

# Technical Standard

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**Mondi AG.**

**Mondi Standard Harmonization**

## ELECTRICAL DESIGN CRITERIA

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## **ABBREVIATIONS**

AC Alternative Current

AI Analog Input

AO Analog Output

ATEX ATmosphères EXplosibles, explosive atmospheres

brown field rebuilt, existing process area

CE Conformité Européenne, European conformity

CENELEC European Committee for Electrotechnical Standardization

DC Direct Current

DCS Distributed Control System

DI Digital Input

DIN Deutsches Institut für Normung, German Institute for Standardization

DN Diameter Nominal

DO Digital Output

DTC Direct Torque Control

e.g. *exempli gratia*, for example

EC European Commission

EHSR Essential Health and Safety Requirements

EIA Electrical, Instrumentation and Automation

EMC Electromagnetic Compatibility

EN European Standard

etc. *et cetera*, and other similar things

EU European Union

EU-MEPS European Minimum Energy Performance Standard

Ex-area Explosive area

FE Functional Earth

green field new process area

HART Highway Addressable Remote Transducer

HD Harmonization Documents

HV High Voltage

i.e. id est, that is

I/O Input/Output

ICT Information and Communications Technology

IEC International Electrotechnical Commission

IP Ingress Protection

ISO International Organization for Standardization

IT no point is grounded directly, but one point can be grounded through impedance

LED Light-Emitting Diode

LV Low Voltage

MCC Motor Control Center

MV Medium Voltage

ND-end Non drive end

OT Operational Technology

PE Protective Earth

PELV Protected Extra-Low Voltage

PLC Programmable Logic Controller

PWM Pulse Width Modulation

SIL Safety Integrity Level

SIS Safety Instrumented System

SPM Shock Pulse Method

SRS Safety Related System

TN-S Terra Neutral Separate

UPS Uninterruptible Power Supply

VAC Volts Alternative Current

VDC Volts Direct Current

VFD Variable-Frequency Drive

VSD Variable Speed Drive

## 1 GENERAL

The purpose of this document is to present the criteria for electrical engineering, equipment and systems in Mondi pulp mill and paper mill projects. The aim is to describe the leading principles and practises. Detailed technical solutions are not presented.

### 1.1 Codes and Regulations

The equipment and installation shall comply with the following standards, regulations and instructions:

- Local authorities' regulations and recommendations
- Laws and regulations currently in force in the current country, especially
  - 250/2021 Sb. „Zákon o bezpečnosti práce v souvislosti s provozem vyhrazeným technických zařízení a o změně souvisejících zákonů“
  - NV 190/2022 Sb. „Nařízení vlády o vyhrazených technických elektrických zařízeních a požadavcích na zajištění jejich bezpečnosti“
  - NV 194/2022 Sb. „Nařízení vlády o požadavcích na odbornou způsobilost k výkonu činnosti na elektrických zařízeních a na odbornou způsobilost v elektrotechnice“
- EU norms and directives (Machine, PED, EMC, Low Voltage, ATEX, etc.)
- Project instructions
- Mill instructions
- IEC recommendations
- Mondi OT Security Policy
- Mondi standards:
  - MG0001 General Mill Specifications Summary
  - MEIA0001 Electrical, Automation and Instrumentation Instructions for Equipment and Machinery Suppliers
  - MEIA0002 Recommended Manufacturers for Electrical and Instrument Equipment
  - MEIA0003 Design Criteria For Instrumentation and Automation
  - MEIA0004 Electrical Design Criteria
  - MEIA0005 Cable standard
  - MEIA0006 Implementation Procedure for Safety Related Systems (SRS)
  - MEIA0007 Instrument and Automation Installation Standard
  - MEIA0008 Electrical Installation Standard
  - MEIA0009 Implementation Procedure for Control Systems (DCS, MCS) and FAT
  - MEIA0010 Implementation Procedure for Quality Systems (QCS, Web Break System, Web Inspection System, Vibration Monitoring System)
  - MEIA0011 Control Systems Process Interfacing Standard
  - MEIA0012 DCS and MCS programming standard
  - MEIA0013 Earthing and Lightning Protection Standard
  - MEIA0014 Building Electrification and Lighting
  - MEIA0015 Operational Technology Information and Communication Technology (ICT) standard
  - MEIA0016 Implementation Procedure for electrification, automation and instrumentation checkouts and cold commissioning
  - MM0002 Piping Standard (Process connections for instrumentation)

### **1.1.1 Machinery safety**

The Goods shall meet all existing legislative regulations of EU and local laws and those foreseen within the supply and commissioning timescales. The Plant and installations shall comply with the Machine directive 2006/42/EC, Low Voltage Directive 2014/35/EU and Electromagnetic Compatibility (EMC) Directive 2014/30 EU and be appropriately CE marked. All machinery will have to satisfy the Essential Health and Safety Requirements (EHSR) of this directive and any other safety regulations or special orders given in the form of standards. All inspections and quality controls required by the authorities before the test run in case of turn key projects shall be covered by the Supplier - otherwise costs to be covered by Purchaser. The costs of necessary X-ray inspection shall be included in the Tender.

In the cases, where the definition of machinery is according to “assembly of machines”, the Supplier of the main equipment is responsible for the complete EU declaration and CE marking.

The delivery of the Supplier includes the safety integration of the machinery with instructions for safe operation, installation and maintenance as well as risk assessment which is one of the obligations set forth for the machine manufacturer in the machine directive 2006/42/EC in order to declare EC conformity and affix CE marking. Further the delivery of the Supplier includes the EC declaration of conformity type IIA and CE marking in accordance with the machinery directive 2006/42/EC. For this purpose, the Purchaser delivers for the Supplier the EC manufacturer’s declaration type IIB of the motors and the conformity declarations according to LV and the EMC directive of the electrical and control equipment, which the Purchaser has bought from a third party according to the specifications by the Supplier.

### **1.1.2 Functional Safety**

International Generic Functional Safety Standard EN / IEC 61508 (Functional safety of electrical/-electronic/programmable electronic safety related systems) and the Technical Application Standard EN / IEC 61511 (Safety Instrumented Systems for the process industry sector) require complying with the safety life cycle model described in these standards in everything, which deals with operational safety.

