STANDARD DESIGN CRITERIA (StDC)

ELECTRICAL EQUIPMENT SYSTEMS

EDITION MARCH 2022

HOLCIM

Change Index

Version	Description	Tool Owner
All	Update March 2022	Corporate CEM/PME Michael Weihrauch

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Document Number: LHSTX-PM&E-OS09-000000-003-02

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HEALTH & SAFETY

Health and Safety is our core value. At Holcim, we want to do more than prevent accidents. We want to create a healthy and safe environment for our employees, contractors, communities and customers based on a true safety culture.

Health and Safety is at the center of everything we do, from the daily routines in our plants to our customers' project worksites and our actions in our neighboring communities. Our aspiration is to conduct our business with zero harm to people. We believe in visible leadership and personal accountability for Health and Safety at all levels and throughout our organization.

To reach this aspiration, we are committed to:

- Maintain a global Health and Safety Management System designed to continuously improve our performance and actively manage risk in our business
- Drive for operational discipline by instilling a mindset of safe execution and follow-up
- Communicate openly with all stakeholders on relevant health and safety issues

INTRODUCTION

Objectives of the Standard Design Criteria (StDC)

- Provide standard technical specifications to the Holcim community that is based on proven technologies and practical experiences from constructing, maintaining and operating plants.
- Achieve an optimized balance between high Overall Equipment Efficiency (OEE) and Mean Time Between Failures (MTBF) during the expected lifetime of the assets considering the lowest possible CAPEX.
- Ensure transparency and consistency among Supplier's offers to Holcim projects.

Application and General instructions

- The Standard Design Criteria (StDC) covers all engineering projects including Cement and Geocycle.
- The StDC is a reference guideline for designing new plants in Greenfield, Brownfield replacement and revamping projects. This document is also equally applicable and relevant for quarry & plant operation and maintenance teams for achieving efficient operation & maintenance which will ultimately improve the overall plant performance.
- All statements and paragraphs marked with  are design provisions for safe construction, operation and maintenance of the plant. Deviations and exceptions are not allowed.
- For non-safety related design variations, justification of the alternative must be properly recorded.
- The Basic Requirements document contains general specifications applicable for Mechanical, Electrical and Civil design.
- The Mechanical Equipment, Electrical Equipment and Systems, and Civil and Structural Works documents shall be used in conjunction with the Basic Requirements section.
- Specifications for Mechanical, Electrical and Civil components of the projects shall be reflected in the Data Sheets (where available). They are intended to standardize the way Suppliers present specifications to Holcim.
- The Standard Design Criteria lists certain codes and standards. In the event that any such specified codes and standards are inconsistent with any codes or standards enforced by law, the most stringent standard shall govern the Contractor's performance as far as not in conflict with local regulatory obligations.

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GLOSSARY

The following terms and definitions will be used in the Standard Design Criteria for Electrical Equipment and Systems:

ASD:	Adjustable-speed drive or Variable Speed Drive (VSD).
BUS systems:	The Plant fieldbus for the communication of the I/O with the process stations, the Plant-Control-Bus for the communication between process stations and servers and the Plant-Automation-Bus for the communication between servers, operator stations and other IT devices.
Busbar line-up:	All Equipment mounted in adjacent MV/LV panels and directly connected with the same busbar. A busbar coupler will separate two different busbar line-ups. The coupler belongs to the busbar line-up.
Compartment:	One of the sections into which an enclosure is divided or partitioned (e.g. LV compartment of MV Switchgear Cell).
Component:	Is the electrical or control Equipment connected with one power and/or one control cable (motors, valves, heaters, actuators and sensors).
Cost Center:	The manufacturing process is subdivided into related cost centers. Main-, pre-process- and auxiliary cost centers exist.
Department:	The subdivision of the manufacturing process according to Cost Center and production line. It normally includes the corresponding auxiliaries as required to make the process operational (refer to the Asset Coding Manual for more details).
Distributed I/O:	I/O devices connected via field bus, mounted in field I/O boxes or panels to connect field sensors and actuators and motor control or direct field bus connection to measuring systems and sub-control-systems.
Drive:	The motor is up to the mechanical coupling, including its starting-, control- and protection devices.
Enclosure:	An electrical enclosure is a cabinet for electrical Equipment. It also prevents electrical shock to Equipment users and further protects the contents from the environment.
Electrical Equipment:	Includes all electrical- and process control Equipment and all associated systems.
Functional unit:	Standardized electrical circuits for the control of a normal drive, reversible drive, variable speed drive, feeder, valve and actuator.
Group (E00-E90):	In the context of the StDC meaning the sub-division and grouping of Electrical Equipment Systems applying certain criteria such as general/specific voltage levels, power distribution/conversion etc.
High Level Control (HLC):	Advanced process control system on top of the PCS.

Module:	Standardized arrangement of electrical switching, protection and control devices and related circuitry for the control and protection of a functional unit. This may as well include measuring and indicating devices.
Operator stations (OS):	Using standard IT Equipment and corresponding industrial software, assuring a simple and efficient human machine interface (HMI) for the remote operation of the Plant.
PAG:	Platform Architecture Guide: The purpose of the PAG is to give a comprehensive overview about the configuration rules to be applied for a PCS project.
Panel line-up:	All Equipment mounted in adjacent panels and directly connected with the same busbar.
Panel:	See Enclosure; Synonyms: Cabinet, Box, Cell and Cubicle.
PCS Automation:	Consists of a plant automation bus, plant control bus and plant fieldbus Zone.
Process stations (PS):	Using industrial controllers (processors) with their software, assuring the safe operation of machines, of the production process and providing all required communication interfaces.
Screen area:	Part of the total displayed content, showing e.g. process (department or group) information or standardized navigating information.
Screen:	Displayed content (text and picture/graphic) on an HMI monitor.
Section:	A freestanding panel (part of a busbar line-up or panel line-up) containing one or several compartments.
Servers:	Using standard IT Equipment and corresponding industrial software, assuring safe and efficient data storage.

0. GROUP E00: ELECTRIC POWER AND CONTROL

0.1 General Requirements

a) The Standard Design Criteria (StDC) shall apply to all electrical Equipment and systems.

b) The StDC identifies the minimum requirements for electrical Equipment and electrical systems.

c) Electrical Equipment and systems designed in due consideration of the StDC shall meet the primary objective of providing a safe, reliable, and energy efficient installation.

d) Electrical Equipment and systems shall be designed in line with good engineering and construction practices considering the cement industry environment.

e) All electrical Equipment shall be accessible for maintenance and for easy replacement.

f) Deviations from the StDC may be accepted in order to reduce costs (value engineering). However, such deviations are subject to mutual agreement.

g) An emergency-stop/emergency switching-off concept shall be elaborated for the Plant.

h) Each motor feeder/switchgear for Crushers and Mills shall be equipped with a unique “trapped” key system.

0.1.1 Loading and Spare Capacity

The loading and spare capacity of electrical Equipment is detailed in the individual Chapters of the StDC.

0.2 Standard Design Criteria Organization

The Standard Design Criteria for Electrical Equipment and Systems are arranged according to the various Equipment types, called groups, and are coded E00 to E90.

0.3 Detailed Electrical Equipment Specifications (Data Sheets)

a) Plant-specific electrical Equipment data, process data and requirements are detailed in the respective data sheets of the individual Equipment specification sheets.

b) In addition, civil requirements related to electrical installation (electrical rooms, transformer bays, cable basements, etc.) are specified in the Civil and Structural Works Standard Design Criteria.

0.4 Applicable Standards

a) Electrical and control Equipment shall be designed according to the Applicable Laws and Applicable Codes and Standards.

b) The general standards and regulations to be applied shall be as specified in the Project Description and Scope.

c) Technical terms and definitions used in this document are based on IEC standards.

d) The SI units shall be applied for all process measurements.

e) Equipment shall be designed taking into account the site conditions and Electrical Site Specification.

f) Electrical and control Equipment located in hazardous (classified) areas shall be designed according to the relevant applicable international and local regulations, codes and standards.

0.5 Electrical Equipment Standardization

a) In order to limit the necessary stock of spare parts, the same make, standard sizes and capacities for all electrical Equipment shall be used.

b) Sub-control panels and systems shall not be used. Required functions shall be realized in the Electrical Distribution, MCC and PCS systems. If this is not possible due to performance guarantee, then the hardware shall be of the same make and type as used for the PCS and power distribution Equipment (MV-switchgear/LVD/MCC/Lighting).

0.6 Electrical Data

0.6.1 Power System Frequency and Voltage Levels

Plant specific power system frequency and voltage levels are detailed in the data sheets.

0.6.2 Operating Tolerances

a) At normal network conditions, the supply of electrical power will be within narrow limits. Occasionally, larger deviations may be compensated by the incoming transformer on-load tap changer. However, the voltage regulation (automatic or manual) may not fully compensate at any instant and the limits may be exceeded. Therefore, all electrical Equipment shall be designed and sized to operate at rated performance during slow excursions of the power supply system (see item below).

b) Special measures shall be adopted to maintain operation of the kiln department and other important services such as the process control system, laboratory automation, IT network, dispatch automation, etc., whereby other departments might shut-down (see item b) below).
If the required special measures cannot be justified (too high costs, selection of brand does not allow, etc.), it shall be clearly expressed and deviations mutually agreed.

   a) Full performance of Plant taking into account voltage and frequency variations (not coinciding) as follows:

      - Voltage ± 10%
      - Frequency ± 2%

   b) Uninterrupted service of kiln department and other vital services during transient network disturbance as follows:

      - Voltage dip -100% (for 100ms)

0.6.3 Electrical Equipment Sizing

a) The sizing of electrical Equipment including the rated power and currents shall be determined according to the requirements of the mechanical Equipment.

b) Spare capacities as specified in this document shall be included.

0.6.4 Power Factor Correction/Total Harmonic Distortion (THD)/Filters

a) The power factor shall be corrected in order to achieve the power factors as specified in the data sheets.

- Low voltage power factor correction: LV-Equipment shall be compensated through automatically regulated reactive power compensation Equipment situated at low voltage power distribution (refer to Group E30: Low Voltage Distribution and MCC). The harmonic content produced by non-linear Equipment shall be eliminated at the source to guarantee a trouble-free operation of all Equipment within the ranges given by standards and the requirements of the Equipment.
- Fixed speed drives supplied from the MV-busbars shall be compensated through tuned reactive power compensation Equipment correcting the power factor as well as harmonics generated. In case of pure power factor compensation, capacitor bank detuned reactors shall be provided.

b) The level of harmonic distortions at the point of common coupling (PCC) with the utility company shall not exceed the limits specified by the utility company. During all operating conditions of the Plant, the level of harmonic distortions at any in-plant point of coupling (IPC) shall not exceed the limits specified in:

- IEEE 519 (Recommended Practice and Requirements for Harmonic Control in Electrical Power Systems)
- IEC 61000-2-4

0.6.5 Power System Design

a) A power system study shall be the starting point for any power system design and subsequent electrical Equipment engineering.

b) The power system study shall include at least the following:

- Load Flow Analysis
- Short-circuit Analysis
- Motor Starting Analysis (for large MV DOL motors)
- Harmonics Analysis
- Selectivity Study (the coordination of all protective devices shall fully be selective)
- Arc-Flash Study

0.7 Emergency Power System

a) The emergency power system shall serve for the supply of electrical power to the Plant (e.g. for kiln auxiliary drive, essential drives, UPS power supplies, emergency lighting, elevators, computer center, etc.) in case of power failure.

b) The emergency power system shall include provisions/instructions on procedures in case of power failure.

0.8 Electrical Enclosure

a) Dimensions shall be standardized.

b) Degree of protection by enclosure when installed inside electrical rooms shall be of minimum IP 21 for low-voltage Equipment and of minimum IP 31 for medium-voltage Equipment.

c) Degree of protection by enclosure, when installed outdoors in the field, shall be of minimum IP 55. When installed in hazardous (classified) areas, the degree of protection by enclosure shall comply with requirements specified in the relevant applicable standards.

d) Design of panel enclosures shall comply with the following:

- Pad-lockable incoming isolator switch with insulated incoming terminals to allow safe working on electrical Equipment inside the panel enclosure.
- All electrical components and connections inside the panel shall be protected against direct contact as per IP 20B (protection against accidental touch of live parts).
- All electrical components inside the panel enclosure shall be accessible for maintenance.
- Electrical components (except for cabling/wiring) shall not be installed on sidewalls of a panel enclosure.
- Panel doors shall require a standard tool for opening or be equipped with a handle which shall be lockable with a standard tool.

e) Degree of protection by enclosure, when installed in the area of water washing facilities, shall be of minimum IP 67.

0.9 Electrical Room Requirements

a) Refer to Civil and Structural Works Standard Design Criteria.

b) Electrical rooms can be part of a building or structure or can be designed with a stand-alone enclosure such as a container.

c) Electrical rooms shall be designed and used to accommodate only electrical- and control Equipment.

d) Electrical rooms shall not be considered as a storage room, warehouse, workplace, office, restroom and the like.

e) Segregation of electrical Equipment of different voltage levels shall be applied.

f) A separate electrical room shall be foreseen for each production department to avoid fire propagation.

0.10 Electrical Equipment Finish Coating and Painting

The requirements specified in the relevant chapters of the Basic Requirements shall apply.

0.11 Nameplates Labels

a. Warning labels shall be in both, the local language and in English.

a) All electrical Equipment shall be clearly labeled. Refer to Basic Requirements.

b) Nameplates/labels shall be sized to allow easy reading. Labels shall be of industrial type/laminated and engraved (Lamacoid/Resopal).

c) All warning labels shall be designed according to applicable international and local codes.

d) Electrical Equipment (Asset) labels shall contain:

- Equipment designation
- Asset code reference

1. GROUP E10: MAIN TRANSFORMER STATION

1.1 General Requirements

a) The location of the main transformer station shall consider the prevailing wind direction (minimize dust contamination) and that incoming overhead power lines shall not be routed through plant premises.

b) Applicable authorities and the Utility Company's specifications shall be followed.

c) Main transformer station shall be designed for standalone operation not requiring permanent attention of an operator.

d) Service transformers shall be foreseen for supply of Equipment installed at the Main Transformer Station.

e) Check metering shall be foreseen for measurement of the plant electrical energy consumption.

1.1.1 Loading and Spare Capacity

a) The main transformer shall be sized according to the calculated total utilized power demand (ONAN based) plus at least 10% (refer to Power Consumption List and data sheet).

b) The nominal secondary current of the main transformer shall not exceed 4000A.

c) The main transformer station shall be designed to allow future installation of one additional main transformer.

1.2 Main Power Transformer

1.2.1 General

a) Applicable Standard: IEC60076.

b) Main transformer shall be three phase, oil immersed (biodegradable oil), outdoor type and shall not contain any PCB.

c) Transformer feeders should not pass through other transformer bays; each transformer bay with all Equipment shall be independent. If this is not possible for technical reasons, fire protection (REI120 as per EN 13501 – 120 minutes fire resistance) shall be applied.

d) Main transformer shall be equipped with standard transformer protection devices (protection relay & Buchholz relay).

e) Transformer load and temperature shall be continuously measured and transmitted to the CCR.

f) Main transformers shall be equipped with an automatic on-load tap changer (OLTC) connected to the primary windings.

g) The OLTC shall be equipped with standard protection devices, automatic voltage regulator (AVR) with IEC61850 communication facility and with tap changer condition monitoring.

1.2.2 Neutral Grounding

Neutral grounding shall be designed according to the requirements of the Utility Company and the specific plant configuration.

Secondary grounding: Neutral-earthed through a resistor limiting the fault current to 50A/5s or as per the system requirements.

1.3 HV Switchgear and associated Equipment

1.3.1 General

Depending on the Plant layout, the available space and the requirements of the Utility Company, the following types of HV-switchgear arrangement can be applied for the incoming main transformer station:

a) Air Insulated Switchgear (AIS)

b) Hybrid switchgear

c) Gas-insulated switchgear (GIS)

1.3.2 HV-Circuit Breaker

a) Circuit breakers shall be 3-pole, with a 3-pole or single pole operating mechanism as required.

b) They shall include all standard and special features for remote control and supervision.

1.3.3 HV-Isolating Switch

A 3-pole, single throw horizontal break-switch shall be used, capable of either manual (crank) or electrical operation.

1.3.4 HV-Grounding Switch

a) Grounding switch shall be remotely operated

b) Operational interlocked grounding switch

1.3.5 HV-Insulators, HV Surge arresters

a) Basic insulation level (BIL) shall be as required for the specific application.

b) All insulators shall be designed for increased creeping path of at least 31 mm/kV.

c) Surge arresters shall be applied at the incoming line and at the main transformer.

d) Surge arresters shall include standard features for supervision and control.

1.4 Data Communication to Utility Company

The data communication shall be designed as per Utility Company’s requirements.

1.5 Energy Metering

All general- and specific energy metering devices for billing purposes, protection and relaying functions shall conform to Applicable Laws and Applicable Codes and Standards.

1.6 Control Power Supply/Battery Charger

a) The Main Transformer Station shall be designed with the required uninterruptable DC power supply for the operation, control and monitoring of the Equipment.

b) DC power supply shall also be used to power a UPS of the PAS.

c) DC power supply shall include the following:

- Battery (rack or panel mounted)
- Rectifying and charging Equipment
- Distribution panel

d) Alarming shall be provided for loss of AC supply voltage, charger fault, and low DC voltage.

1.7 Power Automation System (PAS)

a) The concept of a PAS for the HV switchgear may be considered.

b) Design requirements are described in Group E20, Chapter 2.7.

2. GROUP E20: MEDIUM VOLTAGE DISTRIBUTION

2.1 General Requirements

a) The medium voltage (MV) distribution system shall be designed to supply power to individual process departments (individual process departments are determined by HAC.

b) Boundaries between the main process cost centers shall be maintained for the purpose of energy consumption metering (in kWh) in accordance with HARP and HAC.

2.1.1 Loading and Spare Capacity

a) MV busbars shall be designed according to the main transformer's rated capacity (based on ONAN).

b) Parallel operation of transformers/busbar line-ups shall be avoided

c) The nominal secondary current of the distribution transformer shall not exceed 4000A.

2.2 MV-Switchgear

a) MV-switchgear Equipment shall be placed in an electrical room.

b) MV-switchgear shall be of the metal enclosed and compartmented type switch- and control gear.

c) MV-switchgear shall be type tested and designed according to IEC 62271-200.

d) The IEC-busbar line-up shall conform to IAC (Internal Arc flash Classification) FLR (Front-Lateral-Rear).

e) Each individual MV cell shall have its individual protection relay with metering functionality and communication capability adjusted to the type and size of the connected load.

f) Current transformers shall have a protection core and a measuring core. Measuring devices and meters shall be connected to the measuring core of the current transformer and not to the protection core.

g) If metering is required for billing, revenue class current and voltage transformers with corresponding accuracy classes shall be applied.

h) Anti-condensation heating shall be used as required by local climatic conditions.

i) Each MV cell shall be provided with a label, indicating designation and Asset code of the supplied Equipment in line with the Single Line Diagram.

j) Core balance current transformers shall be foreseen for the earth leakage current measurements of outgoing cells in systems with earthing resistors.

k) Rear door/cover positive interlock shall be considered through means of Solenoid and Limit switch (applicable to equipment where back-access is inevitable).

l) Temperature measurement possibilities for the busbars, contact areas of the circuit breaker racks and cable connections shall be installed. Either infrared windows for thermography or appropriate temperature monitoring systems should be used.

2.3 Distribution Transformers MV/LV

a) Distribution transformers shall be of the dry type. Liquid-filled ONAN distribution transformers with biodegradable oil, if not in conflict with the local rules, could be used.

b) Temperature shall be continuously measured and transmitted to the PCS.

c) Transformer capacities shall be standardized to a maximum extent up to 2500kVA.

d) Specially reinforced transformers shall be used on mobile Equipment (e.g. crusher, mobile transfer stations, etc.) to withstand possible shocks and vibration.

e) The transformer room design (sheltered) shall allow for utilization of the full rating of transformers by natural air draft cooling. Distribution transformers shall be kept outside the e-rooms, adjacent to the load centers with proper fire safety provisions.

f) Transformer feeders should not pass through other transformer bays; each transformer bay with all Equipment shall be independent.

g) Transformer capacities shall be rated with a minimum reserve of at least 30% of the utilized power of the connected load.

2.4 Circuit Breakers/Contactors

a) Circuit breakers and contactors shall be of the draw-out type provided with automatic shutters in separate compartments of the metal clad section.

b) The circuit breakers shall be capable of local and remote control (electrically) and local emergency off (mechanically).

c) Safety measures shall include:

- Lockable in off-, racked-out- and grounded position

d) Zero-voltage (0-voltage) trip coils shall be considered for all incoming feeders and outgoing motor feeders.

e) The operating mechanism shall be spring-loaded (stored energy).

f) For maintenance purposes, circuit breakers/contactors shall be operable in the racked-out/test position.

g) Tiebreakers (busbar couplers) shall be equipped with synchronism check when simultaneous different power sources are available.

2.5 Local Isolation Switch (Load Break Switch/Switch Disconnector)

If required by the local rules, for a distribution transformer supplied from an upstream circuit breaker, a pad-lockable manually operated switch (load-break switch/switch-disconnector/earthing switch with short-circuit breaking capacity) shall be connected to the transformer primary side in order to provide local isolation.

2.6 Power Factor Correction

a) The power factor correction Equipment shall be automatically controlled and equipped with filters to guarantee the quality of the plant network with respect to voltage (coordinated with main transformer OLTC), power factor and harmonics.

b) The capacitors shall be sized to achieve a power factor at full load operation as specified in the data sheets.

c) The reactive power units shall be designed as follows:

- Modular design using capacitor units of standardized sizes
- Complete with protective devices and contactors

d) All Equipment shall be installed indoors in an electrical room.

2.7 Metering, Monitoring & Control

a) The concept of PAS may be considered where the number of controllable switchgear and protection relays exceeds the quantity of 50 or where a decentralized system with various remote substations is available. In case of lower quantities, PAS shall be an integrated solution within the PCS.

b) The control shall contain all relevant interlocking, alarm/annunciation functions for the medium voltage Equipment.

c) Motor feeders shall be started remotely only from the PCS.

2.8 Control Power Supply

Control power supply concept shall consider local rules and practices.

2.9 Emergency Power Generating Set

The generating set consists of the engine and the generator and shall be designed complete with features and accessories as listed below:

a) The set shall have its own fuel tank for a minimum of 8 hour operation at full capacity.

b) All required piping, valves for connection and filling shall be considered in the design.

c) Automatic start-up in case of power failure shall be provided, including control of all required changeover facilities for feeding to the individual bus systems.

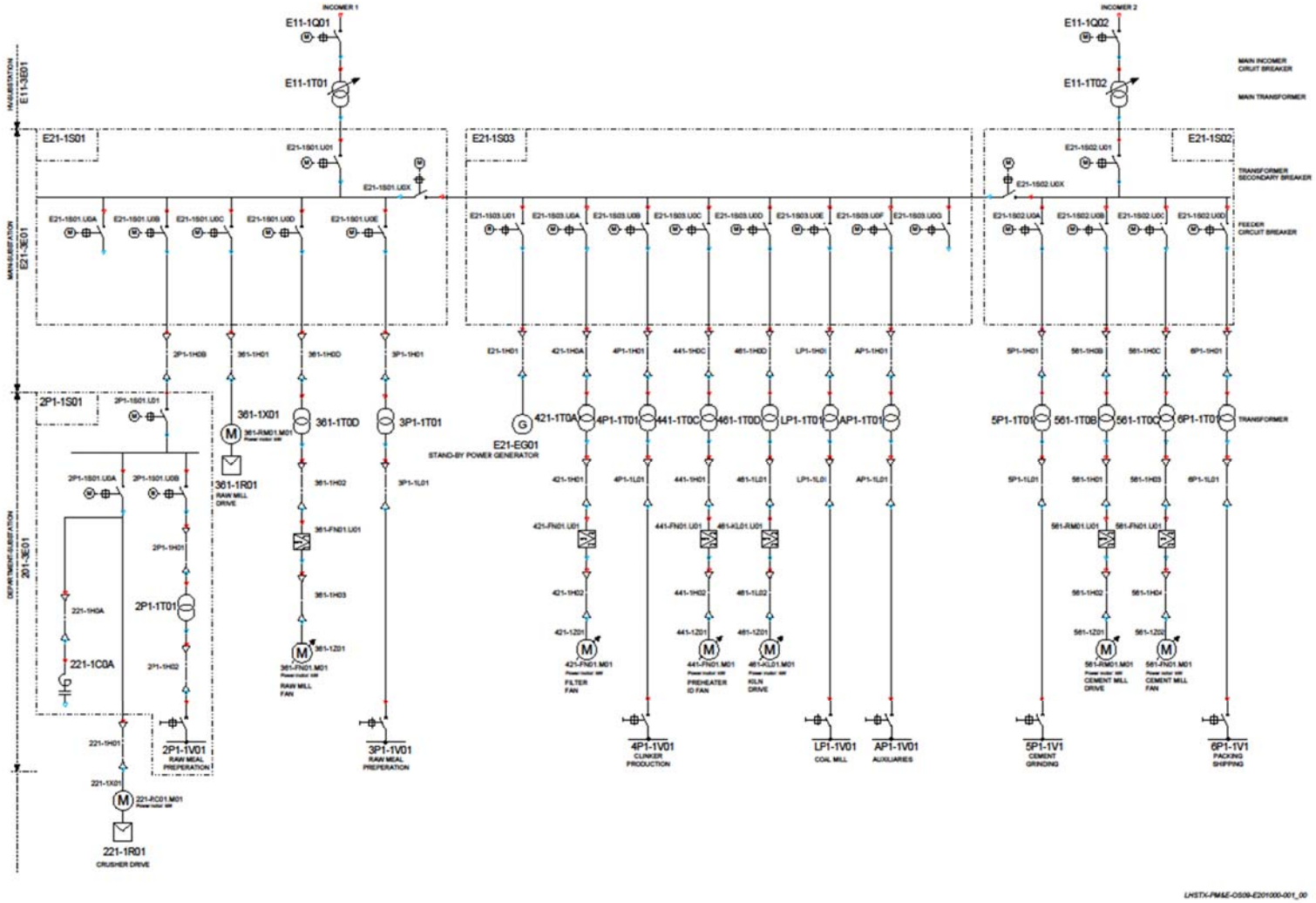
d) The generator shall be rated at 0.8 power factor and of IP 55 protection class if installed outdoors.

e) Provisions for test runs shall be foreseen.

f) Start-up time from start signal to full power shall be less than 30 seconds.

