 3 poles – for an elevator driven by 1 one main motor
   2. 6 poles – for elevators driven by two motors or if the elevator has an auxiliary drive.

c) The same rules shall be applied for bucket elevator’s auxiliary drive(s).

7.4 Control switches

a) Local start and stop function shall be realized by means of an additional control switch or as part of the local disconnect switch.

b) All push/pull buttons for drives, valves, dampers, gates, solenoids etc. will be located close to the field equipment for local control of equipment.

c) The start/stop push/pull buttons and any other type of control interface to electrical equipment will follow a typical layout specification that illustrates the placement of those devices. In general, the central control room always will maintain control.

8 Electrical heat tracing

a) The electrical heat tracing system shall include; self-regulating heat tracing cables, thermostats, junction boxes, cable glands, signaling boxes and accessories: connection kits, insulating kits, end kits, e.g. supports, fixing straps and labels.

b) The heating cables will be fed from the heat-tracing panel, preferably located in substations, buildings or under weather protection in safe areas.

c) In case of malfunction, the PLC shall be informed by a contact.