The standard requires leading the requirements from the analyzed risks, to carry out the design fulfilling all the requirements, verifying and qualifying the various design stages. Operation and maintenance instructions shall ensure that the required level of security is maintained throughout the plant life cycle.

### **1.1.3 ATEX Classification**

ATEX (Atmosphere Explosible) classification for each Ex-area shall be made according to standards IEC 60079-10-1 (Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres) and IEC 60079-10-2 (Explosive atmospheres - Part 10-2: Classification of areas - Explosive dust atmospheres).

ATEX Zone classifications to zones 0, 1 and 2 for the explosive gases and liquids and zones 20, 21 and 22 for the inflammable dusts and powders shall be specified in the clarification. Ex-areas shall be presented in layout drawings with necessary sectional views in such a way that exact limits of the Ex-areas are clearly indicated there.

Qualities of the explosive gases and liquids as well as the dusts and powders shall be specified in the clarification. At least the flashing point, auto ignition temperature, explosion limits, temperature class and explosion group shall be informed.

The electrical and mechanical equipment for the Ex-areas shall be specified according to standards IEC 60079-0 (Explosive atmospheres - Part 0: Equipment - General requirements), IEC 60079-14 (Explosive atmospheres - Part 14: Electrical installations design, selection and erection) and ISO 80079-36 (Explosive atmospheres - Part 36: Non-electrical equipment for explosive atmospheres)

## 1.2 References

Machine directive 2006/42/EC

Low Voltage Directive 2014/35/EU

Electromagnetic Compatibility (EMC) Directive 2014/30/EU

MEIA0005 Cable standard

MEIA0008 Electrical Installation Standard

MEIA0011 Control Systems Process Interfacing Standard

MEIA0013 Earthing and lighting protection standard

MEIA0014 Building Electrification and Lighting

MG0001 General Mill Specifications Summary

IEC 60034-30-1:2014 Rotating electrical machines - Part 30-1: Efficiency classes of line operated AC motors

IEC 60072-1:1991 Dimensions and Output Series for Rotating Electrical Machines - Part 1: Frame Numbers 56 To 400 And Flange Numbers 55 To 1080

IEC 60072-2:1990 Dimensions and Output Series for Rotating Electrical Machines - Part 2: Frame Numbers 355 To 1000 And Flange Numbers 1180 To 2360

IEC 60072-3:1994 Dimensions and Output Series for Rotating Electrical Machines - Part 3: Small Built-In Motors - Flange Numbers BF10 To BF50

IEC 60079-0:2009 Explosive atmospheres - Part 0: Equipment - General requirements

IEC 60079-10-1:2020 Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres

IEC 60079-10-2:2015 Explosive atmospheres - Part 10-2: Classification of areas - Explosive dust atmospheres

IEC 60079-14:2013 Explosive atmospheres - Part 14: Electrical installations design, selection and erection

ISO 80079-36:2016 Explosive atmospheres - Part 36: Non-electrical equipment for explosive atmospheres

IEC 61508:2010 Functional safety of electrical/-electronic/programmable electronic safety related systems

IEC 61511:2020 Functional safety - Safety instrumented systems for the process industry sector

IEC 61850:2020 Communication networks and systems for power utility automation

EN 62035 :2014 Protection against lightning

## **2 AMBIENT CONDITIONS AND ENCLOSURE CLASSES**

### **2.1 Ambient Conditions**

Ambient conditions are shown on appendix of General Mill Specifications Summary MG0001.

### **2.2 Enclosure Classes**

#### **2.2.1 Motors**

- |                   |      |
|-------------------|------|
| – Motor enclosure | IP55 |
| – Terminal box    | IP55 |

#### **2.2.2 MCCs, Boxes and Panels**

- |   |      |
|---|------|
| – Process area  | IP55 |
| – Electrical rooms                                      | IP21 |
| – Electrical rooms in some cases (agree with purchaser) | IP54 |

#### **2.2.3 Field Equipment**

- |                     |      |
|---------------------|------|
| – Field instruments | IP65 |
| – Positioners       | IP65 |
| – Local switches    | IP65 |
| – Safety switches   | IP65 |

All electrical and electronic devices as well as components included in the delivery have to be in accordance with the above mentioned enclosure classes, or they have to be mounted in an enclosure in accordance with the ambient condition requirements.

Field junction boxes placed outside and containing sensitive electronics must be protected from direct sunshine, air purged internally, closed door sensors and temperature indication.

The Supplier shall include specification of area classification for special requirements such as ATEX process areas etc. The protection class of the electrical and instrument equipment located inside classified area must correspond to the area requirement.

## 2.3 Engineering

The required engineering within the Supplier's delivery scope has to follow International standard and Best engineering practice.

## 3 VOLTAGES

### 3.1 High Voltage

3-ph. 110 kV, 50 Hz, solidly earthed neutral

### 3.2 Medium Voltages

3-ph. 20 kV, 50 Hz, unearthed

3-ph. 6 and 10 kV, 50 Hz, resistance earthed or unearthed neutral (to be agreed with Purchaser)

### 3.3 Voltage Systems

The available electrical power supply system is a typical industrial network and the quality of the power supply will be of corresponding standard. The equipment shall be suitable for operation in these conditions and with voltage variation of -10...+10 %.

#### 3.3.1 Motor Voltages

Motor ratings:

Voltages:

0.25 kW...630 kW

690 V, 50 Hz (TN-S system without neutral)  
The terminal box connection of 0.25 kW...630 kW is 690 V Y/ 400 VΔ.

> 630 kW, direct on-line motors

6kV or 10,5 kV, 50 Hz (Resistance earthed).

Frequency controlled motors  
≤ 1600 kW.

690 V, 50 Hz (TN-S system without neutral, for single drives, IT system for sectional drives) Maximum power limit must be agreed for each project.

Motors ≤ 0.25 kW.

400 V, 50 Hz (TN-S system)  
Power limits and voltages must be agreed for each project.

Small special motors.

400 V or 230V, 50 Hz (TN-S system)  
Voltage of small special motors shall always be separately agreed for each project.

Motor voltage of small motors (≤ 4 kW) for frequency converter drives can be 400 V, 50 Hz. The voltage of small frequency converter motors shall always be separately agreed for each project.