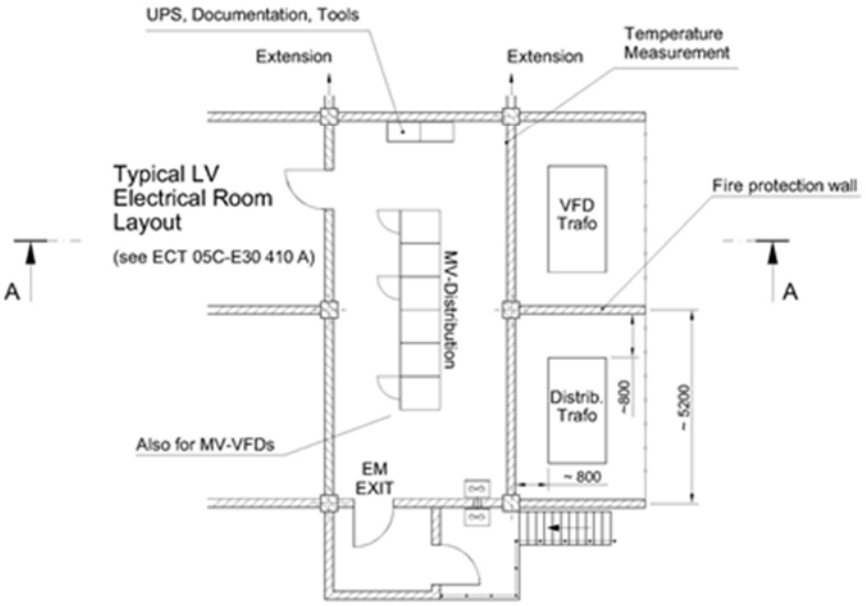
2.10 Typical Drawing, Group E20

The typical SLD schematic below shall serve as a guideline for the conceptual design, arrangement and installation of the electrical Equipment.

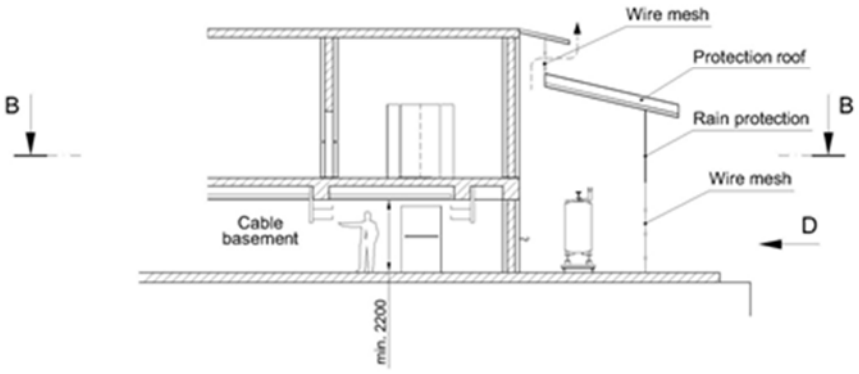

INCOMER 1
E11-1Q01
E11-1T01
INCOMER 2
E11-1Q02
E11-1T02
MAIN INCOMER CIRCUIT BREAKER
MAIN TRANSFORMER
HV-SUBSTATION
E11-3E01
MAIN-SUBSTATION
E21-3E01
DEWATERING-SUBSTATION
201-3E01
E21-1S01
E21-1S03
E21-1S02
TRANSFORMER SECONDARY BREAKER
FEEDER CIRCUIT BREAKER
2P1-1S01
361-1T0D
3P1-1T01
E21-EG01
STAND-BY POWER GENERATOR
421-1T0A
4P1-1T01
441-1T0C
461-1T0D
LP1-1T01
AP1-1T01
5P1-1T01
561-1T0B
561-1T0C
6P1-1T01
TRANSFORMER
361-1R01
RAW MILL DRIVE
2P1-1T01
221-1C0A
221-1R01
CRUSHER DRIVE
2P1-1V01
RAW MEAL PREPERATION
3P1-1V01
RAW MEAL PREPERATION
4P1-1V01
CLINKER PRODUCTION
LP1-1V01
COAL MILL
AP1-1V01
AUXILIARIES
5P1-1V1
CEMENT GRINDING
6P1-1V1
PACKING SHIPPING

Typical MV Electrical Room Layout

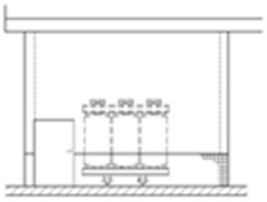
View B - B



View A -A



View D



Note: No steel bar required under transformers as there is no oil pit, anymore.
Check loads!

ECT 05C-E20 404 D

3. GROUP E30: LOW VOLTAGE DISTRIBUTION AND MCC

3.1 General Requirements

a) Each main cost center shall have a dedicated LV power distribution (LVD) system.

b) Applicable codes and standards:

- Apparatus standard — IEC 60947, 61431-1
- Power switchgear and control gear assemblies — IEC 61439-1 & 61439-2

The design of the LVD and MCC shall be based on the standard IEC 61439 as follows:

c) LVD and MCC shall be of arc-resistant design (IEC 61641).

d) LVD and MCC shall have at least an IP2x separation between the busbar and the modules.

e) Every LVD shall have an incoming section with an incoming circuit breaker.

f) Each LVD- and MCC- panel line-up shall have local indication of incoming line voltage, control voltage, and busbar power, energy, phase voltage, current and power factor (multipurpose instrument).

g) Fuse less design shall be applied unless circuit breakers cannot be used for technical reasons.

h) Standardized electrical circuits shall be applied.

i) Easy access to all connection terminals shall be foreseen.

j) Connection terminals shall be clearly separated into power and control terminals.

k) The LVDs, MCCs and DMCs shall be of the same basic design and of the same make and type throughout the Project.

l) The LVDs and MCCs shall be metal enclosed, freestanding, with a corrosion-proof surface treatment.

m) The panel doors (including auxiliary panels and individual compartment doors) shall be equipped with identical locking devices to permit the use of one common key for all doors.

n) Features to apply padlocks for open condition and racked-out position shall be provided for all circuit breakers and isolation switches.

o) Each panel line-up (LVDs, MCCs) shall be supplied with an engraved plate stating description and asset code reference.

p) Each module shall be furnished with a label stating description and asset code reference of connected Equipment and of type of functional unit.

q) LVDs and MCCs shall have earthing (grounding) provisions as required by the selected kind of power system earthing (grounding), preferred TN-C conforming to IEC 60364.

r) LVD and MCC Equipment shall be located in electrical rooms close to the group of consumers it supplies.

s) For all Equipment where emergency stop switches are installed a safety relay shall be foreseen.

t) Form of separation for LVD & MCC feeders should be of minimum 3b.

u) Temperature measurement possibilities for the main busbars shall be installed. Either infrared windows for thermography or temperature monitoring of the busbars should be used.

3.1.1 Loading and Spare Capacity

a) Equipment shall be sized according to the calculated short circuit currents and operational load conditions.

b) The main LVD busbar shall be rated according to the transformer secondary current.

c) Secondary busbars, secondary LVD and separate MCC busbars shall be minimum rated according to the connected load including spare or according to the rating of the feeder circuits.

d) Each panel line-up shall be extendible at least on one side.

e) Each MCC shall provide spare space for the installation of at least one spare module of each type and size up to and including 75 kW. For withdrawable-type the fixed parts shall be ready installed.

f) The cable section of LVD- and MCC- panels shall be minimum 200mm wide for a design with direct cable connection to the module and minimum 400mm wide for a design with separate cable compartments.

3.2 Low Voltage Distribution

a) The low voltage power feed from the distribution transformer secondary side shall be connected to the LVD panel either by cables or an insulated bus duct (busbar trunking), depending on the current requirements, arrangement and distance.

b) The connection and components shall be sized for the full transformer capacity.

c) The LVD shall be composed of the following basic Equipment:

- Incoming circuit breaker and measuring and metering device.
- Incoming circuit breaker with trip coil for panic stop tripping.
- Feeder circuit breakers to non-process consumers.
- LV power factor correction (accommodated in a separate panel is acceptable).
- Feeder circuit breakers to downstream MCCs or SCSs shall be equipped with a trip coil for panic stop tripping.

d) Feeder circuit breakers to non-process consumers (lighting, power sockets, elevators, maintenance cranes, air conditioners, anti-condensation heaters, sump pumps, general purpose compressors, auxiliary drives used for maintenance, UPS etc.) shall be arranged at one end of the panel line-up.

e) An electricity meter shall be provided for measurement of the total energy consumption of all non-process consumers.

3.3 Motor Control Center (MCC)

a) The MCC shall contain motor control Equipment for a safe remote control of the different process groups.

b) Each cost center shall have its dedicated MCC.

c) Process groups shall not be subdivided into different MCC. Except for groups of which not all pertaining consumers can be supplied from a single MCC.

d) The MCC shall be composed of the following basic Equipment:

- On-load isolator switch with trip coil for panic stop tripping
- Outgoing feeders to SCS and adjustable speed drives (ASD)
- Outgoing feeders to process consumers

e) Each outgoing feeder shall contain all elements for the control and monitoring of one consumer and for the protection of its circuitry.

f) The control and monitoring of feeders shall be performed via I/O modules integrated within the MCC.

g) An electronic type protection device shall be used for motor protection.

h) The overload device shall have automatic reset (self-reset type).

i) Reversible motor feeders shall be provided with internal interlocks to prevent short-circuiting.

j) Power circuits and control circuits shall be separated by standard interfaces to allow a future upgrade of the control circuits independent of the power circuits.

k) Internal wiring shall be coded by numbering.

l) Color-coded wires shall be applied to distinguish between different voltage levels.

m) Feeders for all bucket elevators and for consumers' ≥ 75 kW shall be provided with a power transducer.

n) Current transducers shall be provided for consumers below 75 kW, if explicitly required by the process.

o) Star-delta starting shall not be used.

p) MCC back-to-back mounting is accepted on condition that access to busbars and built-in equipment and devices is possible from the front.

3.4 Intelligent MCC

a) Intelligent MCC's may be considered.

b) Each motor controller in the Intelligent MCC connects individually with the plant fieldbus.

c) Intelligent MCC's shall use the same plant field bus as used for the I/O communication.

d) They shall be tested and approved by Holcim together with the selected Standard Software of the PCS.

3.5 Auxiliary Control Center (ACC)

a) ACC shall be foreseen for the supply of single-phase consumers (with or without relay).

b) Each main cost center shall have a dedicated ACC.

c) ACC may supply UPS power or normal power or both.

d) An indicating device shall be foreseen for each incoming voltage.

e) The control and monitoring of feeders shall be performed via I/O modules integrated within the ACC.

f) A disconnect switch with a padlocking facility shall be provided for each incoming voltage.

3.6 LVD/MCC/ACC Control Voltage Supply

a) LVD/MCC/ACC internal control voltage shall be fed from a single source.

b) In-built PCS components shall be fed from UPS.

c) Availability of the control voltage shall be indicated in the PCS.

3.7 Uninterruptible Power Supply (UPS)

a) Each cost center shall have a dedicated uninterruptible power supply.

b) This UPS shall supply control power to sub-control systems and auxiliary power to PCS components and instrumentation.

c) PCS components installed in the CCR shall be supplied from a separate UPS.

d) UPS shall provide autonomous operation of the PCS for at least 20 minutes.

e) The UPS shall be of the static battery-buffered type.

f) Short-duration mains failures shall be buffered by using a battery.

g) Permissible deviations of the main voltages outside the normal tolerance range shall be smoothed out.

h) Frequency deviations shall be compensated.

i) High frequency interference spikes shall be decoupled.

j) Uninterrupted by-pass circuit with an electronic switch shall be provided.

k) UPS shall be designed for continuous duty operation without switch-off periods.

l) As an alternative, a central uninterruptible power supply can be used.

m) The central UPS shall be of modular type, using a minimum of 3 modules with on-line interchangeability and therefore without need for electronic bypass.

3.8 Power Factor Correction

a) Low voltage power distribution directly connected to a transformer, or at remote locations shall be equipped with automatically controlled reactive power compensation Equipment.

b) The capacitor banks shall be sized to achieve a power factor at full load operation as specified in the data sheet, if applicable.

c) The reactive power units shall be designed as follows:

- Modular design using capacitor units of standard sizes
- Complete with protective devices and contactors

d) The switching sequence (rotating load) and the capacitor unit size shall be selected in accordance with the expected loading and shall not disturb or be disturbed by any electronically controlled Equipment.

e) De-tuned capacitor banks shall be used. The power factor correction Equipment shall be equipped with line filter reactors to cope with harmonics.

3.9 Emergency Power Generating Set

Same requirements as described in Chapter 2.9 shall apply.

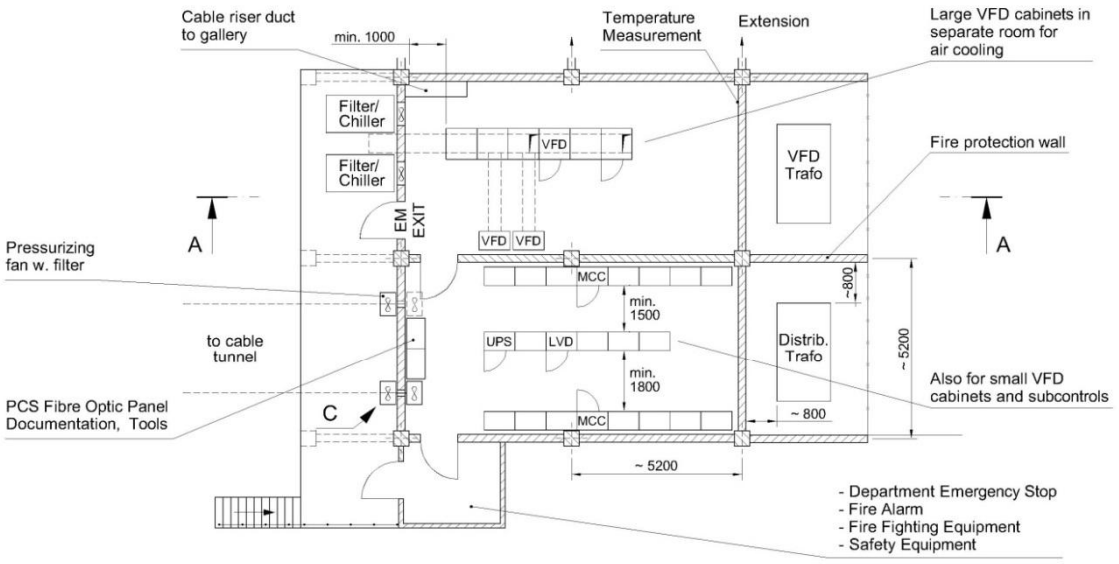
3.10 Typical Drawings, Group E30

The typical schematics:

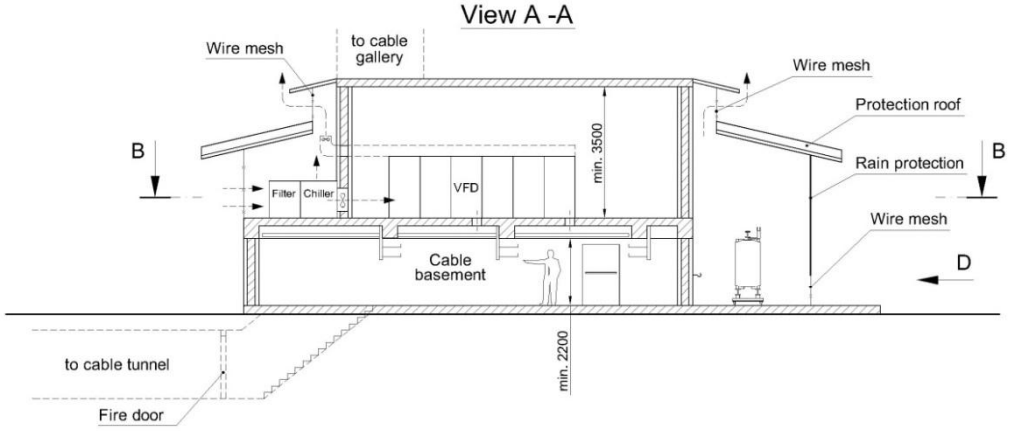
- Protection and Neutral Grounding Concept of LVD/ MCC.
- Motor outgoing feeder below shall serve as a guideline for the conceptual design, arrangement and installation of the electrical Equipment:

Typical LV Electrical Room Layout

View B - B

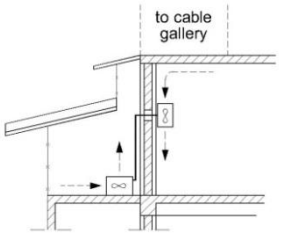


View A -A

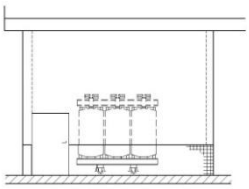


Section Detail C

Air cooling split units



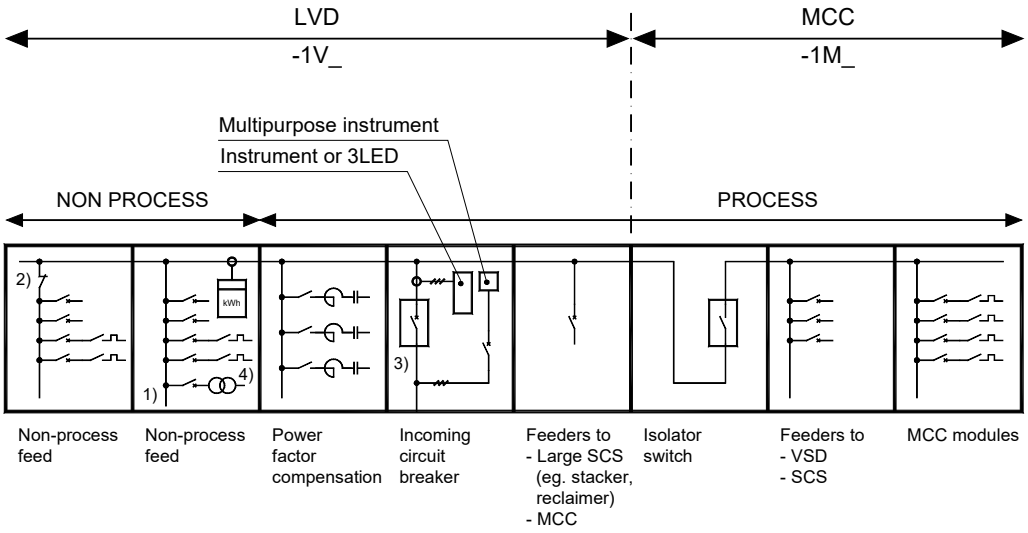
View D



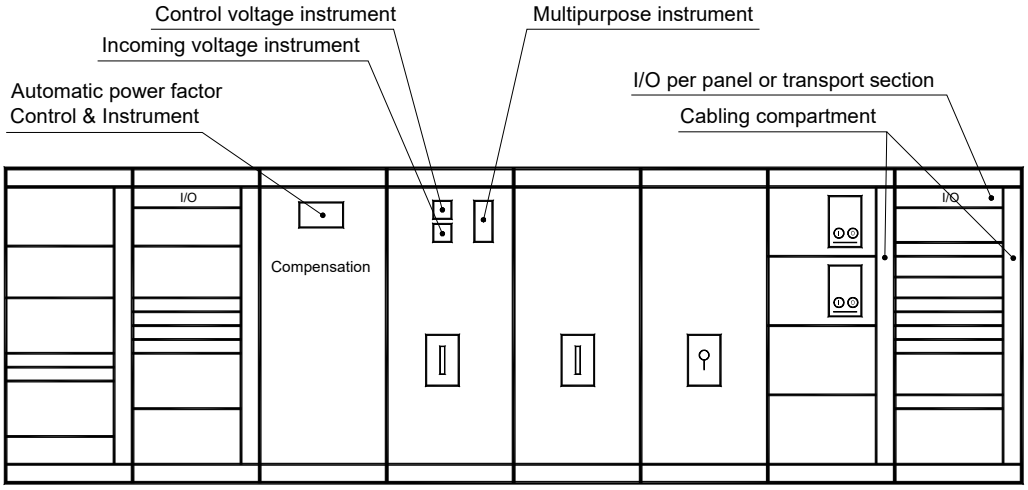
Note: No steel bars underneath transformer required

ECT 05C-E30 410 C

Typical LV-Distribution with Non-Process Feeders and Integrated Process MCC Modules

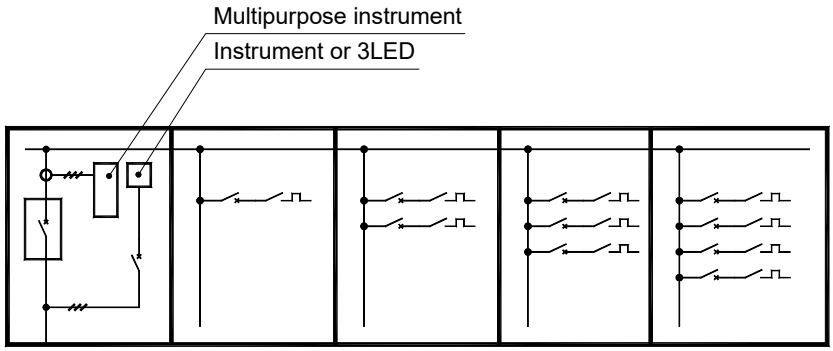


1) Provisions for emergency feed by LV generator
2) Disconnecting non-process loads if required by standby power generation
3) Circuit breaker with trip coil for panic stop function
4) Uninteruptable power supply (Details see ECT 05C-E30 411)