The voltage of large motors > 630 kW shall always be separately agreed for each project.

### 3.3.2 Other Loads

Other loads such as tools, lighting, cranes, etc. will be connected to the distribution system of 400/230 V, 50 Hz; with solidly earthed neutral point, TN-S system. Neutral (N) and protective earth (P) shall not be connected in any part of the distribution system.

Heaters for process equipment will be connected to the distribution system of 690 V or 400 V. The voltage of heaters shall always be separately agreed for each project.

Where the machine delivery includes equipment, which requires the use of safety voltage, it shall be PELV system and voltage 24 VAC, no more than 50V DC. Necessary protective transformers and other equipment (lighting fittings etc.) shall be included in the delivery. If other voltages are needed, they shall be agreed on separately.

### 3.3.3 Control Voltages

The control voltages will be:

–	Binary sensors	24 VDC
–	Solenoid valves, < 2.5 W, preferred	24 VDC
–	Solenoid valves, > 2.5 W	24 VDC (230 VAC in special cases)
–	MCC starter, internal	24VDC or 230 VAC
–	Safety devices on field	24 VDC (230 VAC in special cases)
–	Auxiliary voltage HV and MV switchgear	110 VDC or 220 VDC Voltage of auxiliary shall always be confirmed for each project.

Generally, the control voltage is a solidly earthed voltage of 230 V 50 Hz. Normally it is supplied from 690/230 V or 400/230 V control voltage transformers. For automation and electronic equipment an operational-earthed 400/230 V, 50 Hz voltage secured with UPS equipment will be used. In equipment connected to control systems, 24 V DC is used as field voltage.

Two 24 VDC power supply units (able to operate in redundant mode, one unit is large enough to supply all load) will be used for DCS.

### 3.3.4 Signal Ranges

In green field:

- Analog signal                      4 to 20 mA DC (with Hart)
- Fieldbus                              Profibus PA, Profibus DP, Profinet preferred

In brown field:

- Analog signal                      4 to 20 mA DC (with Hart)

0 to 20 mA DC  
 0 to 10 VDC  
 0 to 20 VDC

– Fieldbus Profibus PA, Profibus DP, Profinet

In the brown field the existing communication protocol will be used. The communication protocol shall always be agreed separately in all projects.

### 3.3.5 Communication

In the green field projects (new process areas) there are 3 alternatives for communication:

- Traditional hardwired signals from field or MCCs to system I/O modules in rack and electrical rooms
- Distributed I/O in the field boxes or in MCC rooms
- Profibus PA, Profibus DP, and Profinet for instrumentation and device bus for motor controls

In the brown field projects (rebuilt) the existing communication protocol will be used.

The communication protocol shall always be agreed separately in all projects.

Communication details are given in document MEIA0011 Control systems process interface.

### 3.3.6 Auxiliary Voltage Supply

- |                            |                       |
|----------------------------|-----------------------|
| - Alternating current (AC) | 230 VAC               |
| - DCS / PLC                | 230 VAC (UPS network) |
| - Direct current (DC)      | 24 VDC                |

These auxiliary voltage supplies will be supplied by a centralised UPS arranged in redundant solution.

## 3.4 Air Supplies

There are two oil free air networks available

- |                             |                     |
|-----------------------------|---------------------|
| – Mill air / Instrument air | 6.0 bar (a) nominal |
|                             | 7.0 bar (a) maximum |

Actuators have to be sized to function at 5 bar (a), critical applications at 4 bar.

If the equipment requires a supply pressure lower than the nominal pressure of the system, a combined filter/pressure reducer shall be included. If there are several pieces of equipment in the same area, a common double filter/pressure reducing station can be used to supply multiple equipment.

Equipment requiring oil lubrication is not to be used where a no lubrication alternative exists.

### 3.5 Voltage Drops

Allowed maximum values for voltage drops are:

<u>Service type</u>	<u>Max. allowed voltage drop %</u>
110 kV switchgear	3 % (caused by large motor start)
20 kV switchgear	8 %
6 kV and 10 kV switchgears	8 % (bigger motors to be check case by case)
400/690V feeder cable to sub-MCC	2.0%
400/ 690 V motor cables:	
– from MCC	5 %, at motor start 10 %
– from sub-MCC	3 %, at motor start 10 %
Control cable	6 %
Lighting panel feeder cable	1.5 %
Lighting home-run	3 %

## 4 POWER FACTOR AND HARMONIC FILTERS

### 4.1 Power Factor Correction Units

Power factor correction is applied at Medium Voltage level by installing capacitor banks including detuned or 5th harmonic filters.

The equipment shall be suitable for outdoor installation. Indoor applications upon request of Purchaser possible.

Insulation system temperature shall be F, Environmental class E2 and Fire behaviour class F1.

Power factor correction units will be used to produce reactive power which will be consumed by motors and other loads. The system will be designed so that produced and consumed reactive power is in balance in the mill connection point of the grid.

### 4.2 Lighting Power Factor Correction

Capacitors fit for inductive loads (gas discharge tube with choke). For projects LED with PF >0.95 should be used. No external power factor correction necessary.

## 5 EARTHING SYSTEM

The earthing system principles are shown in appendix I 400 V TN-S systems, earthing principles and appendix II 690 V TN-S systems, earthing principles. The earthing and lightning protection are given in document MEIA0013

### 5.1 Earth Electrode

Earth electrode consists of 70 mm<sup>2</sup> cu or bare Fe/Zn flat bar iron (5x40 mm), which is installed around the building underneath building foundation at about 1 m depth. Supplementary connecting ropes across the building will be installed at about 80 m intervals. Piling reinforcement steel or 70 mm<sup>2</sup> cu will be connected to earth electrode at about every second or third column. Pigtails for earthing cable connection will be taken up at about every third outside wall building column and one in a transformer room and one or two in cable room on the ground floor. Pigtails for earthing cable connection will be taken up also a few places inside the building.

Process towers/ tanks in the outside of buildings shall be connected to the earthing electrode. Purpose of these connections is lightning protection and also potential equalizing.

### 5.2 Earthing Network

Earthing cable (120 mm<sup>2</sup> Cu yellow-green) will be installed in loop form on main cable routes at each building. The main earthing cable will be connected to earth electrode (pigtails) at regular intervals. The earthing loops of different buildings will be connected together.

Earthing bars will be installed in cable rooms underneath electrical rooms. Also earthing bars will be installed in field above ground floor level, where needed (e.g. under paper machine). These bars will be connected to earthing electrode (pigtails) and to main earthing cable on cable trays.

Each feeder bus-duct shall be including the earthing wire all the way from the feeding transformer.

The Low voltage power distribution system is TN-S system. TN-S system neutral (N) and protective earth (PE) shall not be connected together at any part of the distribution system other than at the main distribution centre.

Each feeder or motor cable shall include earthing wire all the way from the feeding panel or MCC.

Additionally all electrical equipment located at electrical rooms will be connected to earthing bars with adequate size yellow green copper cable for potential equalizing.

Each distribution transformer bay will be equipped with earthing bar.

Field equipment potential equalizing earthing cables will be connected to earthing bars or directly to the main earthing cable.

### **5.3 Signal Earthing**

Screened signal cables shall be used for low voltage signals. The screen will be connected to functional earthing (FE) in electrical or rack rooms. The screen will be isolated in the field end.

Separate dedicated earthing bars will be installed for signal earthing. Only control system signal earths and signal cable shields will be connected to functional earthing bars.

Functional earthing bars (FE) will be connected to protective earthing bars (PE) with 120 mm<sup>2</sup> Cu cable. There will not be separate earth electrode for functional earthing.

Black insulated Cu-cables, marked with FE, will be used for signal functional earthing.

The functional earthing system principles are shown in appendix I 400 V TN-S systems.

### **5.4 Lightning Protection**

In the beginning of design phase shall be made lightning protection risk assessment according to standard IEC 62305-2. According the result will be determined the lightning protection level.

All metallic parts on the roof shall be connected to the lightning protection net (hand trails, walkways, cable trays, ventilation equipments, etc.). Also metal-sheeted outside walls shall be connected to the lightning protection net.

Lightning protection net shall be connected to the main earthing electrode. Interval of the connection points shall be about every third wall column (outside walls) and every outside corner of the building.

## **6 TRANSFORMERS**

### **6.1 General**

Transformers responsible shall be according to Tier 2 class requirements. (The Eco design Directive from the European Commission that takes effect for transformers Tier 2 in July 2021).

### **6.2 Main Transformers**

The main transformers will be oil immersed ONAN/ONAF cooled transformer equipped with an on-load tap-changer.

HV side will be equipped with surge arresters.

MV cable connection will be equipped with surge arresters.

### 6.3 Distribution Transformers

Dry type cast resin air natural (AN) cooled distribution transformers equipped with off-load tap-changers will be used.

Main specifications dry type distribution transformers:

- 4000 kVA,  $20000 \pm 2 \times 2.5 \%$  / 725 V, impedance voltage 8 %
- 3150 kVA,  $20000 \pm 2 \times 2.5 \%$  / 725 V, impedance voltage 7 %
- 2500 kVA,  $20000 \pm 2 \times 2.5 \%$  / 420 V, impedance voltage 8 %
- 2000 kVA,  $20000 \pm 2 \times 2.5 \%$  / 420 V, impedance voltage 6 %

Other alternative transformer sizes will be separately agreed in each project

MV side will be equipped with surge arresters.

#### 6.3.1 Connection Groups

Dyn5 or Dyn11 connections are used in standard transformers. Alternative will be separately agreed for each project which switching group is used (Dyn5 or Dyn11)

Sectional drive systems are isolated IT system. Vector groups Dyn5 or Dyn11 and Yy0 are used in pairs for transformers, which feed IT system, to reduce harmonics. The extra losses created by harmonics shall be always considered when selecting transformers.

## 7 STEP-DOWN TRANSFORMERS

The use of step down transformers shall be avoided and the use shall always be agreed with the purchaser.

10 kV, 6 kV or 690 V  $\pm 2 \times 2.5 \%$  / 400 V dry transformers will be used to feed possible 400 V and 230 V process loads. Connection group shall be Dyn5 or Dyn11 (Alternative will be separately agreed for each project which switching group is used (Dyn5 or Dyn11)) Primary and secondary windings shall be galvanically isolated. 400 V system shall be TN-S.

Transformers shall have 20 % reserve capacity for future extensions.

Enclosure class shall be IP21 in electrical rooms and IP54 in process areas.

Transformers shall be equipped with earthed screen between HV and LV windings.

Transformer shall be equipped with two temperature switches with PT100 sensors. Alarm switch shall be set to 130°C and trip switch to 155°C.

## 8 SWITCHGEAR

### 8.1 20kV, 10kV and 6 kV Switchgears

The switchgears will be type-tested, metal-clad switchgear equipped with withdrawable vacuum circuit breakers. The degree of protection shall be IP3X or

better. Hot gases caused by an arcing fault are directed outdoors via pressure relief channels. The cubicles shall have a front door or front plate to cover the circuit breaker compartment. There shall be no exposed live parts with the door open.

All feeder and incoming cubicles as well as the bus bars shall be equipped with a make-proof earthing device, which can be operated only when the cubicle door is closed and the circuit breaker withdrawn. Reservations shall be made for future additional cubicles.

Main specification data:	<u>20 kV</u>	<u>10kV</u>	<u>6 kV</u>
– Rated voltage	24 kV	12 kV	7.2 kV
– Service voltage	20 kV	10kV	6 kV

Short circuit current (there are only typical values, the sort circuit current must minimum correspond to the calculated value):

– One second withstand current	25 kA	50 kA	50 kA
– Peak withstand current	63 kA	125 kA	125 kA
Degree of protection	IP 3X	IP3X	IP 3X

Each feeder will be equipped with pad-lockable earthing switch.

## 9 AC/DC CONTROL VOLTAGE SYSTEM

The system shall consist of:

- Batteries, 220 V DC or 110 V DC (The voltage will be separately agreed for each project) for 16 h operation
- Automatic battery charger
- AC and DC control and distribution panels including all necessary fuses plus 20 % spares, switches, protective relays ammeters, voltmeters and distribution circuits for supplying control voltages to the switchgear.