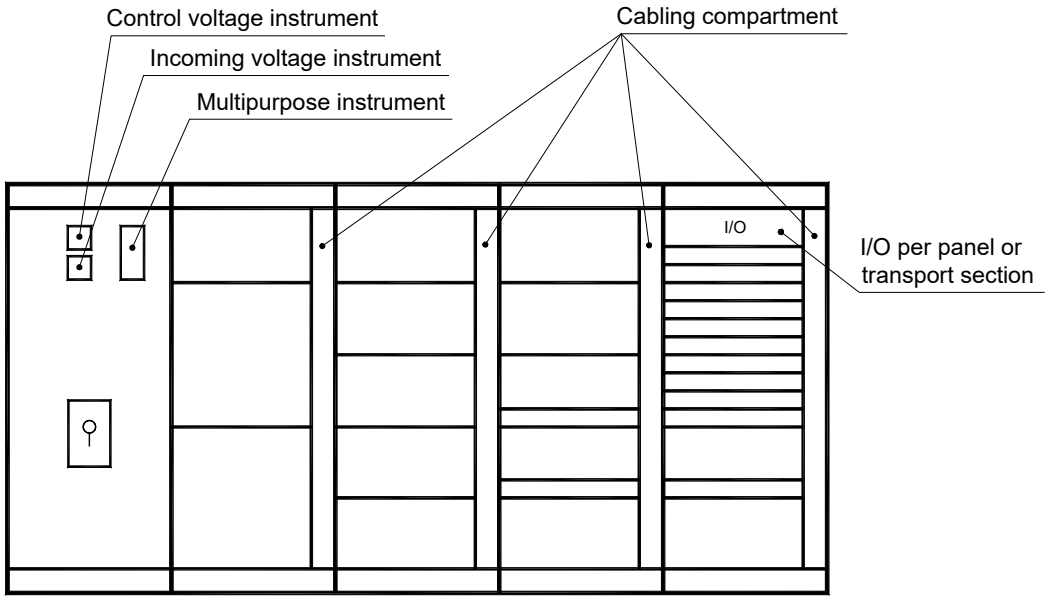
ECT 05C-E30 401 D

Typical Individual Process MCC



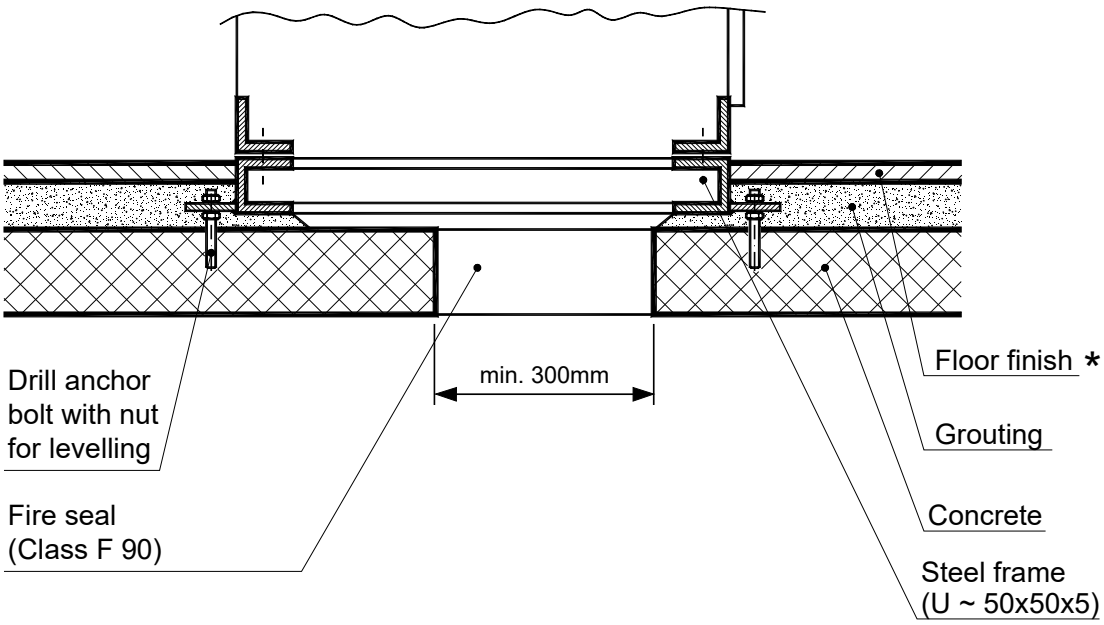
Incoming
on-load isolator
with trip coil
for panic stop
function

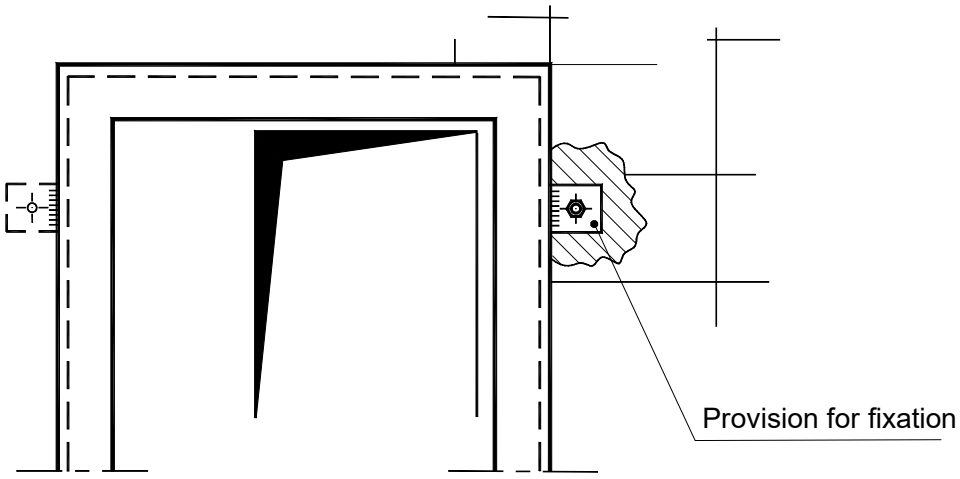
MCC modules



ECT 05C-E30 402 B

Mounting Frame for Electrical Panels and Floor Details

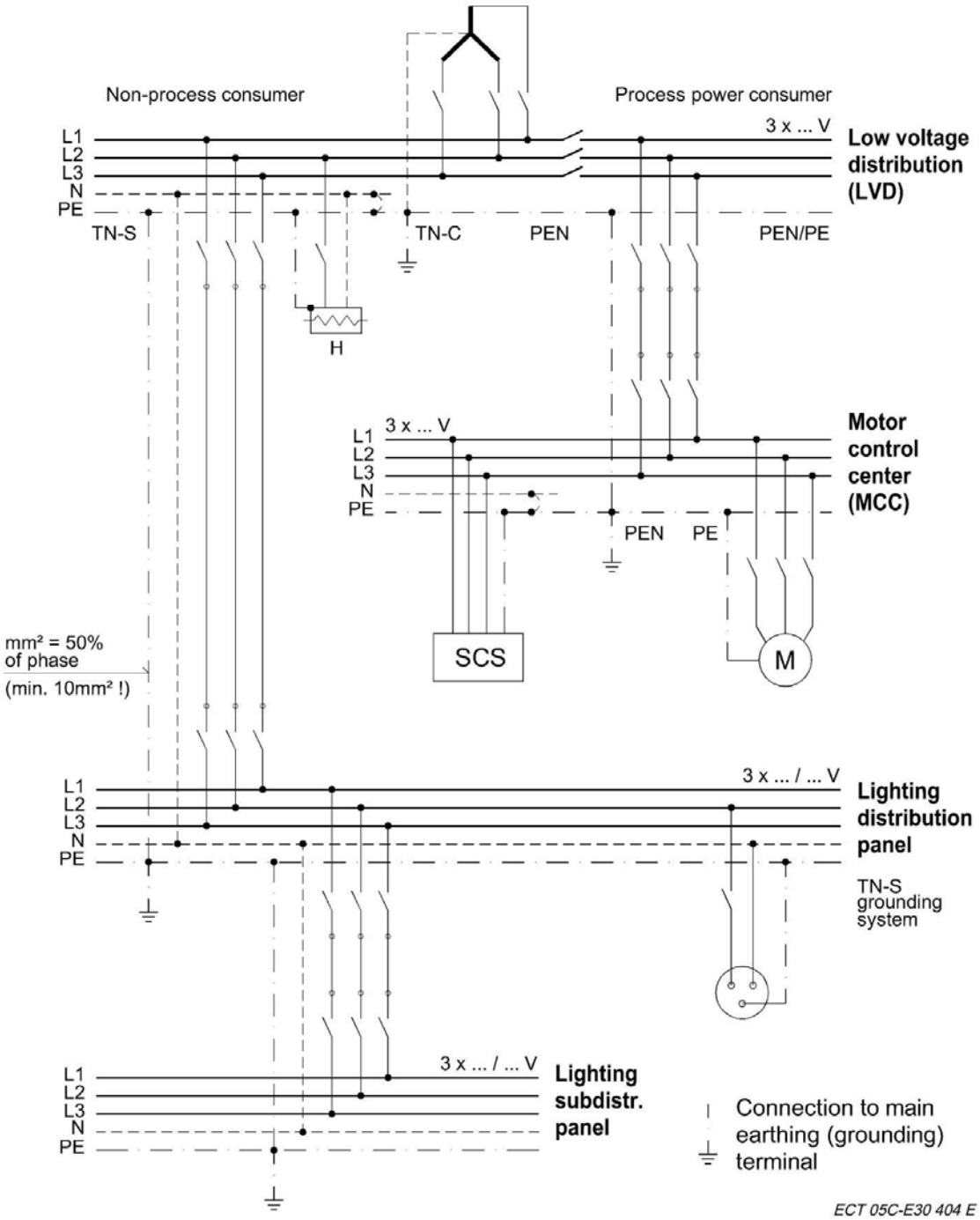


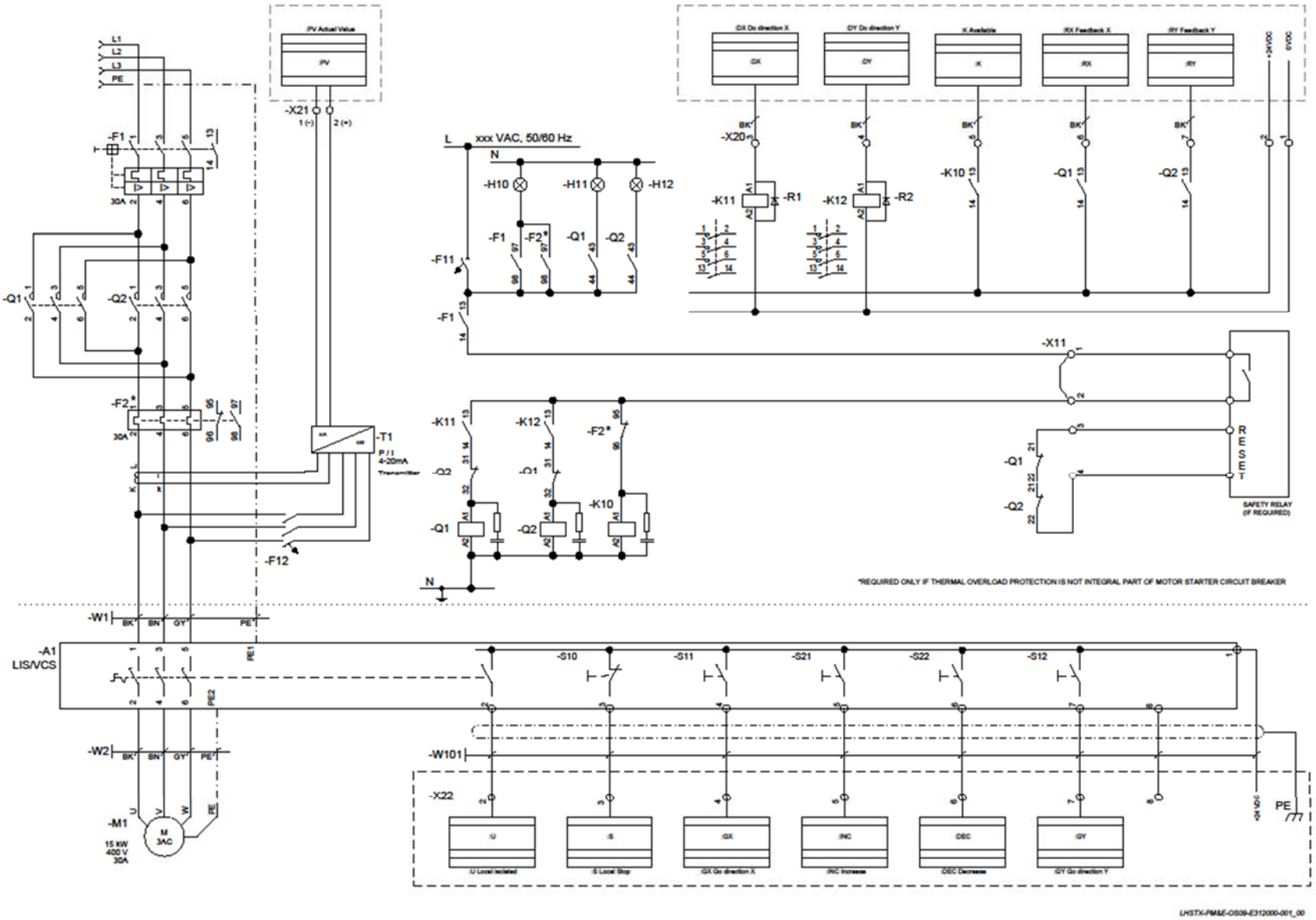


* – For low voltage switchgear rooms high grade quality floor grouting with abrasion
– resistant floor painting is also acceptable

ECT 05C-E30 403 A

Protection and Neutral Grounding Concept of LVD and MCC




L1
L2
L3
PE
-F1
30A
-Q1
-Q2
-F2*
-F12
-X21
1 (-)
2 (+)
-T1
P / I
4-20mA
-W1
BK
BN
GY
PE
-A1
LIS/VCS
PE1
PE2
-W2
-M1
15 kW
400 V
30A
L
xxx VAC, 50/60 Hz
N
-H10
-H11
-H12
-F11
-K11
-K12
-K10
-R1
-R2
-X20
-Q1
-Q2
-X11
SAFETY RELAY
(IF REQUIRED)
*REQUIRED ONLY IF THERMAL OVERLOAD PROTECTION IS NOT INTEGRAL PART OF MOTOR STARTER CIRCUIT BREAKER
-S10
-S11
-S21
-S22
-S12
-W101
-X22
PE
LHSTX-PM&E-OS09-E312000-001_00

4. GROUP E40: LIGHTING AND POWER SOCKETS

4.1 General Requirements

a) Lighting distribution boards (LDB) shall be fed either directly from the non-process section of the LVD or from dedicated lighting transformers connected to the non-process part of the LVD or connected to the MV switchgear.

b) Luminaires installed in the Plant shall be of the long-rated life, high efficiency and low maintenance type, preferably LED.

c) Luminaires shall facilitate easy access and maintenance, whether installed for indoor lighting or outdoor lighting.

d) All luminaires and power socket centers shall be impact-resistant, corrosion protected and of minimum IP 55.

e) Mobile Equipment such as stacker, reclaimer, and crusher shall be equipped with their own on-board lighting system fed from the machine distribution system.

f) Separate LDB shall be foreseen for at least each main cost center.

g) The installation shall be executed as a TN-S system in accordance with IEC 60364, whereby the single-phase voltage is defined as phase to neutral voltage.

h) Single-phase consumers shall be distributed equally on the 3 phases in order to establish a balanced transformer load and to minimize the stroboscopic effect of lighting.

i) Plug socket centers and lighting shall not be combined together in common circuits.

j) Equipment for the lighting and electrical socket circuits shall be earthed by the earthing conductor.

4.2 Lighting Levels

The lighting levels in the various areas shall be the following:

Offices:

• Offices, canteen, conference rooms	250 Lx
• Staircases, hallways	120 Lx

Control rooms:

• CCR (dimmable)	250 Lx
• Computer room	250 Lx

Plant:

• Production areas (crushing, grinding, burning, packing)	120Lx
• Platforms, stairways, main walkways	60Lx
• Conveyor walkways	20Lx

Workshops:

- Mechanical workshops 250 Lx
- Electrical workshop 250 Lx
- Instrumentation and electronic workshop 500 Lx
- Stores 120 Lx

Electrical rooms & installations:

- Electrical rooms, switchgear rooms 250 Lx
- Cable basements, cable tunnels and galleries 30 Lx

Outdoor locations:

- Main roadways and areas 20 Lx
- Store yards 60 Lx
- Gasoline station 60 Lx
- Loading and unloading ramps 60 Lx
- Air traffic warning lights Applicable Law and Applicable Codes and Standards
- Public roads Applicable Law and Applicable Codes and Standards

4.3 Safety Lighting System

a) Safety lighting systems shall be used for lighting of escape routes and be designed for safe evacuation from process areas, buildings and rooms.

b) Illuminated evacuation signs shall be provided for all escape routes.

c) Luminaires shall be of battery-buffered type.

4.4 Emergency Lighting

a) The following facilities shall be subject to emergency lighting: administration buildings, workshops, control rooms, electrical rooms, cable tunnels, and aircraft warning.

b) For remaining areas, approximately 33% of the total number of installed luminaires shall be subject to emergency lighting.

4.5 Indoor Lighting

a) Daylight type, high efficiency lamps shall be used throughout the Plant.

b) Lighting tubes inside fluorescent fixtures shall be secured in order not to fall down.

c) Lighting switches shall be arranged beside each room entry, door and floor access as well as on all floor levels of staircases.

d) Lighting switch circuits shall be operated through pulse relay control.

4.6 Outdoor Lighting

a) For outdoor Plant areas high efficiency lamps shall be used.

b) Wherever possible, lighting fixtures serving street lighting and lighting of places shall be fixed to nearby building structures.

c) Flood lighting shall be foreseen for larger areas and places.

d) Outdoor lighting shall be automatically controlled (e.g. twilight control, timer control).

e) Aircraft warning lights shall be used in accordance with applicable law and applicable codes and standards.

4.7 Traffic lights

a) Traffic lights shall be LED-based.

b) The visibility of the traffic lights shall be guaranteed even in a dusty environment.

4.8 Power Socket Centers, Socket Outlets

a) Each plug socket center and circuits of power sockets shall be equipped with residual current devices (earth leakage current protection) of maximum 30mA.

b) Socket outlets as per local standards shall be provided beside each room door.

c) Further distribution of socket outlets shall suit the room size.

d) Power socket centers shall be of industrial type, installed at each floor of every production building.

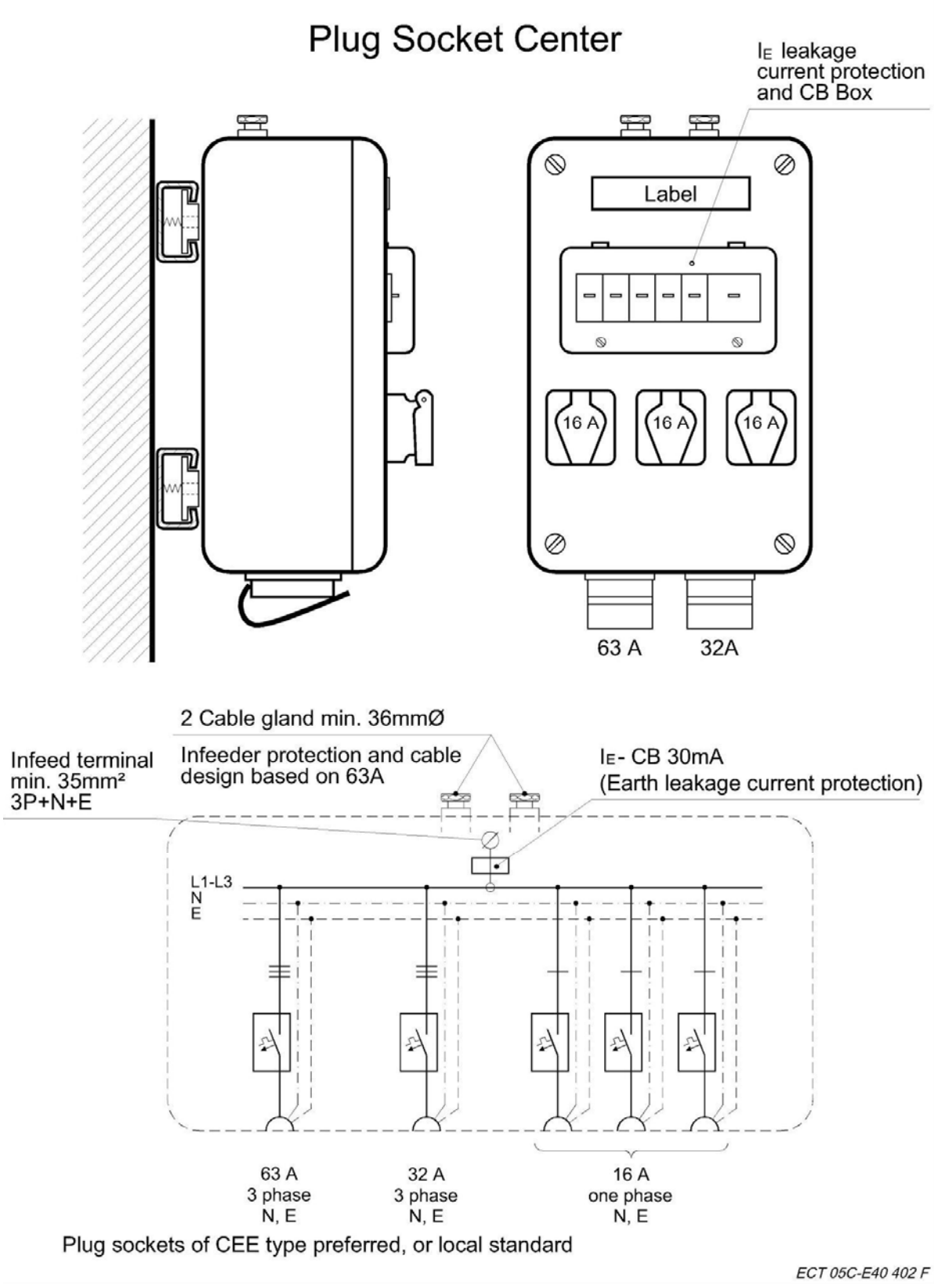
e) A maximum of 3 power socket centers shall be connected in parallel (looped).

f) A maximum cable length of 30 m of mobile tools shall determine the required number of power socket centers.

g) Heavy duty power socket centers shall be provided for welding machines and belt-vulcanizing Equipment.

4.9 Typical Drawings, Group E40

The typical plug socket center schematic below shall serve as a guideline for the conceptual design, arrangement and installation of the electrical Equipment.


Plug Socket Center
IE leakage current protection and CB Box
Label
16 A
16 A
16 A
63 A
32A
2 Cable gland min. 36mmØ
Infeed terminal min. 35mm²
3P+N+E
Infeeder protection and cable design based on 63A
IE- CB 30mA
(Earth leakage current protection)
L1-L3
N
E
63 A
3 phase
N, E
32 A
3 phase
N, E
16 A
one phase
N, E
Plug sockets of CEE type preferred, or local standard
ECT 05C-E40 402 F

5. GROUP E50: PLANT AUTOMATION AND SUB-CONTROL SYSTEM

5.1 General Requirements

a) The process control system (PCS) shall be based on a HOLCIM qualified PCS standard.

b) The PCS shall be designed taking into account the latest version of the following guidelines:

- PCS Programming Guidelines
- HMI Screen Design Guidelines
- Platform Architecture Guide (according to the selected PCS standard)
- Functional Description Guidelines
- Interlocking Guideline
- IS_S14 Cement Plant IT OT Security Group Standard
- PCS tag list required for TIS application
- Technical Information System (TIS) - Communication Watchdog
- TIS OPC Interface (according to PCS standard in corresponding region)

c) Separation of the cement process into independent departments shall be reflected in the design and layout of the PCS.

d) The HAC shall be used to identify all Equipment, materials, associated signals and application software.

e) The PCS shall comprise all necessary hardware and software for controlling the process and for interfacing with High Level Control (HLC) systems and the Technical Information System (TIS).

f) The PCS shall include all Equipment required for safe, local, remote, manual and automatic operation of the process-, pre-process- and of the relevant auxiliary-departments.

g) A high degree of automation shall be achieved to allow operation of the Plant with a minimum of operator interaction.
Typical automation functions are listed below, but are not limited to:

- Automatic filling and refilling of feed bins
- Automatic material routing based on selected source and destination
- Default set points setting based on recipes
- Start and stop of Equipment via control groups with a limited amount of groups
- Continues process control functions shall be realized by control loops
- Operation of stacker/ reclaimer shall be fully automatic, if applicable
- Heat up and cooling down phases shall be fully automatic

5.1.1 Loading and Spare Capacity

a) PS (controller) CPU loading < 50%.

b) PS (controller) memory utilization factor < 60% (for future expansion only, disregarding memory required for on-line changes).

c) OS (server) nominal CPU loading < 50%.

d) Operator station memory utilization factor < 60%.

e) Maximum number of tags on HMI servers < 75% of manufacturers design rule.

f) I/O utilization (discrete, analog and Plant fieldbus nodes) per process station < 75% of maximum I/O module connections.

g) Spare space for I/O in each field I/O box > 20%.

h) Spare equipped I/O points provided for each module type in each process department: 10%.

i) Spare number of fibers in fiber optic cables > 15%, min 4 spare fibers (2 pairs).

j) Maximum number of PS, OS clients, OS server and other nodes on the network shall be < 75% of manufacturers design rule.

k) After commissioning, the PCS shall have current alarms <20 and alarms/day <200.