Separate AC and DC panels shall be provided with fused switches for feeders including 3 pcs per each type for installed spares. Fuses shall be selective with MCBs in switchgear cubicles. All feeder fuses and the main battery fuses shall be provided with alarm contacts. Alarms for under voltage and earth faults and charger alarms shall be included.

Alarms, measurements and indications will be connected to the one of the protection relays in switchgear or separate device to enable a transfer to the mill digital control system.

The batteries and the charger shall be rated according to the maximum DC load including 30 % extra capacity for future extensions. The batteries shall be installed taking into account efficient cooling.

## **10 DIESEL GENERATOR**

### **10.1 General**

Emergency diesel generator set with automatic load transfer capability will be installed to supply stand by power to essential services and critical loads.

### **10.2 Diesel Engine Cooling System**

The cooling system shall be of the closed loop type.

The full load immediately after start. The pre-heater shall be equipped with a thermostat-controlled electrical water heater.

### **10.3 Fuel System**

The size of the fuel tank shall be sufficient for 8 hours continuous running at full load.

Requirement to use Diesel exhaust fluid AdBlue AUS 3, DEF.

### **10.4 Lubricating Oil System**

In the design of the lubrication system automatic starting of the engine should be considered (automatic priming).

### **10.5 Exhaust Pipe and Silencer**

Exhaust pipes from the engine to the outside air and silencers with flexible coupling to the engine.

### **10.6 Generator**

The generator shall be a self-ventilated brush-less synchronous machine, with protection class IP 23 or better.

Accuracy of voltage in steady state conditions shall be  $\pm 1\%$ .

Anti-condensation heaters shall be included, automatically connected when the generator is not energised.

### **10.7 Automatic Starting Equipment**

Equipment shall be provided for automatic starting of the set as described with starting battery and charger and necessary ammeters and voltmeters.

### **10.8 Controls**

The following controls shall be provided:

- diesel generator synchronizing: AUTO-MANUAL
- diesel generator synchronizing: SYNCHRONIZING
- machine operation selector switch: AUTO-0-MANUAL
- lubrication oil priming selector switch: AUTO-0-MANUAL
- diesel engine preheating switch
- start, stop and test run switches
- speed (frequency) setting switch
- voltage setting switch

## 11 UPS

### 11.1 UPS unit

Centralised UPS-systems shall be provided to feed power to LV switchgear; process equipment and field instruments requiring unbreakable power, DCS, PLC, etc. UPS- systems consist of UPS and main distribution board. Each UPS shall be complete with rectifier, batteries, frequency converter, automatic static switch and manual by-pass switch. Additionally a manual maintenance switch (with make-before-break contacts), which by-passes UPS, shall be provided in each UPS- system. Main distribution board includes feeder for voltage distribution panels located in different electrical and control rooms.

3-phase UPS device rating:

- voltage setting switch
- Nominal output as required, allowed loading max. 50 %
- Nominal voltage, interface 400 V,  $\pm 10$  %, 50 Hz, 3-phase
- Nominal output voltage 400 V,  $\pm 1$  %, 3-phase
- Output frequency 50 Hz,  $\pm 1$  %
- Overload 150 % of rated power – 5 sec
- Overload 135 % of rated power – 30 sec
- Battery runtime 30 minutes

The UPS units' construction shall comply with protection class IP20. The battery bank shall comply with protection class IP20 (capacious cabinet). Isolation transformers at UPS output will be used.

### 11.2 Batteries

Stationary sealed LiFePO<sub>4</sub> batteries shall be used.

Battery life shall be at least 12 years (a so-called 12+ year battery).

The batteries shall be installed in parallel in two groups so that they can be used at half load (50 % + 50 %). The battery poles shall be reliably screen-protected.

## 12 LV MCC'S

### 12.1 Dimensioning

Main dimensioning data Rated voltage 400 V:

400 V Main board		
Rated insulation voltage	V	1 000
Rated operational voltage	V	400
Rated Frequency	Hz	50
System neutral		TN-S

Short circuit currents (there are only typical values, the sort circuit current must minimum correspond to the calculated value).

Short circuit current with a 2000kVA transformer:

- One second withstand current            50 kA
- Peak withstand current                    125 kA

Short circuit current with a 2500kVA transformer

- One second withstand current            63 kA
- Peak withstand current                    160 kA

Main dimensioning data Rated voltage 690 V:

<b>690 V MCC's</b>		
Rated insulation voltage	V	1 000
Rated operational voltage	V	690
Rated Frequency	Hz	50
System neutral		TN-S without neutral

Short circuit currents (there are only typical values, the sort circuit current must minimum correspond to the calculated value).

Short circuit current with a 2000kVA transformer:

- One second withstand current            50 kA
- Peak withstand current                    125 kA

– Short circuit current with a 4000 kVA transformer:

- One second withstand current            63 kA
- Peak withstand current                    160 kA

Bus ducts will be used for power connection between transformer LV terminals and MCC incoming cubicle.

## 12.2 Incoming Section

MCC incoming cubicle will be equipped withdrawable circuit breaker with a multifunction protection and metering relay. Bus-duct earthing switch and bus-bar earthing switch.

Main MCC's and main lighting boards will be equipped with arc protection.

### **12.3 Earth Fault Alarm**

690 V sectional drive centres (IT -system) will be equipped with Bender (or equal) ground fault alarm and localization system.

### **12.4 Motor Starters**

MCCs and Switchboards, which will be located in separate electrical rooms. Motor starters will be equipped with intelligent motor controllers, which are controlled via fieldbus.

Withdrawable cassette type MCC's with intelligent starters will be used. Withdrawable cassette types are used  $\leq 55\text{kW}$ . The power limit must be agreed with purchaser on a case by case basis.

Starters up to 250 kW motors will be sized to accept next larger size motor by replacing just fuses and/or thermal relay.

690V fused motor starters with contactors for motors  $\leq 400\text{ kW}$  and starters equipped with compact circuit breaker for motors  $\geq 500\text{ kW}$  shall be used.

Compact circuit breaker (CBs) shall be withdrawable.

The typical wiring and circuit diagrams are shown in appendix III. They are factory specific and they will be separately agreed case by case. The purchaser must always confirm them separately.

### **12.5 Sub MCC's**

25, 63, 125, 250, 400 and 630 A sub MCCs will be fed with fuse-switches from main board.

800, 1250 and 1600 A sub MCCs will be fed with circuit breaker feeders from main board.

Short circuit withstand current requirements for circuit breaker feeders will be the same as for main board.

### **12.6 Reserve space**

Each MCC shall have about 20% spare space and additionally 15% ready furnished spare starters. Installed motor power shall be taken account when spare starters are selected.

## **13 MOTORS**

### **13.1 General**

Motors should be suitable for heavy industrial use

Only direct-on-line squirrel cage induction will be used. The use of other types will be separately agreed for each project. High efficiency motors must be used.

Special and high- output motors shall be separately agreed for each project.

### **13.2 Standards**

The frames and shaft extensions of the 400/690 V motors have to comply with the IEC recommendations 60072-1, 60072-2 and 60072-3. The electrical characteristics have to be in accordance with the CENELEC specifications HD 231. Motor sizes will be selected from the following series: 0.25, 0.37, 0.55, 0.75, 1.1, 1.5, 2.2, 3.0, 4.0, 5.5, 7.5, 11, 15, 18,5, 22, 30, 37, 45, 55, 75, 90, 110, 132, 160, 200, 250, 315, 400, 500 and 630 kW.

### **13.3 Efficiency**

0,75 - 1000kW motors shall be at least efficiency class IE3 (premium efficiency) and 0,12 -055kW motors shall be at least efficiency class IE2 according to IEC 60034-30-1 (Rotating electrical machines - Part 30-1: Efficiency classes of line operated AC motors).

### **13.4 Frame Structure**

The terminal box and terminals shall be built according to Project motor cable standard. Cable glands and angle adaptor shall be included.

Frequency converter driven motor cable glands shall be meet EMC installation instructions and be appropriated for shielded cables

Preference is for top mounted main terminal boxes with cable entry from any direction except the top. If this is not possible, terminal boxes shall be located on the left-hand side, viewed from load coupling side of motor, with cable entry from front, back or bottom of the box.

All motors should be cast iron. Deviations will be separately agreed for each project

First choice shall be the use of foot mounted, horizontal motors (B3).

Flanged motors shall be equipped with feet (B3/B5 or B3/V1).

All totally enclosed frames shall be provided with a drain hole and threaded plug at the low point. All motors shall be built in IEC standard frames.

For squirrel cage motors 690 V / 400 V ( $\leq 630$  kW) the fan must be so designed that the motor can rotate in both directions without change of fan.

### **13.5 Dimensioning**

Sufficient reserve power (about 15 %), exceptional use (long starting time, frequent starts, jogging) and ambient temperature at the motor location (over +35°C) have to be taken into account in motor selection. Considerable over sizing should however be avoided.

IC 411 motors will be used whenever it is possible.

The motors shall be of insulation class F with class B (+80 °C) temperature rise.

Primarily four-pole motors (1500 l/min) and secondarily six-pole motors (1000 l/min) shall be used.

The manufacturer's instructions concerning the bearings and shaft ends have to be checked for the suitability of belt drive.

The motor foundation stud for the motor shall be large enough to receive the next larger standard rating. If the shaft height of the next-size motor is higher, the motor shall be installed on intermediate plates, which can be removed should change of the motor be required. Necessary intermediate plates are part of the machine delivery.

In hot environments special greases need to be taken into consideration

### **13.6 Accessories of Motors**

6 kV and 10,5 kV motors shall be equipped with winding and bearing Pt 100 or Pt 1000 temperature sensors. Motors shall be equipped with doubled Pt 100 or Pt 1000 temperature sensors in windings. The first element will be used and the other will be spare.

The Supplier shall ensure that harmful effects of bearing currents are avoided in all motors.

Motors  $\geq 7,5$  kW shall be equipped with temperature sensors (2xPt 100 or Pt 1000), the first element will be used and the other will be spare.

Frame size IEC100 and larger motors shall be equipped with re-lubrication nipple.

Frame size IEC 160 and larger motors shall be equipped with vibration monitoring test points (SPM) and condensate drain holes.

All motors must have stainless steel rating plate which must also specify all the special characteristics and installed options of the motor.

In frequency converter drives, if the motor ventilation is not enough at low speed, a higher power motor or a separate fan can be selected. The decision shall be agreed with the purchaser.

Frequency converter driven 690 V motors shall be equipped with reinforced insulation. ND-end insulated bearings or bearing shields shall be installed in frequency converter motors (both 400 V and 690 V) According to the motor manufacturer's instructions and motor bearings shall be able to run with 100Hz frequency. Insulated bearings has to be use with FC from axial height 280 mm.

An additional earthing terminal shall be provided on the motor frame.

Motor resonance frequency of motors shall be taken into consideration.

Vertical motors shall be protected with a protection cap.

No terminal blocks shall be allowed. Instead, flexible leads with eye-type cable connectors shall be supplied.

A stud with two nuts shall be provided inside the terminal box for earthing protection conductor (PE).

Lifting devices, such as eyebolts or lugs, shall be provided on all motors.

### **13.7 Rating and Nameplates**

All motor nameplates, marked per EU-MEPS (European Minimum Energy Performance Standard), shall be made of stainless steel or approved equal. In addition, they shall identify each bearing by the manufacturer's designation or approved equal. The motor weight shall be included on nameplate.

Mounting and delivery of additional info/rating plate is included.

### **13.8 Protective coating and painting**

The external surfaces shall be treated to withstand heavy industrial environmental conditions.

The protective coating and corrosion protection of the motor shall be described by the Supplier in his tender.

All external parts of the frames that will be exposed to ambient shall be protected against corrosion by sufficient painting.

Sufficient corrosion protection shall be applied to the internal parts.

All electrical motors shall be painted following manufacturer's standard.

The colour of the final painting shall be approved by Purchaser.