5.1.2 Response Times

The PCS shall be configured with the following response times:

a) The time for an input event (I/O), such as a transition in motor state or a change in pressure, to be reflected on the operator station display shall take no longer than 1 second.

b) Operator station (OS) static display call-up time shall take a maximum of 1 second.

c) Updating of all dynamic values on an operator station display (approx. 200 values/display) shall take no longer than 2 seconds.

d) Real time trend call up with all traces updated shall take no longer than 5 seconds.

e) Process station (PS) controller cycle time shall be < 100 ms for time critical applications, e.g. stop on position switch, local start/ stop, pulse counters.

f) PS scanning time for a discrete signal shall be < 100 ms.

g) PS scanning time for an analog signal shall be < 250 ms for time-critical values (e.g. pressures).

h) PS scanning time for an analog signal shall be < 2500 ms for non-critical values such as temperatures, levels.

5.1.3 Redundancy

Redundancy shall be used in the following areas:

- Human Machine Interface (HMI) and servers (e.g. OS, domain controller)
- Plant control bus if processors are not located in server room
- Plant field bus(I/O communication) outside buildings (ring type)

5.1.4 Online Change Capabilities

Online change (without shutdown of production process) shall be possible for the following features:

- Change of parameters (time, loop, limits etc.)
- Change of PS program (respecting certain documented rules)
- Change of message text
- Change of pictures (graphics) and its animation

5.2 I/O Devices

a) Input and output (I/O) devices shall be installed decentralized in the different areas.

b) The different types of I/O modules shall be standardized to a maximum of 2 different types of DI, 3 different types of DO, 1 type of AI and AO (4-20mA), 1 type of PT100, 1 type of thermocouple input.

5.2.1 I/O-Panels and Field I/O-Boxes:

a) All required components shall be mounted in field I/O boxes (FIOB) or I/O panels of standardized modular design and size.

b) Both shall be fed from UPS (refer to Chapter 3.6).

c) FIOB shall be totally enclosed (IP 55) with additional internal heating/cooling as required for the specific application.

d) Field signals shall be directly wired (2 wire concept) through a wire guide with one labelled position per signal or by using junction boxes with standardized trunk cables.

e) Field signals shall be connected by cage clamp terminals using one terminal per wire.

5.3 Communication Networks

5.3.1 General requirements

a) Fiber optical communication networks shall be installed between buildings and to field I/O boxes and process control systems installed outside of buildings for transport systems, stacker/reclaimers, etc.

b) These networks shall be redundant by using a ring structure with different cableways.

c) The minimum bundle running between electrical rooms/control rooms shall be twenty four pairs (48-fibers) with fiber break-out panels of minimum protection type IP55 provided at each end.

d) All communications that contain control commands shall be supervised by a bi-directional watchdog.

e) The communication networks for the PCS (plant automation bus, plant control bus and plant fieldbus) shall be strictly separated from the office network.

f) Internet and email access from the PCS automation zone is prohibited.

g) The PCS communication networks should consist of separate dedicated network infrastructure (switches, fiber optics etc.) and be managed as a separate LAN/VLAN using appropriate security measures with a firewall connection to the office network.

h) To enable remote support and diagnostics for systems in the plant-automation-bus, VPN access will be provided.

- The login will be done via VPN on the office network, which will be linked by use of a firewall to the plant-automation-bus.

i) All fibers of all fiber optical cables shall be measured for dB losses at the appropriate frequency.

j) A network measuring protocol/certification shall be issued before production starts.

5.3.2 Network Components

a) The type of network switches shall be as recommended by the PCS supplier.

b) “Hardened” and “managed” industrial network switches shall be considered when Ethernet is used as a plant fieldbus system.

c) All network components shall be fed from UPS.

5.3.3 Industrial IT solutions and cyber security

a) The communication network shall be designed respecting the local IT and OT guidelines.

b) Industrial IT Solutions shall be considered to protect the PCS from the risk of industrial cyber security threats and vulnerabilities.

5.4 Process Stations

5.4.1 General requirements

a) Process Stations (PS) shall be arranged per department, allowing independent control and supervision of each distinct department.

b) Small departments can be controlled by a common PS.

c) Each PS shall handle the following tasks:

- Motor local and sequence control and interlocking
- Machine protection and supervision
- Analog value processing and supervision
- Closed loop control
- Logging and conditioning of production data
- Establishment of first alarm and message information
- Handling of control commands from operator stations
- Data exchange to the servers
- Signal and data exchange to field sensors, actuators, MCCs, VSDs, SCS, drive systems, subsystems, other PS, etc. through distributed I/O or Plant fieldbus

5.4.2 Hardware

a) The hardware shall be as defined by the PAG for the selected PCS supplier.

b) The PS controller shall be located in the server room close to the central control room (CCR) within the same building.

5.4.3 Software

a) The software shall be structured as follows:

- System software
- Standard software
- Application software (based on functional description)

b) The system and standard software shall be the same on all PS.

5.4.3.1 Standard Software

a) The application software shall be structured as defined by the Holcim standard for the selected PCS supplier:

   a) Department Control
   A department is typically controlled by several control groups (see below).
   To ensure a high level of automation a master group shall be defined which starts/stops several underlying control groups of the respective department.

   b) Group Control

b) From the operator station it shall be possible to perform for each individual group the following standardized control functions:

- Start
- Normal stop
- Immediate stop
- Local mode
- Single start (password protected, for commissioning purpose only)

c) Start-up warning shall be initiated before starting any type of machine from CCR and on a case-by-case basis in Local mode. For sporadic starting, the start-up warning must be initiated by the sequence and a local warning label must be installed.

5.5 Operator Stations

5.5.1 General requirements

a) The PC-based Operator Stations (OS) shall provide high-performance human-machine communication with the process.

b) The control shall be performed with an arrangement of minimum 2-monitors where each mouse (keyboard) is dedicated to one or two departments.

c) Any allocation of the monitors to any department or section thereof shall be possible.

d) The displays on the monitor shall show the overview of the departments and direct command of the most current operator action shall be possible.

e) All main operator commands shall be possible with the mouse only.

f) The mouse (keyboard) Equipment and the displays shall be arranged to allow the operator an easy control from a sitting or a standing position.

g) The PCs and servers shall be installed in the computer room.

h) The panel shall be dust-tight (IP 65/NEMA12) with an air-to-air heat exchanger to allow independent operation also during maintenance of the computer room.

i) A KVM (Keyboard-Video-Mouse extender) switching unit shall allow access to all servers/PCs from one station (engineering station) in the computer room.

j) Redundant servers shall be used for data storage of the configuration and for intermediate storage of process data.

k) All data of process values and of all events shall be stored and be available on-line on the operator station for at least 4 weeks.

l) Hardware and software shall generally be of same type and make as the OS but with additional hardware and software to cope with the specific requirements regarding data security and redundancy.

m) Communication to OS and PS shall be with standard Ethernet TCP/IP.

5.5.2 Operator Station Input Device

a) Standard PC input devices (optical mouse or trackball, PC-keyboard) shall be used.

b) All operator commands shall be performed as directly as possible, generally not using more than two hierarchical levels (e.g. first: display selection, second: operator command).

5.5.3 User rights/security levels

a) Parameter adjustments (engineer level) such as setting of alarm limits, PID loop setting, etc., shall be clearly separated from the normal operator commands.

b) At least 4 levels shall be implemented: view only, operator, supervisor, and administrator.

5.5.4 Process screens

a) Screens are representations of the Plant Equipment and are the operator's primary means for controlling and monitoring the entire process.

b) The following standard colors shall be used to indicate the functional status of the Equipment:

RGB	COLOR	Standard HMI (sHMI)	Situational Awareness HMI (aHMI)
192R 192G 192B	Light Grey (25%)	Mimic Background	Running / Material Flow
230R 230G 230B	Light Grey (10%)	Measurement / Background Standing - Ready	Mimic Background
	Arial Black	Actual Values	* Actual Values & Measurement background
000R 000G 000B	Black	Symbol Outline / Material Flow	
000R 255G 000B	Bright Green	Running	
255R 000G 000B **	Red	Alarm Failure	
255R 153G 000B	Light Orange	Diagnostic (override)	
255R 255G 000B	Yellow	Alarm Warning	
128R 000G 128B	Purple	Not Ready	
000R 000G 255B	Blue	Selection / Command / Selected	
255R 255G 255B	White	Local	
153R 051G 000B	Brown	Bar Graphs (where applicable)	
164R 255G 142B	Light Green	Intermediate position (Dampers)	Running

*** Numbers in Bold**

**** Light red can be used for the same purpose as the standard 255R 000G 000B in order to differentiate between source, protagonist or indicator**

- These standard colors shall be applied on all different displays and for all plant departments. They shall not be used for any application other than for the one specified above. On mimics these colors shall be used as background. To avoid confusion with red, the Diagnostic (override) function shall be applied as a frame or in another special shape or pattern on the corresponding sensor/drive/measurement. Text and numbers to be Arial Bold either black or white. Other colors than black/white for text or numbers shall be avoided. Blinking of symbols or text shall not be allowed. Blinking of colors shall generally be avoided and only be allowed for those applications, which ask for high priority operator attention as e.g. acknowledgement of a failure alarm or restart of a sequence.
- Background color on printouts shall be white.

c) The screen arrangement, mainly the navigation and operation on standard screen areas, shall be used as defined by the HOLCIM standard.

5.5.5 Message Screen and Alarm Handling

5.5.5.1 List of Alarms

The following alarms shall be individually monitored (per machine or drive), interlocked as required to avoid nuisance alarms, and displayed in clear text:

a) Non-availability of individual motor feeder circuits (including supervision of fuses, main power- and control power circuit breakers, and/or by supervision of control voltage).

b) Contactor fails to open or fails to close (contactor failure).

c) Thermal protection (Overload).

d) "STOP" or "OFF" position of the local switch (local stop).

e) Safety switch (e.g. disconnect switch, pull-cord etc.).

f) Machine Protection/Process Alarms (speed, flow, pressure, vibration, torque, temperature, level, position, etc.).

g) Selected Plant auxiliaries and system failures and warnings.

5.5.5.2 Alarms Management

a) For all analog signals and, where available, for binary (ON/OFF) signals, pre-alarms (warnings) shall be included.

b) Sensors for critical applications (e.g. the kiln department) shall be interlocked and supervised with time delay to avoid immediate stop of production in case of minor sensor problems (e.g. maintenance on the temperature sensor).

c) Travel time for actuators/dampers shall be supervised and alarmed accordingly.

d) Hysteresis shall be included for the analog signal limit of the control modules.

e) Rate of change alarms and other types of alarms of pre-processed calculated signals shall be used as required for the special application.

f) First alarm is required. All subsequent alarms shall be suppressed by the interlocking system. As necessary, alarms shall be supervised with time delay (e.g. flow, etc.) in order to avoid false alarms.

g) Alarm messages shall not be activated during a stop of the group or stop of the specific motor unless a predefined specific process condition requires alarming (e.g. high temperature in a coal bin shall always be alarmed, rope switch shall not be alarmed when the group is standing).

5.5.5.3 Alarms Acknowledgement

a) Alarm acknowledgement shall be synchronized (i.e. when an operator acknowledges an alarm on one operator station, all other operator stations show that the alarm is acknowledged).

b) Alarms shall be viewed, silenced and acknowledged from any operator station.

c) Acknowledgement of the alarm also silences the alarm gong.

d) Silencing of the gong can be performed independently.

e) All alarms that occur shall be sent to a current alarm display page and once acknowledged, deleted from the current alarm display if the condition has returned to normal.

f) All messages (alarms, status and OK) that occur shall be sent to an event summary page.

5.5.5.4 Type of Messages

The following table gives an overview of the message handling and naming conventions:

<table>
<tr><td rowspan="2"></td><td colspan="4">Messages and representation on the HMI screen</td></tr>
<tr><td colspan="2">Alarm: Current Alarm Display</td><td rowspan="2">@ (3) DIAGNOSTIC (light orange)</td><td rowspan="2">$ (4) STATUS (grey, green, white)</td></tr>
<tr><td>Group in Operation (starting, running, stopping)</td><td>! (1) FAILURE (red)</td><td># (2) WARNING (yellow)</td></tr>
<tr><td>Group not in Operation (standing), not pre-selected</td><td colspan="3">Not Ready - No Message (violet)</td></tr>
<tr><td></td><td>Faulty status of failure sensor or of failure drive

Max or min process limit

Value out of range after time delay</td><td>Faulty status of warning sensor or of warning drive

High or low process limit

Value out of range</td><td>Override sensor or measurement (System password protected)</td><td>Operator commands and system/process status</td></tr>
</table>

a) All messages shall be stored in the PCS for a minimum of 2 weeks.

b) All messages shall be transmitted to TIS.

5.5.5.5 Alarm Messages

Two types of alarm messages shall be presented, "FAILURE" alarms and "WARNING" alarms:

- **"FAILURE"**
  FAILURE alarms result from the faulty status of a device or a process condition causing a stoppage in the transport or production process associated with that particular group. FAILURE alarms are indicated by the "FAILURE-Gong" (hard sound) to alert the operator and are indicated in red if the group was active at the time of failure. Otherwise the failure will be indicated in violet and shall not create a message entry in the alarm list.
- **"WARNING"**
  WARNING alarms result from the faulty status of a device detected by a sensor or an upset process condition, which does not immediately cause a stoppage in the production line, but upon which action should be taken to correct the fault. WARNING-alarms are indicated by the "WARNING-Gong" (soft sound) to alert the operator and are indicated in yellow. The "return to normal" condition shall normally be the "OK" indication of the sensor or the back-to-normal (with hysteresis) of the process condition. "Warning" alarms can also result from an entire drive (e.g. a failure in the auxiliary dedusting screw does not stop the main transport group and therefore triggers warning alarms).

5.5.5.6 Status Messages

- **"DIAGNOSTIC"**
  Diagnostic messages result from the override (bypass, software bridge) function of a device to prevent shut down of the production during sensor problems or maintenance. On the HMI screen they are indicated in light orange.
- **"STATUS"**
  This information results from operator commands. The following items shall issue a status message:
  - Group stop, group immediate stop
  - Local access permission (on/off)
  - Group start
  - Change of limits, parameters etc.
  - Selections
  - Bypassing sensors

5.5.5.7 Back to Normal Message

- **"OK"**
  Back to normal messages shall be issued for all WARNINGS, FAILURES, DIAGNOSTICS and selected STATUS messages.

5.5.5.8 Remote Alarming

a) A simple procedure shall allow the selection of each individual alarm or alarm group that shall further be transmitted remotely outside of the PCS e.g. SMS-system or cloud-based solution.

5.5.5.9 Presentation of Alarms and Status

a) Current alarms of the department shall be shown on the dedicated section of the display as long as the "alarming condition" persists.

b) Printout of the different information shall be possible through simple commands.

c) FAILURE, WARNING, DIAGNOSTIC, STATUS, OK - messages shall be marked with clearly distinguished symbols in the message lists allowing filtering and sorting.

d) The clear text message shall make use of the full line (min. 80 characters) indicating time of occurrence, type of message, signal code (detail as per HAC), Equipment description, and description of message, location, and classification. The message archive and the printout shall additionally include the date of the message, PS I/O address of the signal and other relevant data.

e) An alarm shall only describe the initial cause of an "alarming situation" and thus shall only appear when Equipment and process malfunction is detected.

5.5.5.10 Local Control Box

a) Local control boxes are activated in local mode and allow safe local operation of machines in the field.

b) All machine protections are activated and if further Equipment is required for the operation then this Equipment is being started (in a sequence) and interlocked with the machine.

c) Local control box may be used for:

- Ball mill auxiliary motor with lubrication pumps and brake
- Separator drive with lubrication/grease pumps
- Filter fans with interlock to filter and other fans
- VRM fan with the condition of running the grease pump on the separator
- Kiln auxiliary drive, brake and lubrication
- Crusher with lubrication
- Others

d) Local control boxes shall either be built with standard indicative lamps and push buttons or as an alternative they shall be based on a programmable touch panel.

5.6 Link to Technical Information System (TIS)

a) TIS is a database for technical data gathering, analysis, storage, consolidation and reporting. It combines all technical data of a cement plant, allows easy remote access and makes data available for higher reporting levels.

b) The HOLCIM qualified supplier's software and application programming procedures shall be used for this purpose.

c) To enable automatic data acquisition, TIS has a direct interface to the PCS using OPC (OLE for Process Control) and also direct interfaces to the laboratory Equipment. Other Equipment such as SCS, CEMS, energy meters, weigh bridges shall be connected directly to the PCS.

d) Three main modules are included in TIS:

- **PIMS** – Production/Process Information Management System
  - Reporting operation for every main Equipment
  - Reporting daily/weekly/monthly production
  - Reporting Energy
  - Reporting Emissions
  - Material Balancing
- **LIMS** – Laboratory Information Management System
  - Data registration of all laboratory operation
  - Reporting laboratory and quality data
  - Material Certificates
  - Sample management
- **SAP interfaces** (PP-PI, PM, SD-MM, BW)

5.7 Link to External Systems

a) External systems include but are not limited to:

- High Level Control Systems (HLC)
- Technical Information Systems (TIS)
- Laboratory automation
- Shipping/Receiving automation

b) The link to External Systems shall be performed with Object Linking and Embedding (OLE) for Process Control Data Acquisition (OPC DA) and OLE for Process Control Alarm and Events (OPC AE) as well as Historical Data Acquisition (OPC HDA).

c) The OPC server shall reside on the redundant OS server to ensure high availability.

d) The interface shall be switched together with the redundant changeover from one server to the other.

e) The link to HLC will require Data Acquisition (OPC DA) only.

f) Data transfer to HLC will include:

- Selected process values.
- Process conditions.
- Setpoints and parameters.
- Corresponding programming of closed loop control in the PS with external setpoint and setpoint validation parameters.
- The data update rate will be approximately 2 seconds.

g) Data transfer to the TIS shall include

- All analogue values (process variable).
- All messages.
- All reporting values (energy, running hours and integrated production values).
- Selected discrete status information (main group running, local, selections etc.).
- Selected ASCII strings (e.g. type of material).
- The data update rate will be approximately 60 seconds and for some selected signals 1 second.

h) Data transfer with the laboratory automation will include:

- Selected process values.
- Process conditions.
- Setpoints and parameters.
- Corresponding programming of closed loop control in the PS with external setpoint and setpoint validation parameters.
- The data update rate shall be 2 seconds.

i) Depending on the application, the data communication will normally be included in the plant-control-bus, connected via TIS gateway/firewall to the IT network.

j) Data transfer to the shipping automation shall include:
   - Alarm and status messages.
   - Reporting values (integrated production values).

k) The shipping automation will normally directly communicate with SAP.

l) All communication has to be designed in such a way that no routing via the office network is required.

5.8 Engineering System

5.8.1 Engineering Station and Documentation System

a) The engineering system and the documentation system shall be installed separately from the process control system.

b) As a minimum one industrial type mobile engineering station and one engineering-documentation system shall be included and allow the uploading and downloading of programs, the storage, editing (online) and print-outs with symbolic and explanatory programs.

c) All process control system parameters (hardware and software) shall be stored in one common database.

d) Program code shall be commented in clear text to ease the understanding of the program logic.

5.8.2 Test and Training System

a) A test system shall consist of a mobile test rack containing all elements of a departmental control system (PS, OS).

b) The test rack shall contain a minimum of one piece of each type of PS/OS system component and one or several input and output cards used for the process control system.

c) ‘’Intelligent’’ MCC module shall be considered in the mobile test rack.

5.9 Control Desks

Operator Stations (Human Machine Interface) shall be arranged on control desks located in the CCR.

5.9.1 Central Control Room Desks

a) The desks shall be designed according to ergonomic criteria and rules. The special rules applying for 24 hours workplaces shall be considered.

b) The desks shall provide enough room to accommodate the process control system displays.

c) The control desk shall also provide enough room to accommodate displays for HLC systems and the TIS.

d) The desks shall be designed to allow extensions or alterations.

5.9.2 Local Control Panels:

Local control rooms and control Equipment shall in principle comply with the requirements specified for the central control room/desks but additionally comply with the ambient local conditions.

5.10 Power Supply

a) The entire PCS including network, I/O's and signal levels shall not be affected by any disturbance of the power distribution system.

b) The entire PCS Equipment shall be fed from a UPS as specified in Chapter 3.

5.11 Sub-Control Systems

5.11.1 General requirements

a) Sub-control systems (SCS) shall be avoided. Required functions shall be realized in the PCS.

b) Electrical control systems supplied as a complete standard pre-tested system for certain Equipment shall be considered as SCS.

c) SCS may contain control Equipment for:

- Electrostatic precipitators (excluding rapping and transport system)
- Bag filters
- Furnaces
- Stackers, reclaimers
- Packing machine
- Palletizer
- Water system

d) SCS that are supplied as part of the mechanical Equipment shall be clearly defined and listed. This definition shall include Specifications of Equipment, quantity and make etc.

e) Data of all SCS shall be listed in the Sub-Control Systems List.

f) Control of such systems shall be part of the control system used for the complete Plant.

g) If SCS cannot be avoided, the standard, design, engineering and control Equipment shall comply with the data given in the StDC.

h) The hardware used for SCS shall be the same make and type as used for the PCS.

i) In order to allow easy handling of Sub-Control Systems through the process control system, they shall be equipped with a standardized interface as per the enclosed drawing.

5.11.2 Specification of Sub-Control System

a) Electrical panels of SCS shall be equipped with the same make and type of contactors, circuit breakers, indicating elements, etc. as used for the main control Equipment.

b) The color of cables, pushbuttons, indicating elements, control switches and the like shall be standardized throughout the Plant according to the function of the element.

c) SCS-panels shall be of protection class IP 65 for local installation.

d) Fuses (in lieu of circuit breakers) shall be used for special applications only.

e) Spare fuses shall be included within the main delivery.

f) The failsafe principle shall be applied to all control circuits:

- Cable breakage as well as loss of voltage shall be detected and treated as a fault.

g) The SCS shall be delivered complete (all elements wired, including testing and documentation) with all required elements and devices such as control Equipment (relays, PLC, etc.), motors, sensors, control panel, cable connectors, cables and installation material.

h) Where entirely prewired SCS are not possible, then the external mounted electrical Equipment shall be clearly indicated on a drawing:

- Such Equipment is subject to written approval.

i) The power departures shall provide the SCS with the required power and shall include the protection of the feeding cable.

j) A lockable on-load isolator (LIS) at the incoming of the SCS shall allow disconnection of all Equipment of the SCS.

k) Protection of the drives as well as the provision of the internal control voltage is part of the SCS.

l) SCS operating tolerances shall be as specified in paragraph 0 (Group E00) and shall not need any “reset” feature after a power failure.

m) Control voltage for the SCS or systems shall be fed from the UPS.

n) Interface terminals shall be installed in the SCS in defined sections as follows:

- Power supply terminals
- Control interface terminals
- Internal power terminals
- Internal control terminals

5.11.3 Definition of Input and Output Circuits

- **Signal: D**
  The "ON/OFF command" affects the SCS as a whole. Contact closure (relay energized) causes the SCS to start-up automatically with the correct sequence and carries out its service (if internal circuits are correct). Contact opening (relay not energized) causes the SCS to stop automatically in the correct sequence and terminate its service.

- **Signal: K**
  The "availability" contact affects the SCS as a whole. The information "available" shall signal to the process control the readiness of the SCS before operation. It is not dependent on whether the "run" signal is present or not.

  The following conditions shall be continuously fulfilled in order that this contact may remain closed:

  - Control voltage available.
  - No fault in the system (neither "overload", nor "emergency", nor "off"-switches, etc. shall be activated).
  - All switches "service" or "remote" shall be in the "remote"-position.
  - If any of the conditions given above is no longer fulfilled, the contact "availability" will open immediately.
- **Signal: R**
  The "run" is the feedback signal after a normal start. It means that the SCS is carrying out its service. If the "run" signal does not appear within a fixed, predefined time after starting, the relay's "ON/OFF command" (D) is de-energized by the process control.

  All the above-mentioned signals shall be included from each SCS.

  The following signals shall be included, as required by the specific control application:

- **Signal: W**
  The "warning" signal is a pre-alarm which does not (or not yet) stop the normal "run" of the SCS. The warning contact shall open as long as the warning condition prevails.
- **Signal: F**
  The "fault" signal is an alarm which causes the SCS to stop automatically. The fault contact shall remain open until the fault has been locally rectified.
- **Signal: xx.SP**
  The "setpoint(s)" will be received in the form of a 2-wire 4-20 mA signal or by a connection to the Plant fieldbus system. The signal shall be completely galvanically isolated (against ground and possible power supply) in the SCS unit.
- **Signals: xx.PV**
  The "actual values" shall be a 2-wire 4-20 mA signal or by a connection of the Plant fieldbus system. The signal shall be galvanically isolated (against ground and possible power supply).