## **14 VARIABLE SPEED DRIVES**

### **14.1 Single Drives**

Variable speed drives must be controllable via Profinet / Profibus DP in the green field projects. In the brown field projects (rebuilt) the existing communication protocol will be used. The communication protocol shall always be agreed separately in all projects.

The frequency converters shall feed AC induction motors of the squirrel cage type, and will be digitally controlled, of the Pulse Width Modulation (PWM) type with flux vector control, or Direct Torque Control (DTC), scalar control or equivalent. Unless specifically requested, the motors will not have pulse-encoder feedback or equivalent.

Rectifiers are generally 6-pulse type. For very high power frequency controllers other solutions may be discussed.

A thermistor function for each converter-controlled motor > frame size IEC132 shall be included. A thermistor connected to the frequency converter.

The VSDs shall be freestanding ("stand alone"), wall mounted or alternately integrated in the MCC. Direction of power cabling (or busbars) and fixing shall be agreed during design phase. The degree of protection by enclosure of frequency converter cabinets shall be at least IP21 (IEC). Cabinets shall be installed in ventilated electrical room.

To avoid voltage raise in the motor terminals the frequency converters shall be provided with necessary common mode, du/dt-filters, sine-filters etc. The Supplier shall specify and deliver equipment when filters are necessary.

The VSDs shall be provided with a local control panel, located in the door of cabinet or in the switchgear door, including all necessary cables and accessories, with which the parameters, alarms, actual values of drive can be read and modified. In addition, applicable PC software(s) is included to the delivery.

The VSDs shall be provided with all necessary electrical protective functions for reliable and safe operation of drives.

The VSDs shall be provided with dynamic DC bus voltage support. This function is essential to keep the drive running until overcurrent/ time breakers clear failures in power distribution. DC Bus is fed by Inertia of rotor.

EMC shielded cables should be used for VSD used motors.

Motors  $\leq 500$  kW, VSD is selected so that it is possible to upgrade the motor with the next higher power level. If motors power is larger than 500 kW then VSD selection must be approved by the purchaser.

VSD protection degree against aggressive media must be selected in accordance with the quality of the electrical room air and the requirements of EN 60721-3-3 classification, or ISA S71.04-2013 standard.

In electrical cabinets with VDS, the required amount of air for the inverter/s given by the manufacturer must be observed. This means ensuring sufficient airflow to and from the cabinet. If there is a fan on the cabinet door, it should be controlled by a thermostat.

When mounting the inverter or soft starter, the manufacturer's installation instructions must be followed, especially the dimensions below and above the device. Due to airflow and easy fan replacement.

Install one 230V service socket for each VDS or in the field with VDS.

## 14.2 Sectional Drives

Variable speed sectional drives will be AC-drives.

Sectional drives should be equipped with active PFC feeding units to reduce effectively in harmonics in mill grid.

## **15 POWER DISTRIBUTION**

### **15.1 General**

Both medium voltage and low voltage power distribution systems will be simple radial network systems.

Normal practice will be that one medium voltage feeder breaker can be used to supply feeding power for two distribution transformers and MCC's, when these MCC's are serving the same process area.

### **15.2 Control and Monitoring System**

High and medium voltage systems will be controlled from power distribution control and monitoring. The control system will be connected to the mill DCS system (IEC 61850).

Minimum following features will be included:

- Remote control of all MV breakers except for MV motor controls, which will be included in DCS
- Voltages, amps, powers, reactive powers and power factor of all feeder breakers
- Trend of any above signal
- Power distribution alarms and trip signals such as transformer temperature signals, tap-changer remote operation etc.
- Resolution time for alarms and events better than 5 ms
- Data transfer to DCS via bus connection (IEC 61850)
- Protection relay settings can be listed and programmed through the system

### **15.3 Relay Protection System**

#### **15.3.1 General**

Multifunction programmable protection relays will be used at high voltage and medium voltage distribution system. Multifunction programmable protection relays upon mill request also on LV. The relays will be equipped with self-supervision, event memory and time synchronization.

The relays will be provided with communication interface to power distribution control and monitoring system.

#### **15.3.2 Over Current Protection**

The over-current relays will be multiple curve type relays with high set instantaneous tripping and an adjustable time over-current tripping. An overcurrent blocking system will be used for the main short circuit protection. The instantaneous function of each incoming cubicle relay will be equipped with about 100 ms time delay to be activated by blocking signal of outgoing feeder over-current relay. The time delayed functions will be used for selective back-up protection.

### **15.3.3 Earth Fault Protection**

The 20 kV systems are unearthed. Selective earth fault protection shall trip the proper circuit breaker after an adjustable time delay.

The 6 kV and 10kV systems are resistance earthed or unearthed. Systems are factory specific and will be separately agreed case by case.

Differential Protection

Differential protection will be used for:

- Main transformer feeders

### **15.3.4 Arc Protection**

An arc protection system will be included for each HV and MV switchgear, main MCC and main lighting board.

### **15.3.5 Low Voltage MCCs**

Incoming sections will be equipped with circuit breakers. Breakers will be equipped with inbuilt adjustable instantaneous and time delayed over-current relays.

Back-up protection for MCC will be by 20 kV feeder breaker.

Alarming earth fault protection for sectional drive centres will be used.

## **16 MOTOR CONTROLS**

### **16.1 General**

The machinery and processes will be controlled from centralized control room. Local operator panels shall be avoided and be used only if required by the controlled machinery or safety.

### **16.2 Motor Control**

Process motors are controlled via a mill wide distributed control system (DCS). Motor starters are connected to the DCS via fieldbus. Special equipment like roll handling has own control system, which controls the motors and equipment belonging to this process. The necessary information exchange is between the mill wide DCS and the special control systems.

Special room HVAC systems and water chillers are controlled and regulated by local control system, but alarms and necessary information about temperatures, running status etc. is transmitted to the DCS via separate fieldbus.

IEC 61508 and IEC 62061 as well as EN ISO 13849-1 are followed regarding machinery safety. The suppliers of machinery are responsible to perform the risk assessment and to define required safety level.

Local main circuit safety switches will be installed for LV motors

Approved emergency stop relays and circuits will be used for personnel safety risk equipment and systems.