  All signals shall be transmitted over the Plant fieldbus or with OPC through Ethernet, if more complex data transfer is required.

5.11.3.1 List of Alarms

a) The following alarms shall be individually monitored (per machine or drive), interlocked as required to avoid nuisance alarms, displayed in clear text on the local panel and transmitted over the Plant fieldbus:

   - Non-availability of individual motor feeder circuits (including supervision of fuses, main power- and control power circuit breakers, and/or by supervision of control voltage).
   - Contactor fails to open or fail to close (contactor failure).
   - Thermal protection (Overload).

- "STOP" or "OFF" position of the local switch (local stop).
- Safety switch (e.g. disconnect switch, pull-cord etc.).
- Machine Protection/Process Alarms (speed, flow, pressure, vibration, torque, temperature, level, position, etc.).
- Control system failures and warnings.

b) For all analog signals and, where available, for binary (ON/OFF) signals, pre-alarms (warnings) shall be included.

c) Sensors for critical applications (e.g. in the kiln department) shall be interlocked and supervised with time delay to avoid immediate stop of production in case of small sensor problems (e.g. maintenance on the temperature sensor).

d) Travel time for actuators/dampers shall be supervised and alarmed accordingly.

e) Hysteresis shall be included for analog signal limit control modules.

f) Rate of change alarms and other types of alarms of pre-processed calculated signals shall be used as required for the special application.

g) First alarm is required.

h) All subsequent alarms shall be suppressed by the interlocking system.

i) Alarms shall be supervised with time delay in order to suppress false alarms.

j) Alarm messages shall not be activated during a stop of the SCS or stop of the specific motor unless a predefined specific process condition requires an alarm (e.g. high temperature in a coal bin shall always be alarmed, rope switch shall not be alarmed when drive is standing).

5.11.4 Installation

a) The Contractor shall include all required cables and installation material for connections to all sensors and motors, valves etc. controlled from the SCS, as well as special feeding cables (e.g. heavy duty trailing cables for stackers and reclaimers).

b) All cables shall be dimensioned according to the load of the connected Equipment and the short circuit conditions of the Plant network.

c) The current carrying capacity of the cables shall be in full compliance with standards and in consideration of de-rating factors for ambient temperature, laying method and cooling conditions.

5.12 List of Engineering Units

A list of engineering unit abbreviations that shall be used on graphic displays, process controllers and within alarm texts is given in the following table:

Speed (rpm) shall indicate the speed of the driven machine.

Variable:	Description of Use:	Unit Description:	Abbreviation:
CO	gas composition	Milligram per cubic meter CO	mg/m^3 CO
CO	gas composition	Milligram per Normal cubic meter CO	mg/Nm^3 CO
CO	gas composition	percentage CO	% CO
Displacement	kiln, press, VRM	millimeter	mm
Energy	motors & electrical consumers	kilowatt-hours	kWh
Specific energy rate	efficiency of operation	kilowatt-hours per ton	kWh/t
Flow	process gases	cubic meter per hour	m^3/h
Flow	materials	Metric ton per hour	t/h
Flow	oil, water, etc.	cubic meter, liter per hour	m^3/h; l/h
Level	silos, bins, etc.	percentage full	%
Mass	materials	Metric ton (1000 kg)	t
Noise	ball mill loading	noise	%
Nitrous Oxide	gas composition	Milligram per cubic meter NO	mg/m^3 NO
Nitrous Oxide	gas composition	Milligram per Normal cubic meter NO	mg/Nm^3 NO
Oxygen	gas composition	percentage O_2	% O_2
Position	dampers, gates, valves	percentage open	%
Power	motors & consumers	kilowatts	kW
Electric power	power distribution	volt, amp, cosphi, total harmonic distortion current, -voltage	V, A, cosφ, THDI, THDU
Pressure	hydraulic, air, water, etc.	millibar, bar, Pascal, kilopascal, Mega Pascal	mbar, bar, Pa, kPa, MPa
Speed	fan & feeder drives	Revolution per minute	rpm
Speed	cooler drives	strokes per minute	spm
Temperature	general	degree Celsius	°C
Time	time of operation	hours (seconds, minutes)	h (s, min)
Torque	fans, mills etc.	Newton meter	Nm
Vibration	fans, mills, etc.	millimeter per second	mm/s
Weight	silos, bins, etc.	Metric ton (1000 kg)	t

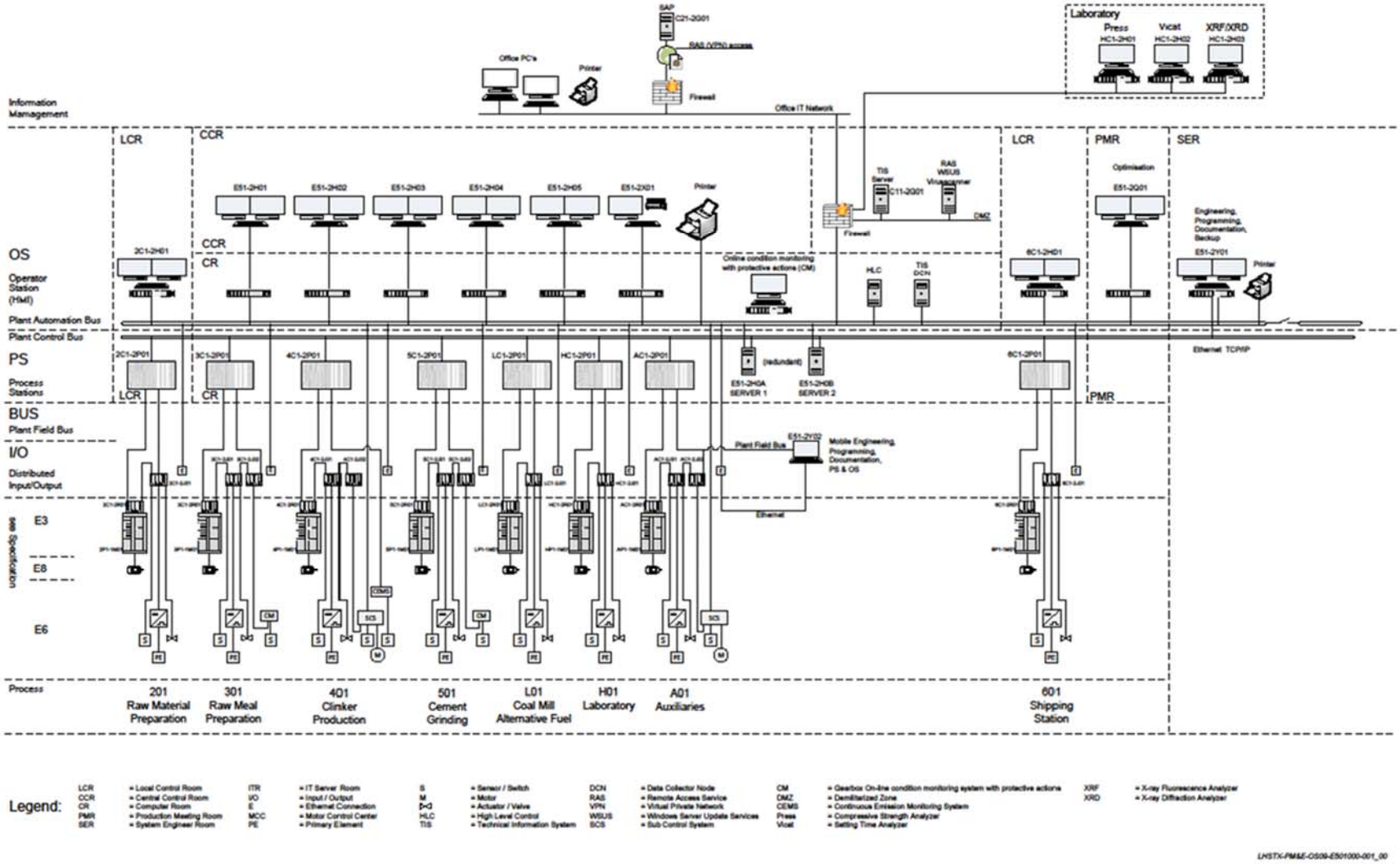
5.13 Typical Drawings, Group E50

The typical

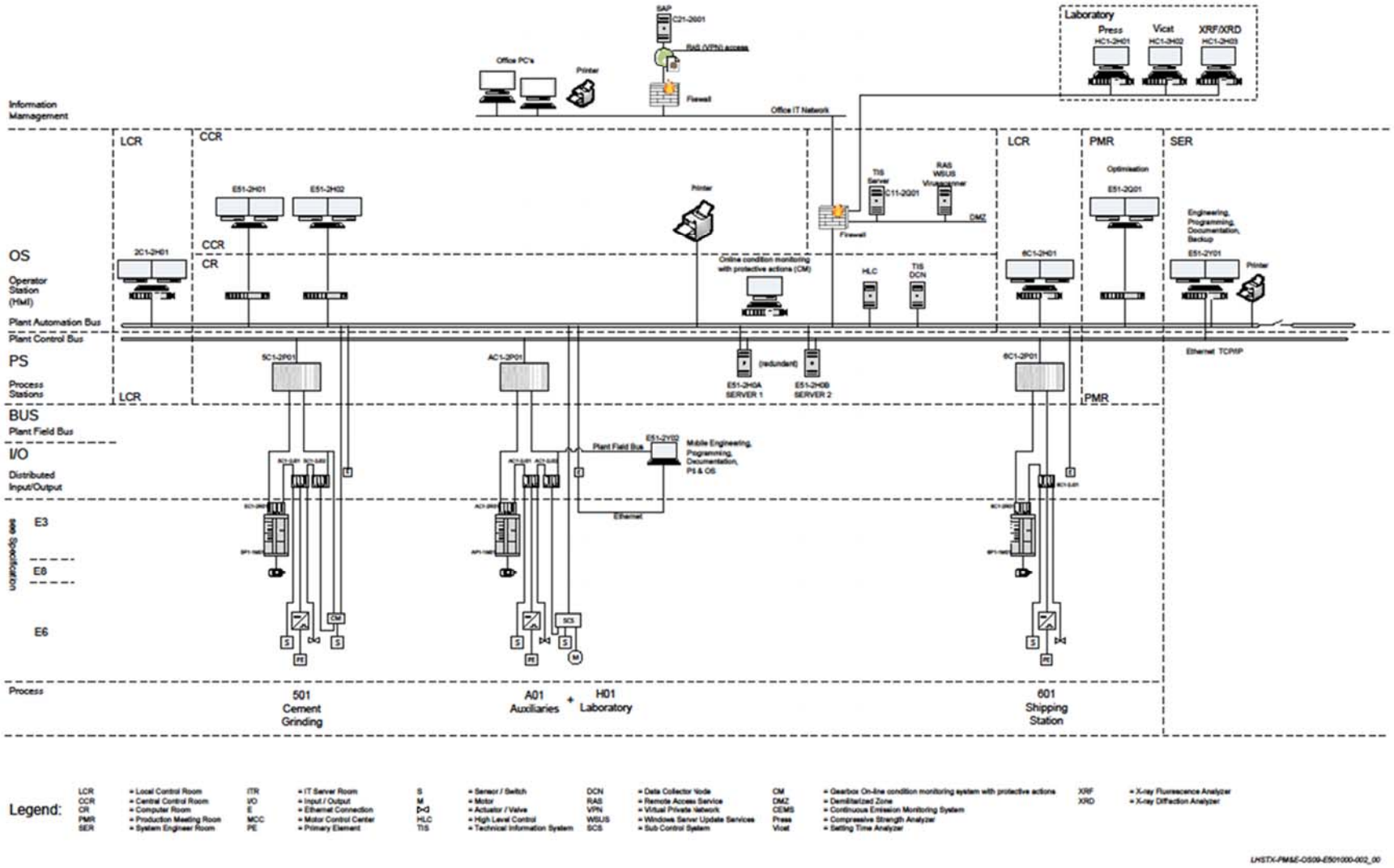
- Process control system layout
- Process control system layout for a grinding station
- Sub control system (SCS) standard interface to the process control system

below shall serve as a guideline for the conceptual design, arrangement and installation of the electrical Equipment.

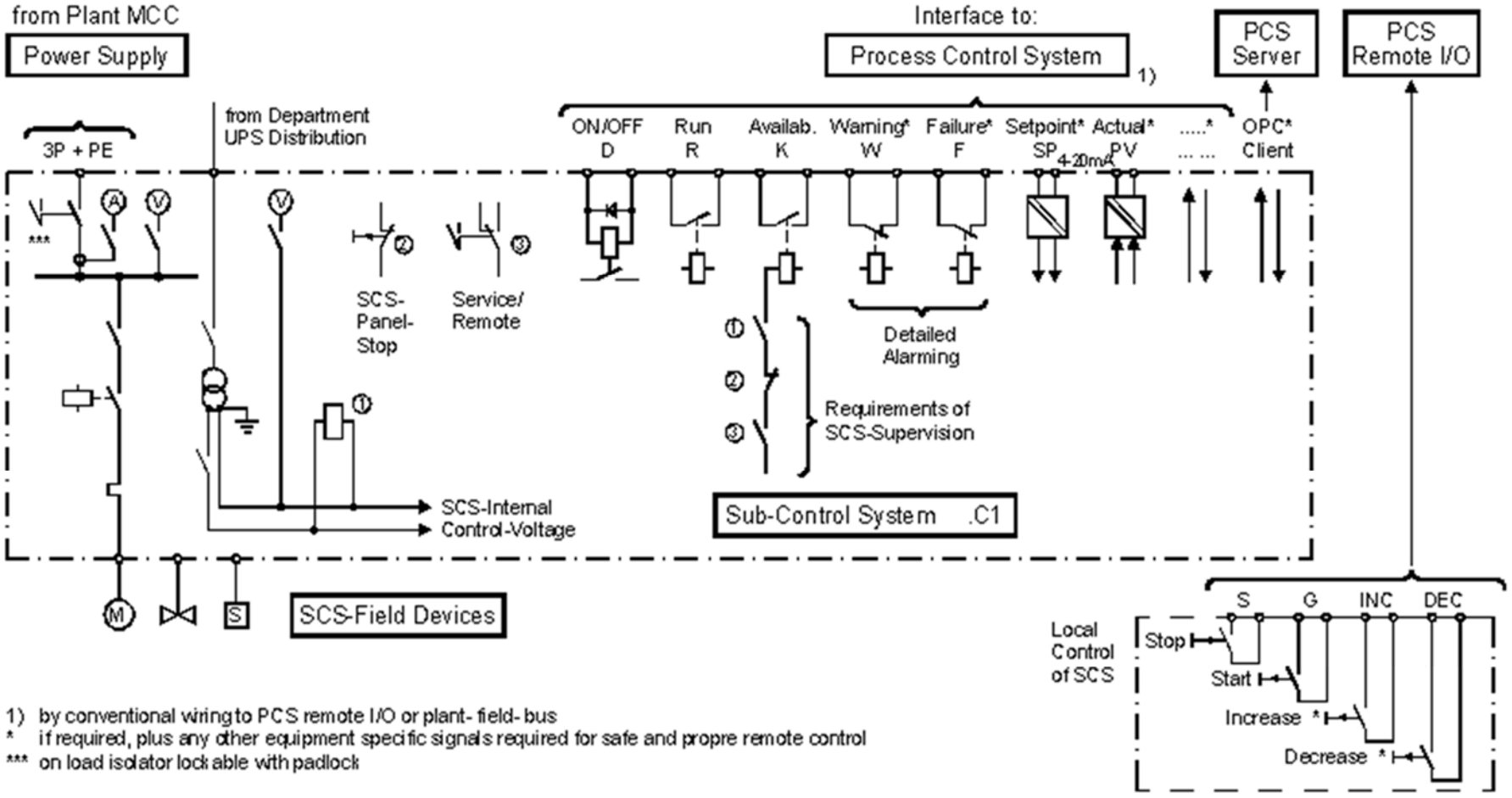
E5: Process Control System Typical Layout



E5: Process Control System Typical Layout, Grinding Station



Sub Control System (SCS)
Standard Interface to Process Control System (PCS)



1) by conventional wiring to PCS remote I/O or plant- field- bus
* if required, plus any other equipment specific signals required for safe and propre remote control
*** on load isolator lockable with padlock

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6. GROUP E60: INSTRUMENTATION & CONTROL DEVICES

6.1 General Requirements

a) The requirements shall apply to the instrumentation required to safely operate and properly monitor the process and easily maintain the Plant.

b) All instruments and sensors shall be listed in the “Instrumentation - Sensor List”.

c) Make and type of instrumentation shall be standardized throughout the Plant.

d) For the application of the different types of instrumentation, refer also to the requirements stated in the Standard Design Criteria for Mechanical Equipment.

Instrumentation shall be in line with the following:

e) Dust and waterproof, conforming to IP 65.

f) Intrinsically safe (Ex “i”) design or other explosion-proof design as required by relevant codes and standards, if installed in hazardous (classified) areas.

g) Corrosion resistant where required, conforming to IP 66.

h) Housing made of metal.

i) Protected against radio interference.

j) Heating and cooling shall be used as required according to local climatic conditions.

k) Resistance against vibration (contact pressure).

l) Suitable for the specified project ambient temperature range and the special conditions of the individual application (sunshine, heat radiation etc.).

m) Easy access for calibration and maintenance.

n) Contacts:

- 0.01 - 0.5A at 24VDC (rated current)
- Potential free
- Wiping action (self-cleaning)
- Encapsulated contacts

o) Electronics:

- Short circuit proof
- Protected against inductive voltage peaks (surges)
- Maximum inverse voltage and overvoltage protection

p) Binary Sensors (measuring instrument with binary output signal):

Binary sensors shall be designed as failsafe (broken cable shall be considered as failure).

q) Analog Sensors (measuring instrument with analog output signal):

2-wire transmitters with 4-20mA standard signals shall be used for the signal transmission from the analog instruments to the I/O system.

Signal transmitters shall guarantee the following properties:

- Fully galvanically isolated against the power supply, primary sensor element and earth.
- Linearity and repeatability within the required limits for process instruments.
- Suitable for Industrial use.

r) Connections:

- Spring type terminals shall be used.
- If a specific sensor is only available with cable lead, then an intermediate connection box shall be installed.

s) Mounting:

- Mounting shall be on the C-profile.
- Mechanical and heat/radiation protection shall be included.
- All field control devices shall be labeled with HAC code.
- Shall be adequately protected from radiation from the sun and from hot parts.

6.2 Field Devices for Personal Safety

6.2.1 Rope Switches (Emergency Pull Cord)

a) The rope switches shall be of heavy-duty type with a manual reset and an indication of the tripped position.

b) Rope switches shall make use of safety relays or safety compliant communication interfaces.

c) The rope shall consist of a flexible steel cable with plastic cable sheath and connect spring loaded to a rope switch.

d) The length of a rope shall not exceed the manufacturers' specification.

e) Each rope switch shall be individually signaled to the PCS.

6.2.2 Local On-Load Isolator Switches (LIS)/Visible Cut-off Switches (VCS)

a) LIS/VCS shall be foreseen to locally isolate LV motors and sub-control systems from the main power source.

b) LIS/VCS shall be foreseen for all motors with rated current up to 630A.

- This requirement may be waived for LV motors in sub-control systems, where a single point of isolation for incoming power is provided in close proximity to the LV motors or other concepts of safe power isolation are in place.

c) The installation of the LIS/VCS shall be such as to allow a clear relation between the motor/machine and the LIS/VCS.

d) LIS/VCS shall be designed with the possibility of connecting up to 3 padlocks in the off-position.

e) Maximum 8 different types of LIS/VCS shall be used to cover the entire range of LV motors.

f) Each LIS/VCS shall be labelled with the HAC of the connected device.

6.2.3 Emergency-stop/emergency switching-off/emergency shut-down devices

a) Emergency-stop, emergency switching-off and emergency shut-down devices shall be heavy-duty, red color mushroom type push buttons, unlatched by rotation and clearly indicate the tripped position.

b) They may be wired to safety relays, looped into trip circuits or connected directly to safety instrumented systems.

c) Devices installed

- at the personal entrance door (inside and outside) of a substation/electrical room,
- in the central control room,

shall cut-off the power supply to the complete substation or electrical room.

d) Devices installed

- in the field close to MV fix-speed motors and motors pertaining to ASD systems,
- at panel doors,

shall cut-off the power supply of the respective Equipment.

e) Devices installed

- in the process areas

shall cut-off the power supply of consumers pertaining to a dedicated process.

6.2.4 Start-up Notice (Start-up Warning)

a) Separate devices shall be foreseen for audible and visual start-up warnings. Each of the devices shall provide for individual control.

b) Audible and visual devices shall be foreseen to indicate starting of machines.

c) Start-up warning devices shall be arranged per group (sequence) of machines and in accordance with all applicable regulations.

d) In special cases a single machine may require a dedicated start-up warning.

e) Different plant areas shall have individually controllable groups of start-up warning devices.

6.3 Field Devices for Maintenance and Local Operation

6.3.1 Local Control Devices

a) Local start and stop push buttons shall be foreseen for all machines for local operation.

b) Local start and stop push buttons shall be installed in such a way that when starting, the machine can be observed.

c) Local start and stop push buttons may be integrated into the LIS/VCS enclosure.

d) For valves or a set of valves, start push buttons shall be provided for testing purposes.

e) Additional start/stop push buttons shall be foreseen where required for maintenance (e.g. at each bucket elevator inspection door).

f) Further push buttons shall be provided if required by the application (e.g. increase/decrease, left/right, release).

6.4 Instrumentation for Machine Protection

a) The below listed sensors, instruments and devices shall be completed with all required installation equipment such as brackets, flanges, supports, protection covers etc. as well as all necessary access platforms etc. for checking, calibration and maintenance.

b) Measuring instruments and devices shall be individually wired to the respective I/O's.

c) Redundant sensors for machine protection shall be provided where specified for the particular application (e.g. PT100 motor winding temperature, filter inlet temperature).

6.4.1 Proximity Switches

a) Proximity switches shall be a standard 2-wire type.

b) Application examples: chute gates, belt take-up, tripper positioning, valve position, clutch position, brake position and similar.

6.4.2 Limit Switches

a) Wherever possible, mechanical type limit switches shall be replaced with proximity switches.

b) Where required by the application, they shall be equipped with 1 NO and 1NC contact.

c) They shall be equipped with an appropriate heavy duty lever for the application.

6.4.3 Speed Sensors

a) Speed sensors shall be of the proximity head-fitted type.

b) The rotating primary element shall be of safe design without open moving parts.

c) The primary element shall be made of a plastic/metal cylinder with easy adjustment of the distance between the sensor and the primary element.

d) Rotation speed monitors or zero-speed switches shall be 2-wire type with binary signal output.

e) Speed measurement with analog signal output may be with proximity sensor and evaluation unit.

6.4.4 Belt Drift Switches (Belt Misalignment Switches)

a) The switch lever shall be of the spring-loaded, heavy duty mechanism without reset.

6.4.5 Pressure- and Flow Switches

a) Pressure switches and flow switches should not be used.

b) Continuous measurement should be considered instead.

6.4.6 Temperature Sensors PT100

a) 3-wire type sensors shall be used only.

6.4.7 Vibration Sensors

a) Vibration sensors shall comprise a sensing element(s) and evaluation unit.

b) Measurement of either vibration velocity or vibration acceleration shall be foreseen depending on the application.

6.4.8 Level Switches

a) Level switches should not be used for machine protection.

b) Level switches are required for specific Equipment only e.g. bag filter hoppers, ESP hoppers, bucket elevators, chutes, etc.

6.5 Process Instrumentation

6.5.1 General requirements

a) The primary elements and transmitters shall suit the individual applications.

b) Locally mounted, continuous monitoring devices are to be used.

c) Instrument air shall be equipped with individual air filter regulators.

d) Location, size and type of arrangements shall be subject to written approval.

6.5.2 Pressure and Temperature Sensors

a) Only 3-wire PT100 elements shall be used.

b) PT100 elements may be used up to 400°C.

c) PT100 elements shall be wired to I/O's. Head-mount transmitters may be used.

d) Thermocouples may be used above 200°C.

e) Special applications may require a locally mounted transmitter.

f) For pressure measurement a manifold valve for calibration and purging of process lines shall be required.

6.5.2.1 Flow Sensors for Process Gas

a) Flow sensors in process gas lines shall use the triboelectric cross correlation technology.

b) Other types of flow sensors shall be subject to written approval.