Intelligent MCC starters with a field bus connection to the control system will be used for process motors.

Motors will be equipped with individual and group control modes from DCS.

Sequence control logic will be used for complicated control requirements.

### **16.3 Interlocking System**

Process interlockings will be basically the same for both individual and group control modes.

Where by-pass of an interlocking will be required, a software switch will be included in DCS display.

The interlocking and sequence diagrams will be issued as a separate document.

## **17 LIGHTING**

### **17.1 Lighting Levels**

Lighting levels for different areas and rooms are specified in the design instruction for lighting is given in document MEIA0014

### **17.2 Process Areas**

Sufficient lighting will be provided to enable operators to circulate freely and safely within the accessible areas. The lighting provisions will be generally as below and when measured 1 meter from the floor or on the floor as appropriate, the average illumination will not vary by more than minus 25% or plus 60%.

Color temperature (Kelvin) level shall be 4000K-6000K and color rendering index (CRI) level shall be > 80.

Lighting shall be designed to be suitable for video surveillance system.

More detail minimum illumination levels and illuminance uniformity are in according with standards EN12464.

Lighting will be controlled locally by push buttons and via PLC.

Lighting will be controlled locally by push buttons, movement sensors, day light sensors, etc via PLC.

Lighting fixture shall be LED type.

### **17.3 Outdoor Lighting**

Outdoor lighting and road lighting as a whole shall be controlled by light-sensor (connected to PLC) and by manual override switch. All types are LED.

Besides road lighting the luminaires shall be fixed to ceilings, walls, columns, steel structures and lighting rails.

#### **17.4 Maintenance Outlets**

Maintenance outlet panels will be installed at 30 m intervals for process areas. In some specific process areas maintenance outlet panels can be located more frequently than 30 m (e.g. paper machine press section).

Maintenance outlets will be provided with residual current protection (<30 mA for 16 A socket outlets and <300 mA for 32 and 63 A 3-phase socket outlets).

#### **17.5 Emergency Lighting**

Exit doors and escape routes will be lit with emergency lighting system. UPS/ diesel back-up power with fire resistant cables will be included. Certified centralized battery system will be used with LED fixtures. Emergency lighting will be installed depending on requirements stated in local fire protection report.

### **18 FIRE ALARM SYSTEM**

Fire alarm system shall be installed in all process and non-process buildings in the Site area. The fire-fighting equipment follows the provisions and regulations of the local authorities as well as with the national and EU laws, stipulations and guidelines.

An automatic fire detection and alarm system shall be provided according to separate fire report accepted by authorities. The fire detection system shall be designed according national standard.

The fire detection system consists of fire alarm central, which collects fire alarm information from smoke, line etc. detectors and gives visual, acoustic and remote alarms. The fire alarm system is also used to control fire dampers and it gives interlockings to ventilation motors.

### **19 ELECTRICAL ROOMS**

Air-conditioned electrical rooms with over pressure shall be built to house electrical equipment, such as switchgear, MCC, sectional drive panels, control system cabinets etc. Chemical filtration must be used in electrical rooms what are exposed to the chemical environment.

Separate electrical rooms shall be built for MV switchgear, LV switchgear and automation equipment.

Transformer rooms are located outdoor walls of the buildings. The transformer rooms shall be designed with air circulation so that fresh air will be taken to the lower part of the room and exhaust air will go out from the upper part of the room. Forced ventilations will be installed for transformer only when natural ventilation is not adequate

Cable room will be built underneath each electrical room.

All electrical and cable room floor and wall openings will be sealed with (60 min) fire stop. (The fire stop shall be designed according national standard).

Oil-immersed transformers to be provided with oil pit. The wall between oil-immersed transformer bay and electrical room will be sealed with (120 min) fire stop (The fire stop shall be designed according national standard).

Equipment layouts, aisles and doors within the electrical room shall be designed to provide at least two escape paths from any position in the room.

Additionally local law and manufacturers recommended space allowance shall be followed and verified the equipment door opening and gear draw-out requirements when placing units close to walls or each other.

All electrical room doors shall be equipped with anti-panic device.

Space besides every MCC shall be reserved for a future cubicle.

## **20 INSTALLATION**

Electrical installation details are given in document MEIA0008. Electrical Installation Standard. and the cables instruction is given in document MEIA0005

### **20.1 Cable Trays and Cabling**

Generally, cables of different voltage grade rating shall not be installed on the same cable tray. In those locations where there is only one cable tray for both power and control cables, they shall be segregated by being installed on opposite sides of the cable tray. Where the installation of signal cables and power or control cables on the same tray is unavoidable (e.g. motor droppers), the signal cables shall be separated from the other cables by minimum 200 mm air space, by a metal plate barrier or by a conduit.

The cables shall normally be installed on the cable trays. However, individual cables may be fixed directly onto the structures, subject to agreement with the Client.

Separate cable trays will be used for the following cable categories. On stacked trays

the order from top to bottom will be:

- High voltage cables
- Medium voltage cables
- Sectional drives power cables
- Low voltage power cables
- Building electrification cables
- 230 V control, lighting and respectable cables
- Signal and communication cables
- Data network cables

The distance between cable trays will be 0.3 m.

The material for cable trays (and supports) and ladder racks shall be hot dip galvanized, acid-proof steel (EN 1.4401) or aluminium according to the process area specification. Acid-proof steel (EN 1.4401), shall be used in paper machine wet end and other areas, where aggressive chemicals are present. The material of the cable tray must be accepted by purchaser.

The material for protection tubes in process areas shall be of acid-proof steel (EN 1.4401), and in the remaining areas stainless steel (EN 1.4301), aluminium or acid-proof steel. The tubes shall be fixed with acid-proof steel (EN 1.4401), heavy duty pipe clamps.

Cables will be tied at regular intervals on bends, on horizontal and on vertical trays. Single layer will be used to install power cables.

Control and signal cables can be installed on multiple layers.

Cable tray can be a combination (e.g. signal and communication cables + data network cables), if there are only few cables per cable category and there is no danger of disturbances.

The floor passing cables will be protected up to 2.0 m above floor to protect from mechanical damage. Cover material same as the cable tray material.