6.5.2.2 Flow Sensors for Liquids

a) Flow sensors for liquids shall be selected according to the application.

b) Non-intrusive types shall be considered such as electromagnetic, Coriolis or ultrasonic.

6.5.2.3 Flow Sensors for coarse and fine materials

a) Special flow sensors should be used to detect material flow in air slides, if required.

6.5.3 Continuous level measurements

a) Continuous level measurements, mounted on top and not requiring additional installations, are generally to be used (radar or microwave type).

b) Inspection openings shall be provided close to the location of the sensor for visual checking of the level.

c) Maximum level probes (level switches for overfill protection) for all bins and silos shall be included. They shall consist of suitable individual level detectors, which are separated from the continuous level measurements.

6.5.4 Load Cells

a) Load cells shall be used for all bins requiring on-line calibration.

b) The Equipment shall be complete with

- Strain gauge type load cells
- Field mounted amplifier
- Brackets
- Expansion assemblies

c) Flexible copper straps to bridge-over each load cell to protect them from stray welding current shall be included.

6.5.5 Control Valves and Actuators

a) Solutions with variable speed drives (for pumps, fans, etc.) shall be considered.

b) Where this is not possible, control valves and actuators and corresponding mechanical linkages shall be used.

c) Actuators and valves shall be standardized.

d) The feedback element shall be 4-20mA, galvanically isolated or by the plant fieldbus.

e) Where required, the feedback element shall be directly connected to the shaft.

f) Actuators, which can operate without internal limit and torque switches, shall be used.

g) Set point control shall be with a standard 4-20mA signal or by the Plant fieldbus system.

h) Actuator travel time and flow characteristics shall be adjusted to the specific application.

6.5.6 Solenoid Valves

a) Solenoid valves shall be equipped with integrated status indication.

b) Valves shall be connected with a plug according to DIN 43650 or equivalent.

c) All valves for cooling systems, lubrication systems, pneumatic transports, etc. shall be standardized.

6.6 Special Instruments

Special instruments shall be evaluated together with HOLCIM to cope with the latest standards.

- Belt conveyors

  Belt conveyors longer than 500 meters and with a transport capacity of more than 500 t/h shall be equipped with a belt condition monitoring system that allows detecting deficiencies in the belt, e.g. surface wear, excessive elongation, longitudinal rips, steel cord damage, up-coming splice failure etc. to protect the belt from failures before they occur.

- Bucket elevators

  Belt bucket elevators higher than 50 meters or with a transport capacity of more than 500 t/h shall be equipped with a belt condition monitoring system that allows detecting deficiencies in the belt, e.g. surface wear, excessive elongation, longitudinal rips, steel cord damage, up-coming splice failure etc. to protect the bucket elevator from failures before they occur.

  Chain bucket elevators higher than 50 meters or with a transport capacity higher than 500 t/h shall be equipped with a chain condition monitoring system that allows detecting deficiencies on the chain, e.g. chain wear, excessive elongation, failure of chain links etc. to protect the bucket elevator from failures before they occur.

- Gear boxes

  All gear boxes larger than 50 kW shall be equipped with temperature and vibration monitoring.

6.6.1 Pyrometers and Special Temperature Measurement

a) Two color ratio type pyrometers shall be installed to suit the individual application and ranges.

b) Locally mounted, continuous temperature monitoring devices are to be used.

c) All essential access platforms for checking and calibration shall be included.

d) Cement mill diaphragm and other not stationary temperature measurements shall be equipped with auto-powered (movement or induction), wireless transmitted temperature sensors/transmitters.

6.6.2 Kiln- and Cooler Camera System

a) Color pyrometer camera systems shall be used at the kiln firing hood for looking into the kiln and at the cooler to look towards the kiln outlet.

b) The camera system shall be equipped with

   - Automatic shutters
   - Automatic retraction systems on failure (pneumatic type or connected to UPS)
   - Alarm signals
   - Cooling system
   - Displays that are located in the central control room.

c) Integrated video and temperature measuring pyrometers should permit measurement of multiple user definable areas of interest.

6.6.3 Kiln Shell Scanner and Refractory Monitoring

a) A kiln shell scanner shall be completed with a fast scanning type sensor allowing sophisticated evaluation in a stand-alone PC-type kiln shell temperature and supervision system.

b) The image resolution of the system at the chosen distance to the kiln shall allow the hot spot detection within one brick over the entire kiln (precalciner kilns).

c) To cope with this requirement, additional sensors may have to be installed to detect “blind zones” e.g. behind riding rings.

d) Refractory management shall be included in connection with the kiln shell temperature scanner.

e) Different presentations shall be possible, adapted to the different tasks of:

- Evaluation of kiln flame, coating
- Supervision of riding ring clearance during heating-up and normal operation
- Evaluation of brick lining (long term tendency)
- Planning of brick lining

f) Storing and easy retrieval of actual and historical data of temperature profiles and of brick data shall be possible.

g) Alarms and key value presentations shall be integrated into the normal operator station display.

h) Data transmission shall be with OPC.

6.6.4 Process Gas Analyzer

a) The Equipment shall suit the individual application as required by the process.

b) Locally installed analyzer Equipment shall be foreseen.

c) Interface to the PCS shall be provided.

d) Gas analyzers shall have a local control panel.

e) Gas analyzers shall either be mounted in electrical rooms or in pre-wired, pre-tested containers.

f) For gaseous measurement and control, the extractive method shall be used.

g) The gas analyzer extraction probe shall be positioned in a way that its operation is not affected by false air.

6.6.5 Metal Detector

a) The electrical Equipment shall comply with the requirements for Sub-Control Systems.

b) The Equipment shall be EMI approved.

6.6.6 Ball Mill Fill Level

a) Ball mill grinding levels shall be supervised by a sonic ear.

b) The transmitter shall be of the digital type, allowing selection of the optimal frequency and frequency range for the individual application.

c) Mounting supports, cables and mechanical filters shall be included.

d) As an alternative, the sensor can be of the impulse type directly mounted on the mill body with wireless transmission of the signal to the transmitter.

e) Communication with the Plant fieldbus system shall be included.

6.6.7 Weigh Bridges (for trucks and rail wagons)

a) Weigh bridges shall be designed as specified in the Mechanical Standard Design Criteria. Specifications for the weighing systems and tolerances for weighing accuracy shall be in line with the local regulations.

b) The electrical Equipment shall comply with the requirements for Sub-Control Systems (E50).

c) Weigh bridges shall be connected to the PCS and to the Plant IT network.

d) The weighing system shall be designed for fully automatic weighing of trucks or rail wagons.

e) Barcode or RFID readers shall be provided for identification of trucks or rail wagons.

f) Local control panels shall be provided with a touch screen.

6.6.8 Weigh Feeders

a) Weigh feeders shall be as specified in the Mechanical Standard Design Criteria.

b) Control shall be done within the PCS, or in a dedicated subsystem.

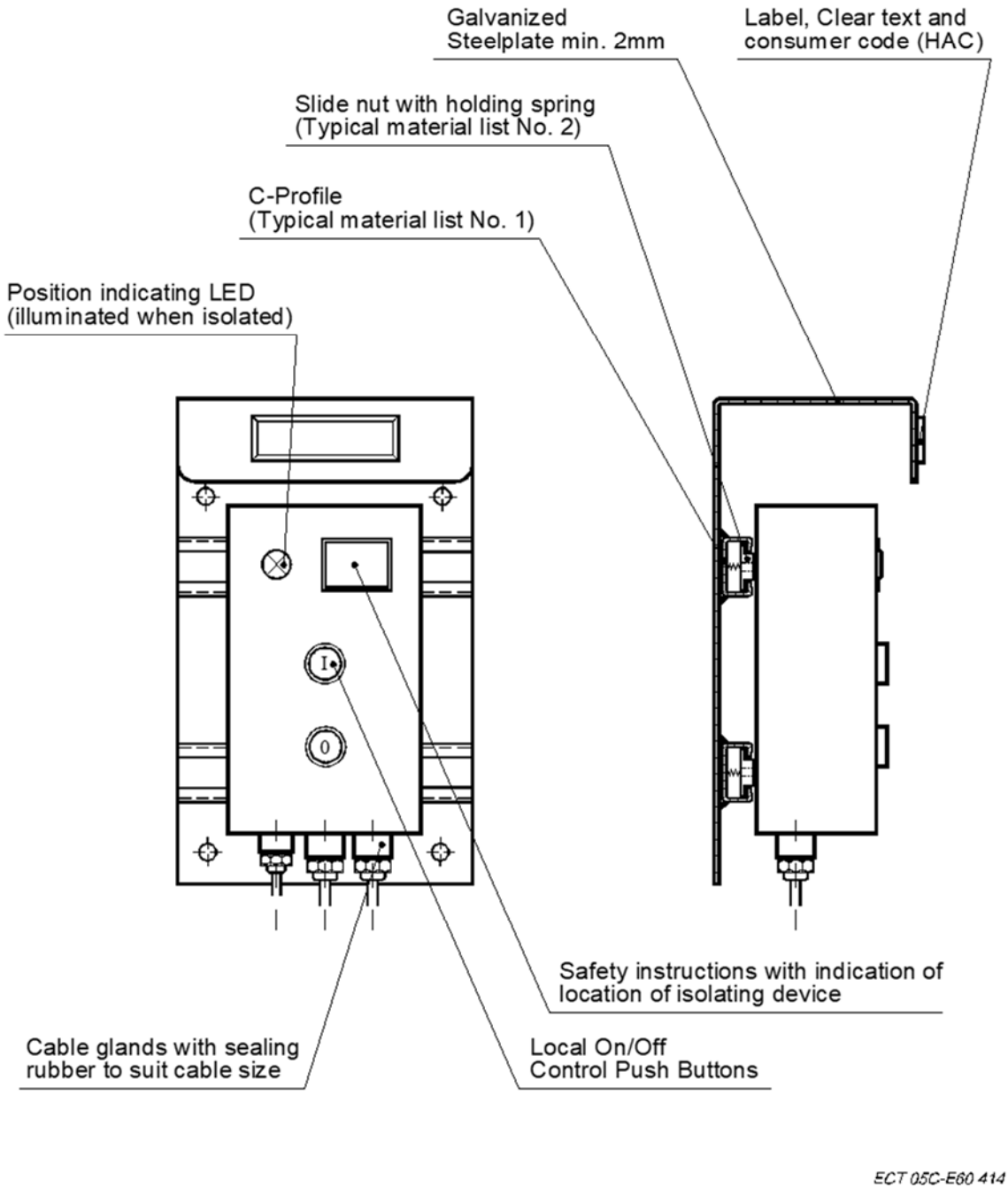
c) The weighing signal shall be transmitted via Plant fieldbus to the PCS.

d) The required interfaces for calibration of tare and check load shall be realized with the standard HMI of the central control room.

e) Where possible, calibration shall be performed online using the load cells of the bin.

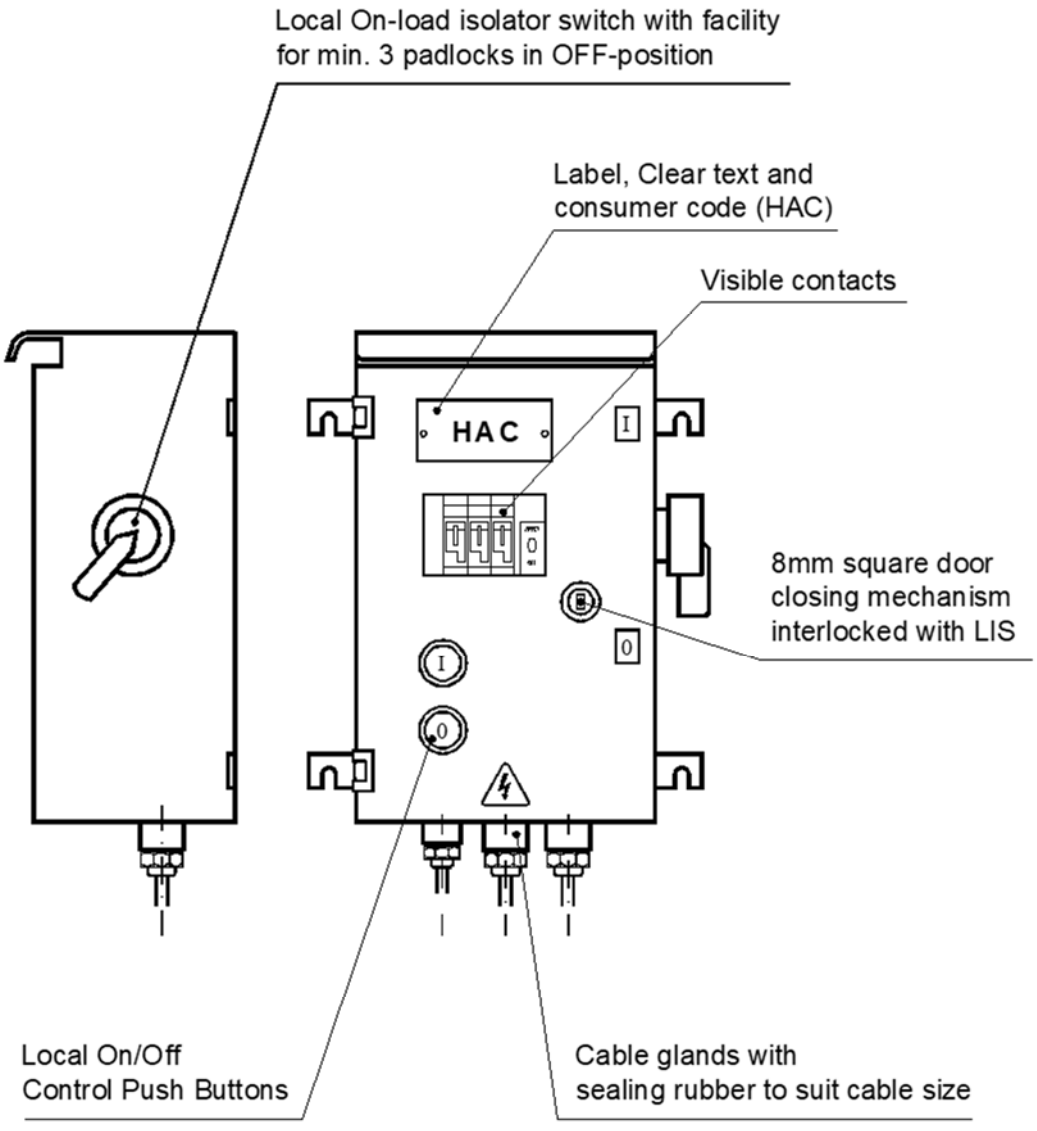
6.7 Typical Drawings, Group E60

Local Control Switch Arrangement (typical for drives without local isolator)



Note: Not to be used in new installations, because Local Isolator/Visible Cut off switch is required

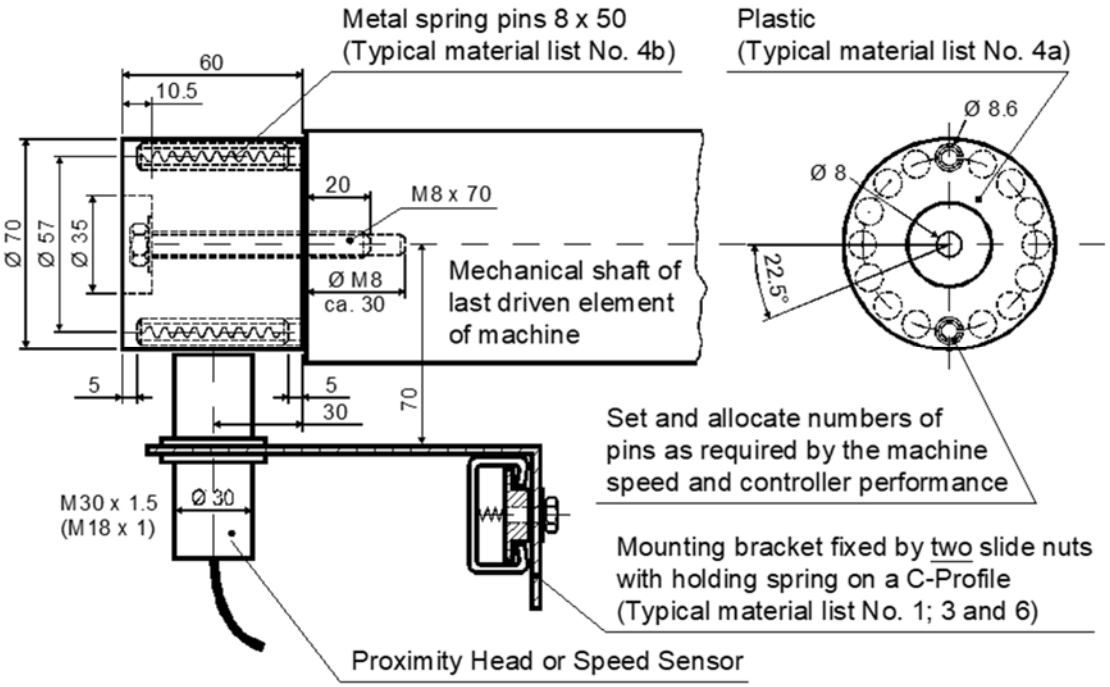
Local Control Switch Arrangement with Integrated On-Load Isolator and Visible Disconnection (typical)



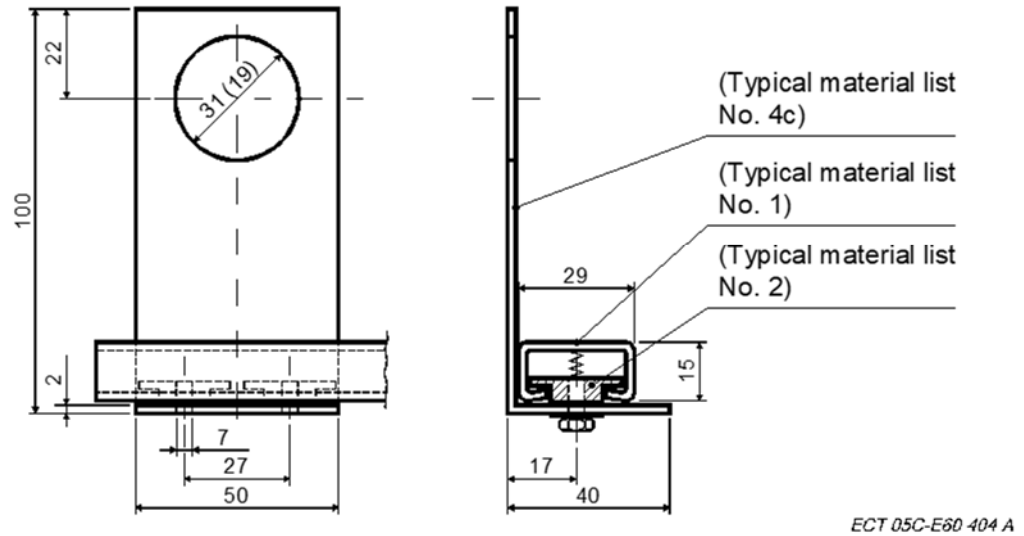
ECT 05C-E60 417 A

Speed Detector Mounting
Primary Element and Proximity Switch
(all dimensions typical only)

Parts and application

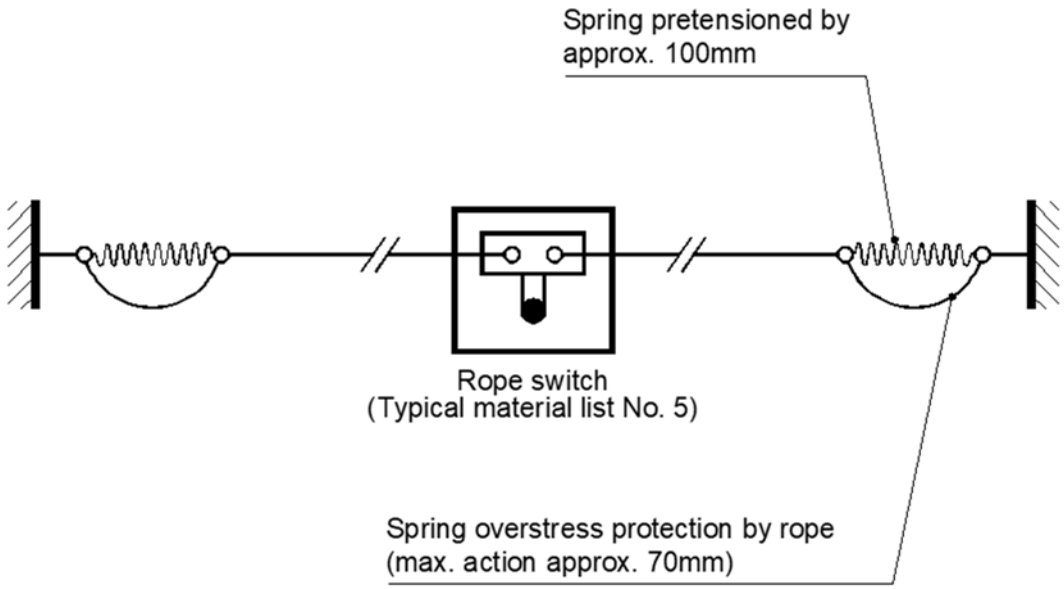


Mounting bracket and arrangement

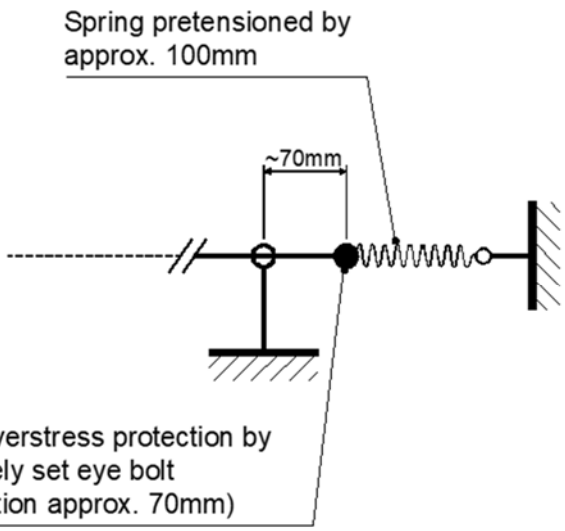


ECT 05C-E60 404 A

Mechanically Fail-Safe Installation of Rope Switches (typical)



Alternative:



ECT 05C-E60 405 A

7. GROUP E70: ELECTRICAL ANCILLARIES

7.1 General Requirements

Electrical- and control requirements for electrical ancillary systems shall be coordinated with the Civil and Structural Works Standard Design Criteria.

7.2 Fire Detection and Alarm System (FDAS)

7.2.1 General requirements

a) FDAS covering all process areas shall be designed.

b) FDAS shall be designed in consideration of the fire zones determined by the fire barrier system.

c) It shall include fire detection and alarming facilities and shall cover all process areas with potential fire hazard including:

- Electrical rooms, transformer cells and cable basements
- Installation tunnels and installation shafts
- Elevator control rooms
- Control and computer rooms, server rooms
- False floors and false ceilings in above areas
- Air-conditioning rooms
- Fuel areas and storage
- Fuel transport and pump areas
- Fuel filling stations
- Hydraulic rooms
- Lubrication rooms

d) The system shall consist of fire detectors, manual fire alarm push-buttons and a central alarm panel.

e) The central FDAS panel with visible and audible alarm shall be installed in the CCR or guard house.

7.2.2 Fire Detection and Alarming

a) Optical type fire detectors and heat sensing cables shall be arranged suitable to the protected Plant area.

b) Heat or differential heat sensors shall only be included if no other types can be used for technical reasons.

c) Passive infrared type sensors are required in very high buildings (e.g. large Substations).

d) Hidden detectors (e.g. in false floors and ceilings) require visible status annunciators close by.

e) Manual fire alarm stations shall be installed at exits, emergency exits and outside of normally locked doors (e.g. electrical rooms).

f) The fire alarm of the automatic detectors as well as the manual stations shall be visualized on a schematic Plant layout.

g) A fire alarm shall automatically stop the ventilation/air-conditioning system of the respective room.

h) A fire alarm shall automatically cut-off the power supply of equipment installed in the room.

i) In case of an active firefighting, each UPS to be disconnected manually via the Emergency push button.

7.3 Closed Circuit Television Cameras (CCTV) for Process Areas

a) Process areas (e.g. crusher feed, extraction points, raw mill feed, kiln, clinker transport, coal mill feed) shall be monitored with cameras.

b) Rotation and up/down movement of each camera shall be foreseen.

c) Each camera shall have an interface to the CCR.

d) The system shall be designed with industrial IP cameras and a video server.

e) The camera system shall include large displays located inside the CCR for supervision and monitoring of the process areas.

7.4 Heating, Ventilation and Air-Conditioning (HVAC) System

7.4.1 General requirements

a) All electrical rooms shall be equipped with a closed loop HVAC system for temperature control and to minimize dust ingress.

b) Humidification and dehumidification shall be controlled.

c) The HVAC system shall be automatically controlled and shall be used for continuous operation.

d) Room temperature shall be measured and wired to PCS.

e) Interfacing to the PCS shall be provided.

f) Temperature and humidity indicating instruments shall be installed in electrical rooms.

8. GROUP E80: MOTORS AND ADJUSTABLE SPEED DRIVES

8.1 General Requirements

a) All motors shall be at least of protection type IP 55.

b) Motors shall be furnished with class F insulation rated for class B temperature rise.

c) If motors are derated due to ambient factors, IEC data as well as the reduced data for current shall be indicated on the motor nameplate.

d) Motor design shall be standardized.

e) The mechanical design shall, however, in all cases allow for direct starting, independent if the process, electrical or maintenance conditions require this type of starting.

f) Where air-to-air heat exchangers are foreseen, the airflow and temperature shall be monitored.

g) All motors shall have cooling fan covers made of metal.

h) All motors shall be equipped with terminal boxes to provide sufficient space for convenient cable connections considering the type of cables applied.

i) Connections inside terminal boxes shall be on connecting studs/terminals exclusively.

j) All terminal boxes shall be made of metal.

k) Earth terminals shall be foreseen inside each terminal box.

l) Identically rated motors shall have an identical terminal box arrangement.

m) AC motors shall have at least 4 poles.
Deviations for particular applications shall be subject to approval.

n) Motor bearings design shall take into account specific requirements related to the mechanical application.

o) Neither 2 speed motors nor other special motors nor special starting methods (as star/delta) shall be applied: ASD or Soft-starters shall be used for these applications.

8.1.1 Motors equal or larger than 75 kW

In addition to the requirements listed in Chapter 8.1, the following shall apply:

a) Motors shall

- be equipped with one temperature sensor type PT100, 3-wire, in the stator winding (per phase)
- have an insulated bearing at the non-drive end
- have provisions for vibration analysis (e.g. SPM) on both bearings

8.1.2 Motors exceeding 250 kW

In addition to the requirements listed in Chapter 8.1 and 8.1.1, the following shall apply:

a) Fixed speed motors shall be medium voltage motors.

b) Motors shall be equipped with an analogue vibration sensor in each bearing (as per ISO 10816).

c) Anti-condensation heaters shall be provided:

- Leads shall all be terminated in a separate terminal box.
- Proper functioning of anti-condensation heaters shall be supervised by heater current supervision.

d) Motors shall

- Be equipped with a minimum of 2 temperature sensors type PT100, 3-wire, in the stator winding (per phase).
- Be equipped with 1 temperature sensor PT100, 3-wire, in each bearing.

e) Motors shall be provided with a standard earth terminal on the motor frame.

8.1.3 Loading and Spare Capacity

a) The voltage drop under heavy start conditions shall not exceed 10% of the motor rated voltage at the motor terminals.

b) The voltage drop shall not exceed 5% of the motor rated voltage at the motor terminals if operated at full load (motor rated power output).

8.2 Low Voltage Motors

8.2.1 General requirements

a) All motors shall be induction type motors (squirrel cage).

b) All motors shall be totally enclosed fan cooled (TEFC) or closed circuit air-cooled with air-to-air heat exchangers suitable for the cement industry environment.

c) All motors shall be at least of severe duty premium efficiency (class IE3 and IE4 as per IEC 60034-30).

d) LV NEMA motors shall be rated for a service factor of 1.15. LV IEC Motors shall be rated for a service factor of 1.0 with the exception of special duty motors subject to prior approval.

e) All motors shall be designed for D (Delta) connection at the specified voltage.

f) Direct-on-line (DOL) starting shall be applied. In case of high starting currents, electronic soft starter devices shall be used.

g) Motor bearings of small motors shall be grease-lubricated for life. Bearings of motors equal or larger 45kW shall be furnished with greasing nipples safely accessible during operation.

h) The bearing design shall allow for excessive lubrication without damage to the motor or any of its components.

8.3 Medium Voltage Motors

8.3.1 General requirements

a) All motors shall be induction type motors (slip-ring/wound rotor or squirrel cage).

b) All motors shall be totally enclosed fan cooled (TEFC) or closed circuit air-cooled with air-to-air heat exchangers suitable for the cement industry environment. Air-to-water heat exchangers can be considered for plants having a closed circuit water-cooling system.

c) All motors shall be of severe duty premium efficiency.

d) Depending on the application, starting of motors shall be controlled with liquid rheostats in conjunction with slip ring motors or with soft starters in conjunction with squirrel cage motors. Direct start may be possible depending on the application.

e) The terminal boxes shall be designed to withstand the network fault level.

f) The motor bearings shall be grease or oil lubricated, depending on the type of bearing, with greasing nipples safely accessible during operation.

g) The bearing design shall allow for excessive lubrication without damage to the motor or any of its components.

h) If a limited end-float coupling is used, sleeve bearings shall be designed with sufficient end float to allow for proper alignment of the rotor and load, taking into consideration shaft expansion due to heat buildup.

i) When the load or coupling exerts axial thrust on the motor shaft, the motor shall be equipped with thrust bearings

- This thrust bearing shall be installed at the drive end of the motor to prevent amplified reactions through the rest of the machine.

j) Motors equipped with sleeve bearings shall have factory installed permanent markers identifying their magnetic center.

- The allowable rotor movement around the magnetic center shall be identified in the alignment manual and drawings.

k) All motors shall be equipped with a transportation rotor locking device.

l) The direction of rotation of unidirectional motors shall be permanently identified on the drive end.

m) Motors larger than 1000kW shall have brushes installed on the drive end of the motor shaft and shall have an electrical insulated coupling to the driven machine.

8.3.2 Slip Ring Motors

a) Motors shall have brushes in continuous contact with the slip rings, thus brush lifting devices shall not be used.

b) The slip ring section shall be separated from the active part of the motor in such a way that contamination of motor windings by brush dust is prevented, e.g. by a separate ventilation of the slip ring compartment.

c) External +air used for cooling of the slip-ring compartment shall be filtered.

d) Slip rings shall be made from brass or copper.

e) Brush holders shall be adjustable concerning the distance to the slip-ring and guarantee the perpendicular position of the brushes on the slip-ring.

f) Brush springs shall be of constant force.

g) Slip-ring compartments shall be equipped with inspection windows on both sides.

8.3.3 Liquid Rheostat for Slip Ring Motors

a) Automatic remote-controlled liquid rheostats shall be used in conjunction with the slip ring motors.

b) To adjust the operation speed of the liquid rheostat, the rheostat shall be controlled by an adjustable speed drive integrated within the terminal box.

c) The Equipment shall include all the necessary protection including:

- liquid level sensor and temperature sensor with contacts for alarm and trip,
- automatic sequenced starter operation, including shorting contactor.

d) The starter shall be designed to allow 3 consecutive starts in cold conditions and 1 additional start every hour.

8.4 Adjustable Speed Drive Systems

8.4.1 General requirements

a) The system including motor, frequency converter and associated transformer is referred to as adjustable speed drive system (ASD).

b) ASD shall be designed as an engineered package including motor, converter unit, cable and transformer, considering overload conditions.

c) Motors shall be designed for ASD operation as specified on the nameplate.

d) Current source type frequency converters shall also include the required power factor correction capacitors.

e) ASD larger than 250kW shall be fed from the MV-distribution and shall have its individual transformer.

f) ASD systems between 250kW and1000kW shall be designed as minimum 6-pulse systems with low harmonics, whereas systems equal or larger than 1000kW shall be minimum 12-pulse or active front-end.

g) A multidrive system arrangement may be considered where several ASDs are required for a particular process section.

h) If possible, multi-cell MV ASDs shall include the cell bypass option.

i) Motors shall exclusively be of the squirrel cage type.

j) Motors above 1000kW shall be equipped with shaft earthing brushes.

k) Forced cooling of a motor with a separate fan shall be subject to approval for the proposed application.

l) Motors applied for ASD systems shall be suitable for operation at nameplate rating as a variable speed drive unit.

m) Continuous operational maximum speed of the motor should be according to the motor nameplate rating.

n) Synchronization (flying start) with a turning motor shall be possible.

8.4.2 ASD Transformers and Reactors

a) ASD transformers and reactors shall be designed for frequency converter operation with non-linear loads.

b) ASD transformers and reactors shall include an electrostatic shield between primary and secondary windings.

c) ASD transformers shall be of the dry type. Liquid-filled ONAN converter transformers with biodegradable oil, if not in conflict with the local rules, could be used.

d) Vector groups shall be selected aiming at reducing the higher harmonic content on the feeding busbar.

8.4.3 Torsional Analysis

Torsional analysis shall be performed for all ASD systems equal to or larger than 250kW.

8.4.4 ASD - Frequency Converter Panels

a) Panels shall be located in electrical rooms equipped with facilities for proper cooling.

b) Panel temperature shall be supervised continuously for free standing panels.

c) Panels shall be located to reach the shortest possible power cable length between converters and motors.

d) ASD systems below 120kW may be suitable for mounting direct-to-the-wall.

e) For ASD systems equal or larger than 120kW the converter panels shall be of the

- free-standing,
- self-ventilated design without a back access facility.

f) Air-cooled or liquid cooled ASD systems may be used.

g) The control power shall be supplied from UPS.

h) The panel shall be complete with

- all required motor and frequency converter protection devices of the electronic type,
- incoming mains power disconnect switch or circuit breaker.

i) Remote indication of power, speed, torque, panel temperature and set point control shall be provided via plant fieldbus.

j) Cooling fans of modules and other auxiliary power consumers shall be fed from an internal independent power source.

k) Cooling fans shall be maintenance free.

l) The control section of the converter panel shall allow local and remote control of each drive with detailed local and remote fault indication for all components.

8.5 Typical Drawings, Group E80

This chapter intentionally left blank.

9. GROUP E90: CABLING, GROUNDING, LIGHTNING PROTECTION

9.1 General Requirements

a) The color of the cable sheaths shall be standardized throughout the Plant to distinguish between the voltage level/function of the cables.

b) All cables shall have soft drawn copper conductors.

c) Conductors of cross-section exceeding 2.5 mm^2 shall be stranded.

d) Neutral and grounding wires shall not be used for any other purpose.

9.1.1 Loading and Spare Capacity

a) The current carrying capacity of the cables shall be in full compliance with Applicable Law and Applicable Codes and Standards (IEC 60287) and take into consideration the de-rating factors for ambient temperature, number of cables installed, methods of installation (at most critical points).

b) All cables shall be dimensioned according to the rated current of the Equipment connected.

c) Connections to and from transformers shall be able to carry its full rated capacity.

d) The voltage drop under heavy start conditions shall not exceed 10% of the motor rated voltage at the motor terminals.

e) The voltage drop shall not exceed 5% of the motor rated voltage at the motor terminals if operated at full load (motor rated power output).

f) Minimum 4 spare fibers in fiber optic cables shall be required.

g) Cableway installations shall be designed to guarantee a minimum of 20% free space at the completion of the whole installation.

h) In a cable tray the following maximal cable laying layers shall be used:

- Power cables: 1 layer
- Control cables: 3 layers (normally not applicable, wired to field I/O boxes)
- Communication cables: 1 layer

i) Cable conduits shall be loaded to a maximum of 40% (the diameter of the conduit shall be at least 1.5 times the cable bundle diameter).

9.2 Power Cables

9.2.1 General requirements

a) Insulation shall be EPR or XLPE (EU type H07X or equivalent).

b) Cables shall be dry-insulated, flame retardant and vermin proof, resistant against abrasion, impact, heat, oil, UV, alkali and acids.

c) Conductors of cables installed between the motor and local on-load isolator (LIS) or visible cut-off switch (VCS) shall be Class 5. Otherwise, conductors of cables shall be Class 2.

9.2.2 High Voltage & Medium Voltage Cables

a) All high and medium voltage distributions shall be of the 3-phase system.

b) The main MV switchgear cables shall be able to withstand 1 second and departmental MV switchgear cables shall be able to withstand 0.6 second full short-circuit current.

c) The same 3 conductor colors shall be used to identify the 3 phases throughout the Plant.

d) HV- and MV-cables shall be either 3-conductor or single-conductor type.

e) HV- and MV-cables shall be unarmored unless required to be armored by local standards.

f) No cables shall be buried directly in the ground.

g) Flexible MV-cables in quarry areas shall be furnished with insulation failure detection, and the cable insulation shall be adequate to the expected rough handling.

h) All high voltage- and medium voltage cables shall have stress cone termination.

i) Cable terminations (stress cones/potheads) shall be considered to be part of the cable end.

j) Cable terminations shall be suitable to meet the specific cable and safety standards required.

k) Cable terminations shall be suitable to meet the physical arrangement of the Equipment to be connected (e.g. transformers, switchgear, motors).

9.2.3 Low Voltage Cables

a) Low voltage motor cables shall have four conductors, with the fourth wire to be used for grounding purposes.

b) For large drives, single-conductor cables may be used with a separate conductor for grounding purposes.

c) All power cables shall have a ground wire.

d) In the case of feeding a single phase consumer or panel, all power cables shall have a neutral wire in the appropriate color.

e) 3 phase feeder cables to non-process Equipment connected to LVD which also contains single-phase consumers shall have

- 5 conductors (phases, neutral, grounding), or
- 4 conductors if Equipment is provided with an isolating transformer.

f) Process feeders, connected to MCC, have phases and ground conductors only (with isolation transformers for single phase consumers).

g) Cables connecting the local on-load isolator (LIS) with the motor shall be

- flexible (Class 5),
- shear force,
- impact resistant cable for motors up to and including 55 kW.

h) Cables in areas with high ambient temperatures (radiation) shall be of the special heat resistant type.

i) Mobile Equipment shall be connected with flexible cables.

j) On installation with a motorized cable reel, the cable shall have special stress release armoring.

9.2.4 ASD Converter Cables

a) The ASD converter cables shall be designed for the application.

b) Cables shall be in accordance with the ASD supplier's directives.

c) Cables shall be selected considering the higher insulation levels, specially required protections (shielding, grounding) and the cable installation methods to eliminate electromagnetic interference with other Equipment (respecting the corresponding standards and recommendations of the ASD systems). Shield: Overall tinned copper braid plus aluminum/polyester tape providing 100% coverage.

9.3 Control and Communication Cables

9.3.1 Extra Low Voltage Control Cables

a) Extra low voltage control cables shall be capable of carrying analogue and discrete signals and shall be arranged in twisted pairs.

b) Maximum of 3 types of control cables shall be used throughout the whole Plant.

c) If color-coded wires are applied then the colors shall follow the same sequence at both cable ends and throughout the whole installation.

d) Special cables serving large machines (e.g. for stackers, for reclaimers) shall be used.

e) Ethernet- and Plant fieldbus cables shall be copper within an individual building only.

9.3.2 Fiber Optic Cables

a) Fiber optic cables for main communication links between electrical rooms shall be designed as follows:

- Rodent proof (e.g. armored)
- Minimum of 24 fibers

b) The types of fiber optic cable shall be standardized to a maximum of 2 (e.g. single mode, multimode).

c) The number of fibers per cable shall be standardized to a maximum of 3 types, with a minimum of 6 fibers per cable for secondary connections (e.g. to field I/O box).

d) All fibers of a cable (including all spares) shall be terminated at a fiber optic panel or pre-terminated fiber cables can be used based on agreement by Owner.

e) Connection of pig tails as cable splicing.

9.4 Cable Installation

a) Depending on the Plant layout, conduit banks, or overhead steel structure cable bridges (galleries) with walkways shall be used between the main electrical power distribution center, the different electrical and control rooms and major buildings.

b) Cable trenches and open ducts shall not be used.

c) A uniform cable installation shall be maintained throughout the Plant.

d) Cable tray installation shall be continuous.

e) High/medium voltage power cables shall be installed on the lowest level, low voltage power cables on the second, control cables on the third and communication cables on the top level.

f) One cable level may require more than one cable tray.

g) As a design guideline, the vertical separation between levels or tray shall be 300 mm throughout, and similar distances shall be maintained on vertical trays to provide for proper access to install the cables and for cooling purposes.

h) Tray dividers shall not be used to separate the different levels.

i) Extra low voltage cables (control and communication) shall be installed on separate cable trays or in conduits, whereby a minimum distance to power cables of 300 mm shall be maintained to avoid interference to the extra low voltage systems.

- Enclosed, non-ventilated tray may be used for the installation of such cables.

j) Cable trays etc. are to be installed with expansion bolts.

k) Powder-actuated fasteners shall not be used.

l) All installation materials shall be hot-dipped galvanized or with equivalent treatment (electrolytic galvanizing not accepted).

m) Each section of tray shall be individually grounded.

n) Strong emphasis shall be laid on proper laying and fixing of cables on trays or ladders and in conduits over their entire run.

o) Twisting of cables shall be avoided.

p) Cables on vertical racks shall be fixed by metal clamps.

q) Single conductor cables shall be fixed with non-magnetic type metal clamps.

r) Bending radius of trays and between conduits shall be at least according to the highest bending radius of the cable of the corresponding type (MV, fiber optic).

s) Cable trays shall be of wire mesh or ladder type.

t) Cable trays shall be horizontally mounted inside cable tunnels, electrical rooms and production areas not exposed to dust accumulation. Sections with the risk of mechanical damage shall be covered.

u) Cable trays shall be edge/flag mounted at production areas exposed to dust accumulation.

v) No cables shall be laid directly on the ground or into the ground.

w) Vertical cable trays or ladders are to be protected on the field against physical damage up to a minimum of 1.8 m above floor level unless further protection is required for local regulations or special reasons.

x) Individual cables installed on structures or machines outside of electrical rooms shall be installed in steel conduits.

y) Conduit ends shall be protected by bushings.

z) Wherever the number of cables in buildings requires several conduits to be run in parallel for the same kind of cable, ladders shall be installed instead.

aa) Local isolator switches (LIS) shall be connected with sufficient spare cable slack close to the switch for future reconnection.

- Special, flexible shear force and impact resistant cable shall be used for the connection of the local isolator switch to the motor.

bb) Field devices and instruments shall be connected with sufficient slack loop of cable length to allow for removal of the device for maintenance purposes without removal of the cable connection.

cc) Cable connection to all Equipment in the field shall be used with cable glands.

- Cable glands shall be of a compression type to release the terminals from cable tension.
- Cable glands are to be made of brass or plastic of equivalent performance.

dd) All cables shall be clearly marked by solidly attached weather and dust proof labels, identically at both cable ends.

ee) The cable label information shall indicate the HAC of both ends Equipment associated with the cable (motor, device and panel number).

- The HAC shall also apply to the cable lists.

ff) Fire barriers shall be provided at wall, ceiling and floor penetrations.

gg) Fireproofing shall be foreseen in areas where FDAS is not available.

9.5 Grounding System

a) As a guideline the grounding system shall comply with the following international Standards and local regulation:

- IEC 61936
- IEC 60364

b) Grounding of all Equipment shall be provided using an integrated plant grounding network.

c) Engineering and execution of the grounding network shall be closely coordinated with the Civil Works (Refer to Civil and Structural Works Standard Design Criteria).

d) Foundation grounding with emphasis on potential equalization shall be applied for the Plant grounding network.

e) Potential Equalization Bar (PEB) shall be provided in each substation and transformer room completely equipped with a copper flat bar including 20% percent spare connection point.

f) All grounding conductors shall be bare, stranded, soft-drawn copper.

g) All embedded ground connections shall be made by thermo-welding or by type-tested connection material.

h) The number of main members of the bottom rebars shall jointly be utilized or a steel tape shall be laid as a ring type grounding conductor into the foundation of every building and large machinery foundation:

- The steel tape shall be fixed onto the reinforcement by welding or wire-tied and shall be used with connecting leads brought out via a standard tapping point at the inside of the building for Plant grounding and bridging of expansion joints as well as outside of the building for connecting the lightning protection.

i) Tapping points shall be connected to an internal grounding network within the building, sized according to the short circuit calculations, but minimum 95 mm2 copper or 200 mm2 galvanized steel tape respectively.

j) Aiming at an integral system for common potential equalization and lightning protection equalization, the following Equipment shall be connected to this network in every building:

- All motor, generator and other electrical Equipment frames and/or bases.
- All steel structures (steel columns, bridges, rails, tanks, steel fences etc.).
- All metallic utility piping (e.g. air, water, gas, fuel, etc.) at their point of entering the building (above and below grade grounding).
- Directly buried installations shall be used with cathodic protection if soil and environmental conditions require it, the Contractor shall investigate and propose the appropriate measures.
- All metallic electrical panels, Equipment enclosures and cable tray and conduit installations.
- Over-voltage arresters of electronic or spark gap type. (e.g. on all power circuits feeding electronic Equipment).
- Central grounding point of control cable shield grounding.

k) Equipment such as motor control centers, control panels, switchgear and transformers shall also be grounded, with at least two connections at opposite ends or corners, using branch ground conductors to the ground grid (ring).

l) All these individual systems shall be interconnected through liberally sized, insulated potential equalization conductors installed in the cable galleries/conduit banks or in the underground utility piping to finally form an integrated grounding and potential equalization system.

m) Smaller buildings (gate house, weigh bridge, etc.) may have one connection to the interconnecting system only.

n) Larger building foundations shall be connected in at least two places to the interconnecting network by an above ground connection, which permits circuitry inspection.

o) The building foundation shall not be used as a through connection for other buildings.

p) The interconnection system shall be a branch-network.

q) All connections shall be corrosion-proof (e.g. CADWELD).

r) All interconnections shall be either embedded in the concrete slab/wall or be accessible with a minimum of 50cm above ground.

s) Compression type cable lugs shall be used for connection of grounding conductors.

t) Above grade ground test stations using bolted connections shall be provided at each substation and electrical room to facilitate measurement of ground resistance to earth.

u) Maximum earthing grid resistance shall be less than 1 Ohm if not stated otherwise in local standards. The calculation shall be based on the worst soil resistivity (dry season).

9.6 Lightning Protection System

a) As a guideline the lightning protection system shall comply with the following international Standard and local regulation:

- IEC 62305

b) A comprehensive lightning protection system shall be installed to cover all buildings and structures.

c) Lightning protection facilities shall use air terminals (lightning rods) and dedicated down conductors to separate lightning grounding electrodes, to divert the lightning current path to ground through circuits of adequately low electrical resistance.

d) The lightning protection system shall be bonded to the Plant grounding system by separate tapping points.

e) The tapping points shall be at the outside of the building walls and shall be individually directly connected to the common below grade Plant grounding system.

f) The system shall consider building internal lightning protection measures (e.g. through adequate separation of installations, overvoltage arresters, etc.).

g) Where overhead wires on poles are used to distribute power, an overhead ground wire shall be installed above the power wires to provide a shield of protection against lightning strikes and shall be connected to

- the grounding grid system
- the rebars of the pole foundation or
- driven ground rods at the base of the pole

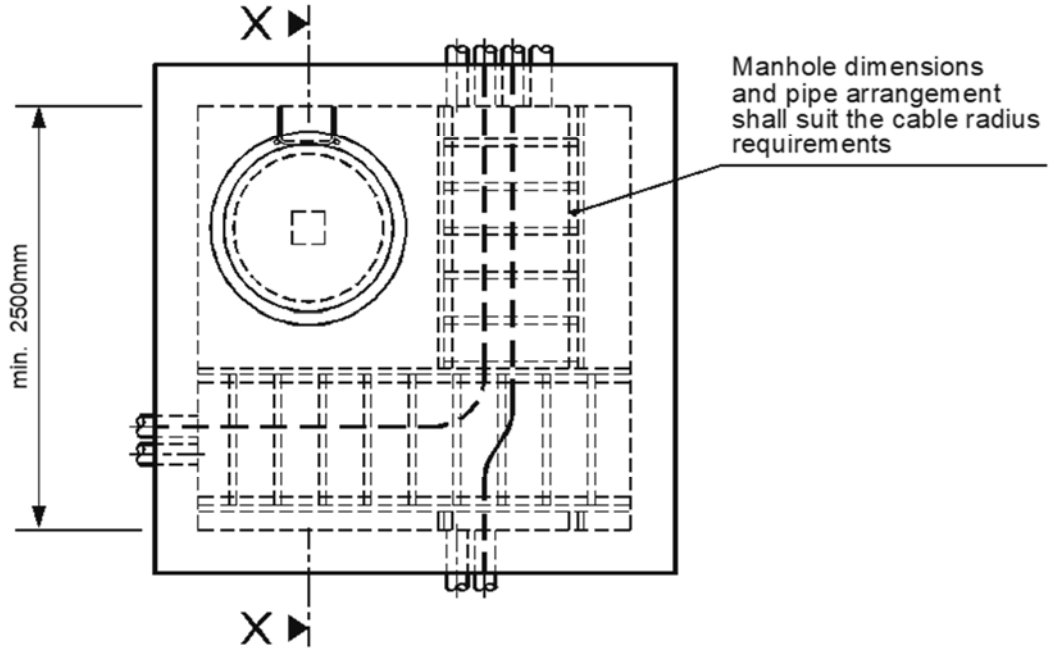
h) Overhead power lines shall be furnished at both ends with overvoltage surge arrestors.

9.7 Typical Drawings, Group E90

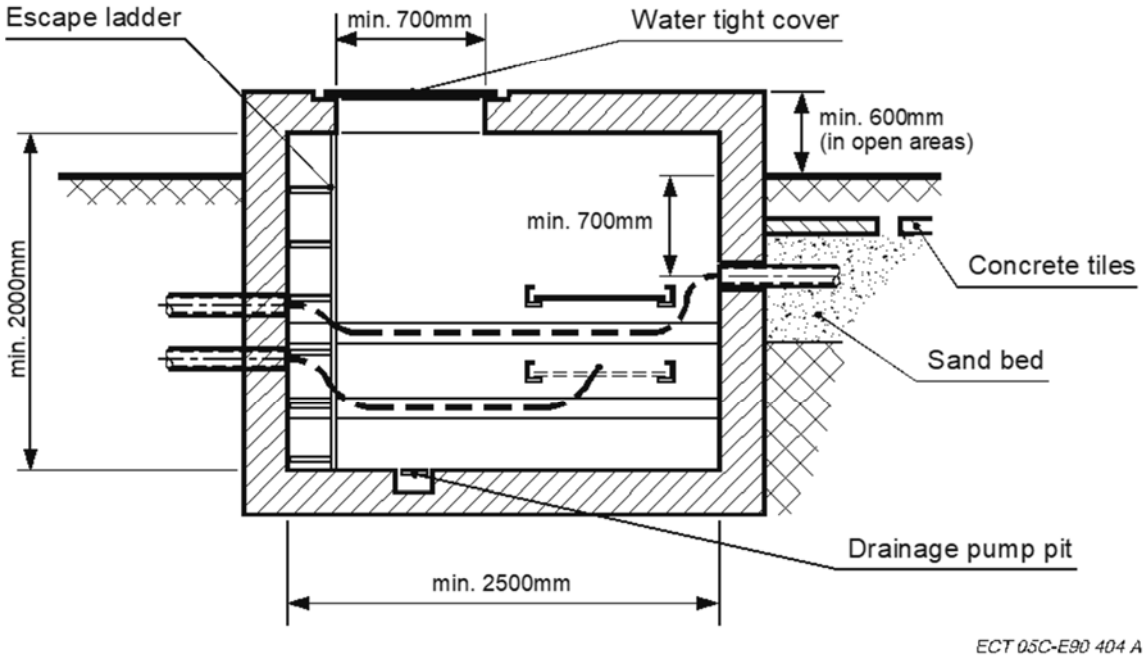
The typical grounding and lighting protection system schematic below shall serve as a guideline for the conceptual design, arrangement and installation of the electrical Equipment.

Manhole (cable pull pit)

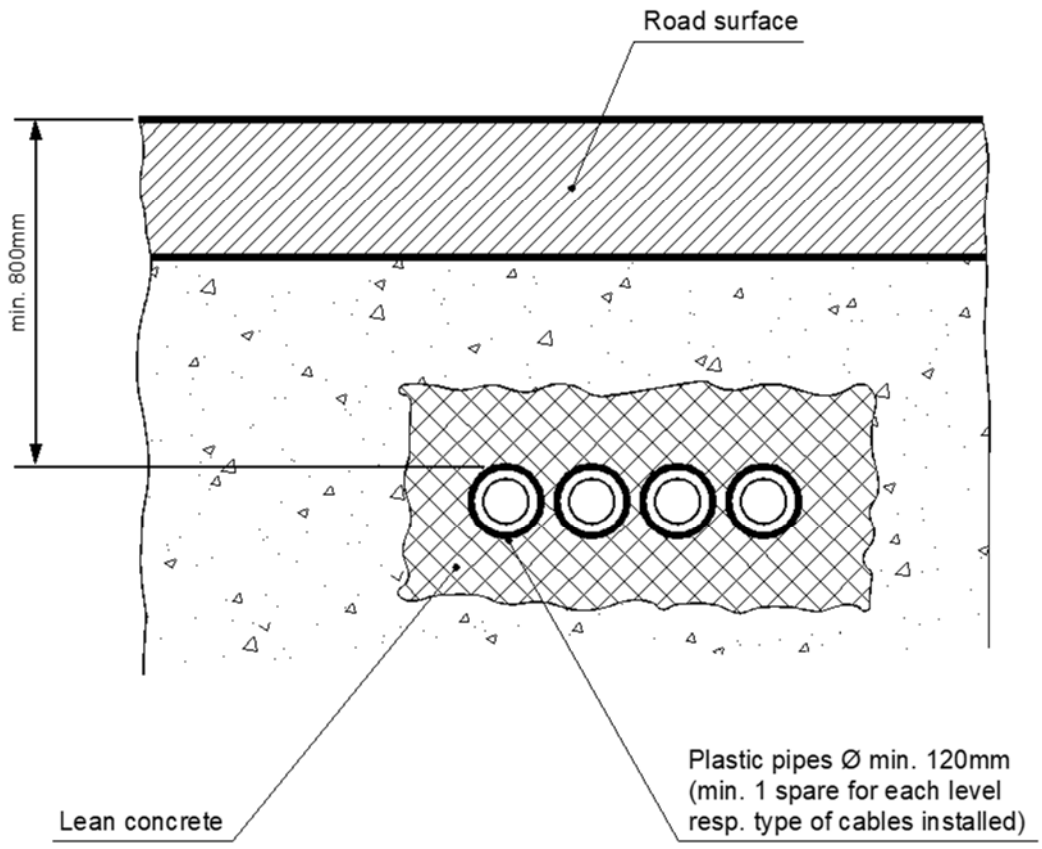
Plan view



View X-X



Road Underpass



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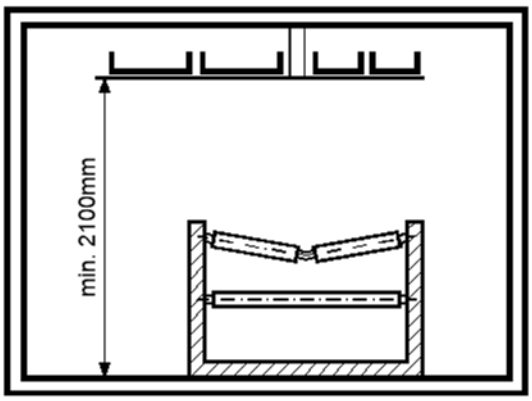
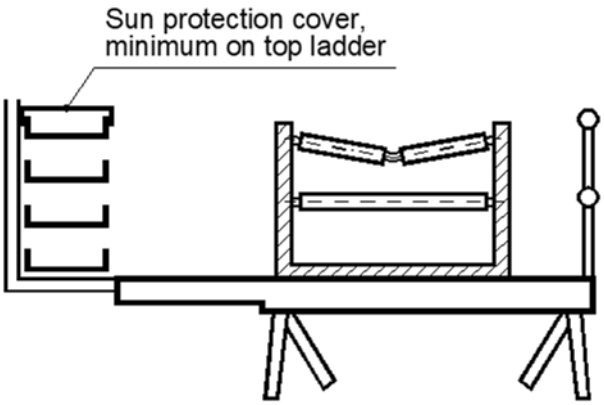
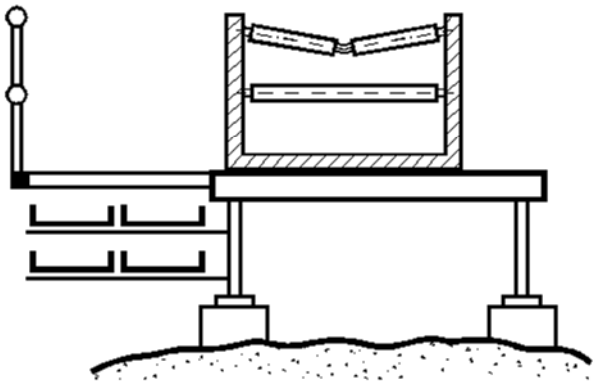
Main Cable Way along Belt Conveyors



If further trays are required above the access area, the head clearance of 2.1m below supports has to be maintained. The bridge structure may have to be adjusted accordingly.



On open bridges, high above ground (no extra hand rails required).



On open bridges with convenient working height for cable installation.

The walkway shall be steel plated instead of grating.

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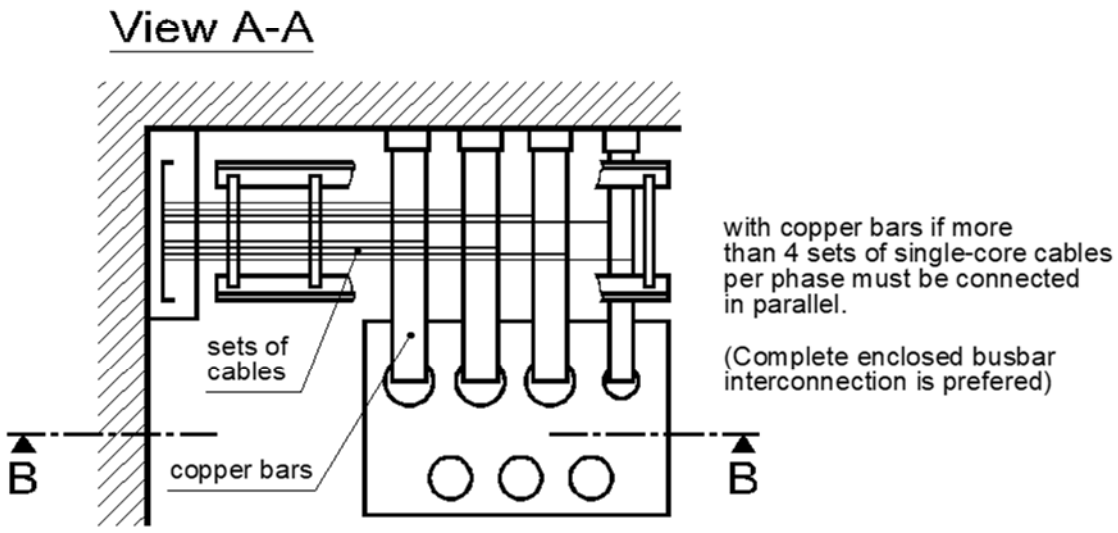
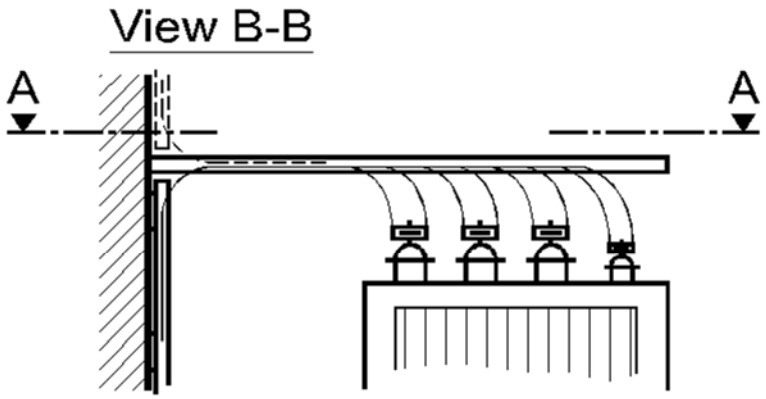
Transformer Connection (Typical)





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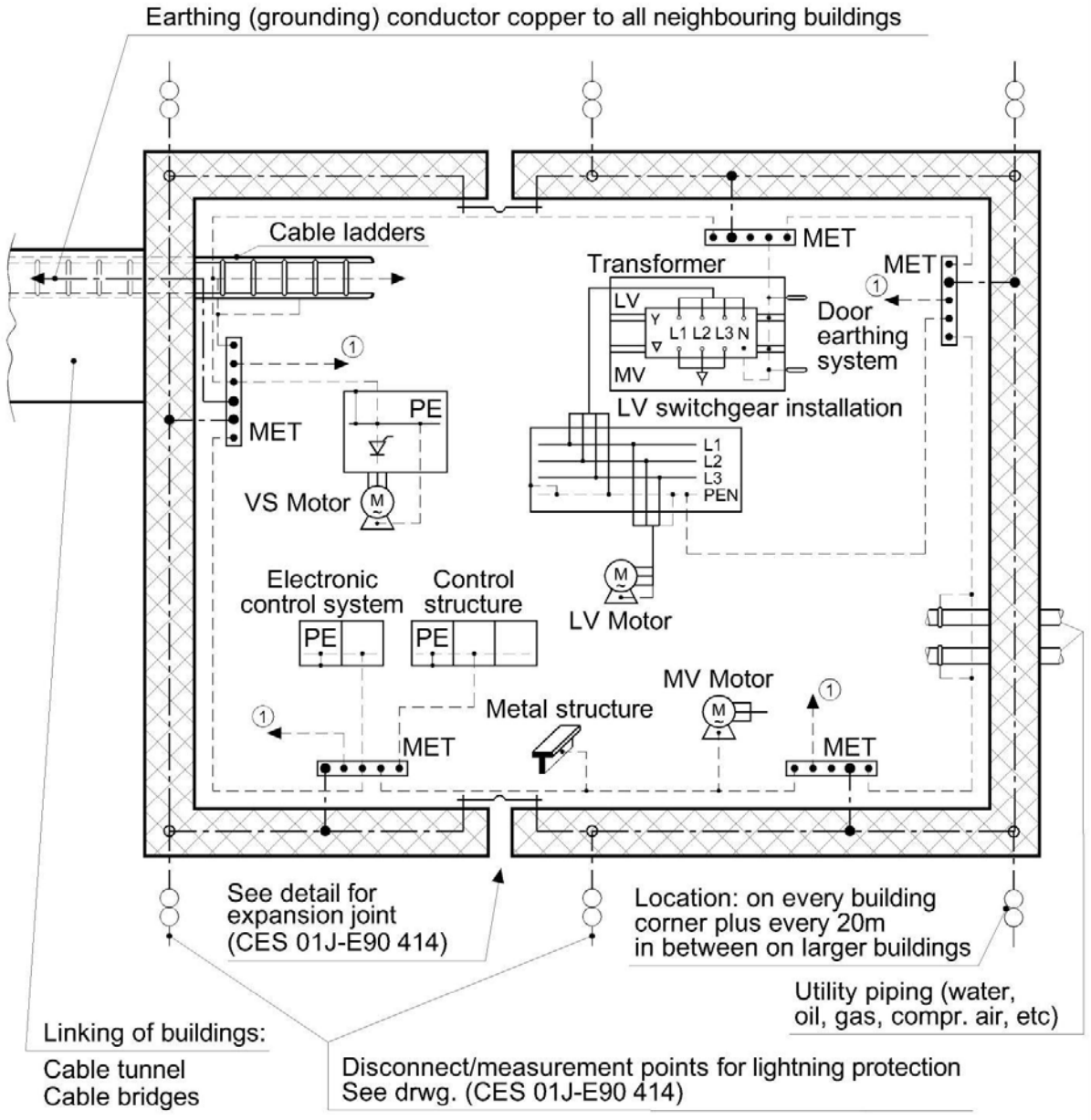
Grounding and Lightning Protection System

Foundation grounding electrode with internal connections to main earthing (grounding) terminal to other buildings and external connections for lightning protection



① = Building internal lightning protection measures. Steel ducting, steel stairs, elevator rails, any vertical steel (steel piping and structure, etc.)

MET = Main earthing (grounding) terminal with extended function for internal lightning protection

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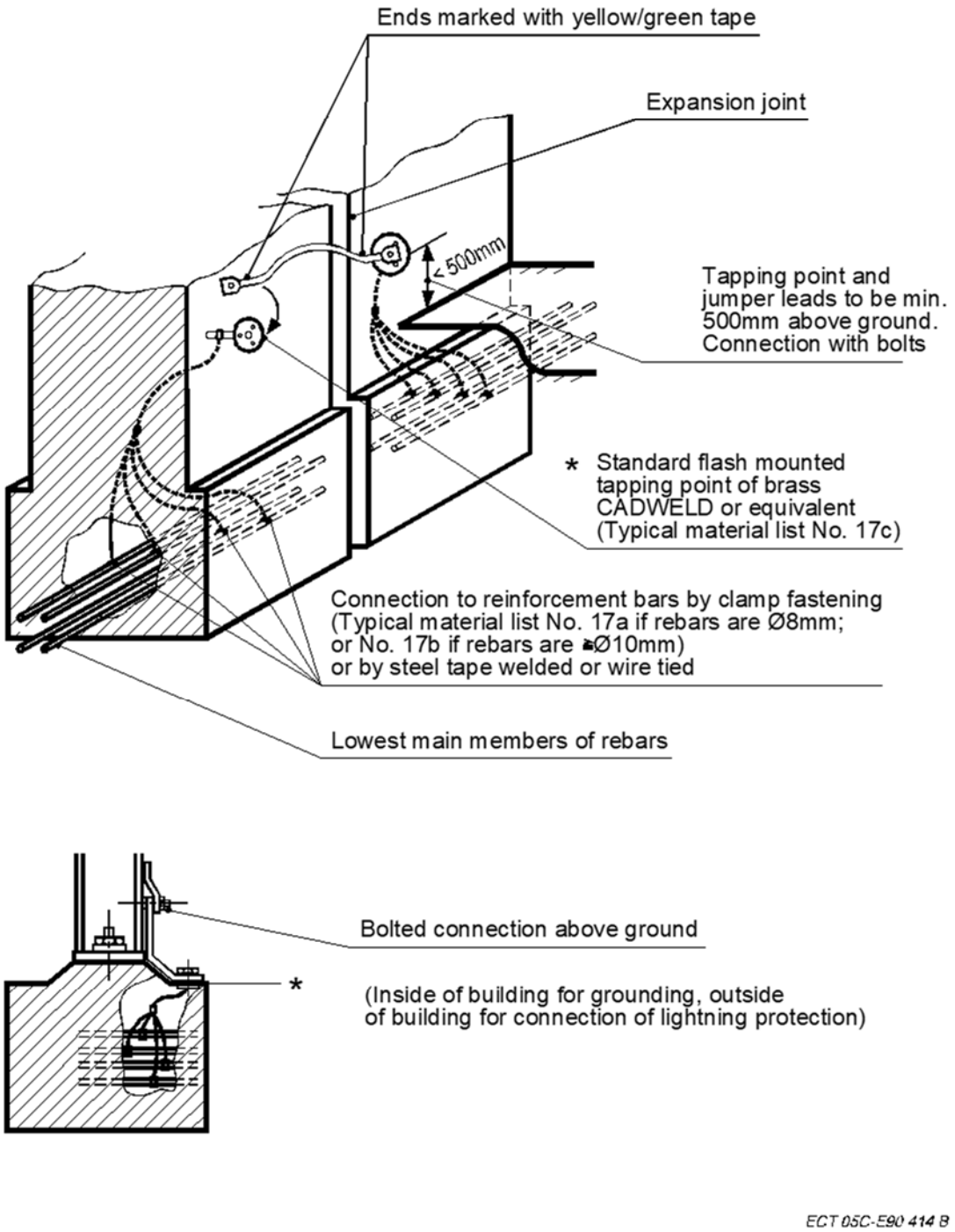
Foundation Grounding and Connecting Points



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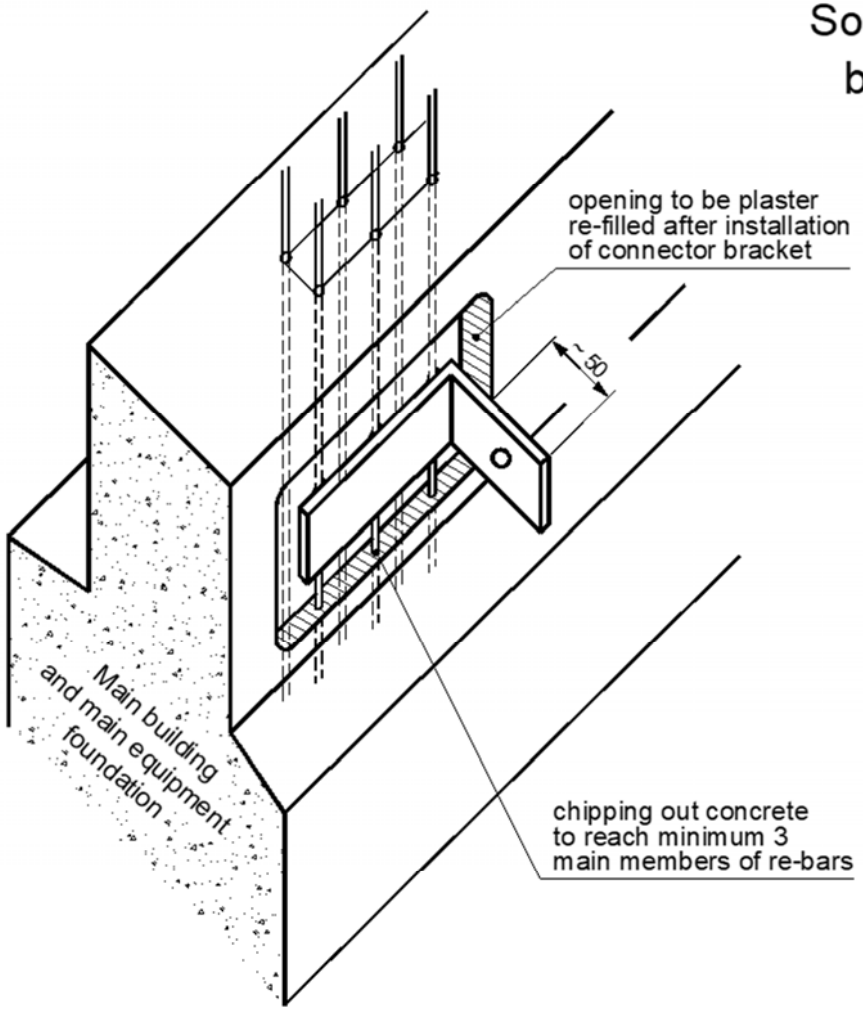
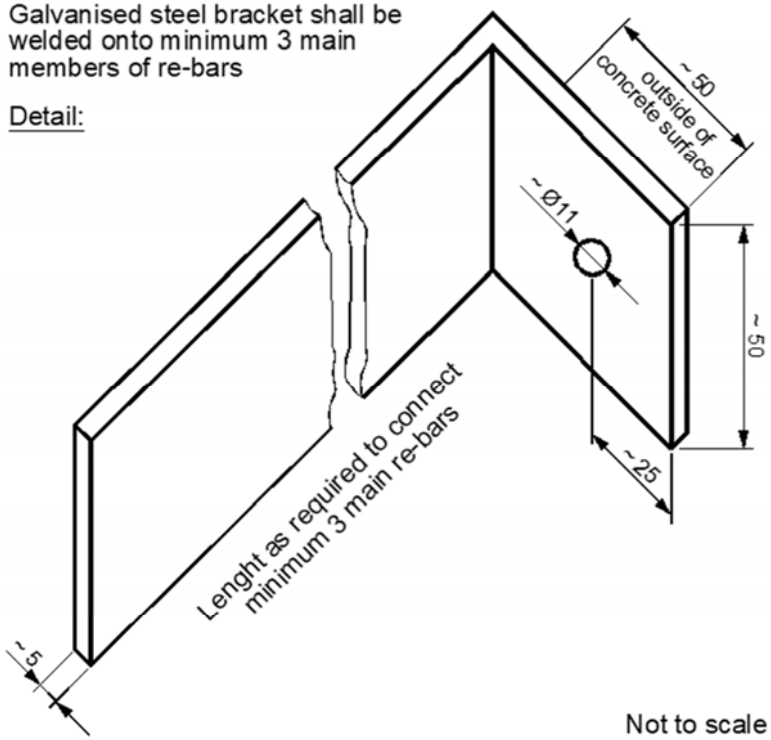
Solution to amend Initial Mesh Grounding by Elements of Foundation Grounding



Each main foundation of existing buildings and main equipment foundation:

Galvanised steel bracket shall be welded onto minimum 3 main members of re-bars

Detail:



Not to scale !

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