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Østfold Avfallssortering IKS - MRF

Title:

APPENDIX A7

ELECTRICAL EQUIPMENT



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1 Introduction

This document specifies the electrical systems, equipment and devices included in the delivery of Østfold Avfallssortering IKS - MRF project.

2 Scope of Delivery

The electrical scope of the plastic sorting plant includes all electrical equipment and sub-systems that are needed for a fully operational plastic sorting plant. It includes design, manufacturing, transportation, installation, testing, commissioning, training of personnel and documentation. The delivery consists of the following, but not limited to:

- Electrical motors
- Electrical control and protection equipment of the mechanical equipment
- Heating elements and trace heating, where necessary
- Emergency stop switches and ripcord switches
- Local control panels and junction boxes
- Main control cabinets
- Motor Control Center (MCC)
- Power and control cables
- Cable ladders, trays and protection conduits
- Earthing of the structures and equipment excluding the underground earthing grid and the lightning protection system of the building(s)
- Double floor inside the MCC room with mounting frame construction

Delivery limit is at the outgoing cable terminals of the Low Voltage Main Distribution Board (LVMD). This means that the main power supply cables shall be delivered by the Contractor.

Contractor has to prepare a detailed listing of the provided equipment with the designation of manufacturer, type and the main technical data for each component and component group. The electrical consumer list, together with a single line diagram of the electrical supply, will give the needed information for the power supply and the design of the LVMD. LVMD to be provided by Client.

3 Design Basis

3.1 General

The electrical equipment and installations shall be delivered and executed in accordance with the standards, rules and regulations in force in the EU as well as any more stringent Norwegian Authority requirements, which may apply for the actual plant.

For Norwegian installations please refer:

- NEK 400:2018, *Electrical low voltage installations*,
A processed Norwegian edition of the IEC 60364 series, the CENELEC HD 60364 series and some complementary national standards.

Atex Directive 94/9/EEC shall be followed to the extent applicable

- IEC 60079-10-1 Explosive atmospheres; classification of areas
- IEC 60079-14 Explosive atmospheres; electrical installation design, selection and erection.

Electrical motors that will be operated in explosive atmospheres shall meet the requirements of the following standards complying with the ATEX directive:

All equipment and systems selected or designed by Contractor shall be presented to Client for review before implementation.

Quantities and units of the international SI system have to be used in all drawings, documents, plates and meters.

The installation of the electrical equipment shall be in a way that it facilitates maintenance. For that, all of the equipment like maintenance switches, sensors, cable junction boxes, terminal boxes, cameras, signal lights, horns, etc. shall be accessible via walkways and platforms without the need of ladders, cherry pickers, safety harnesses, etc. This may not be possible in all cases. If so, the installation has to be discussed with Client and approved by him.

All components of the electrical equipment shall be in an active lifecycle of the supplier and must be easily available in the EU.

3.2 Safety

The plant will be equipped with several emergency stop circuits, depending on the visible areas inside the plant. A superior emergency stop circuit will be effective for the whole plant.

Upon actuation of an emergency stop switch or pull-cord switch in one of the plant areas, the plant parts in the corresponding area must stop immediately except the fans of the de-dusting system and the compressor units. A delay time for the machines to run empty must not be considered.

All dedicated devices such as emergency switches, e.g. ripcord switches, limit switches, sensors, pushbuttons, switches, etc. in the process equipment, are included in the delivery.

All manholes, doors, hatches, housings, etc. which are not allowed to open during normal operation shall not be possible to open without keys or special tools or must be monitored by suitable safety devices and safety circuits.

Further details will be fixed in an emergency stop concept and the risk analysis which has to be made by Contractor.

See also chapter 13.5 for more details.

3.3 Ambient Conditions

Indoor installations:

Ambient air temperature range: -10°C to +40°C. 24 hours average max. 35°C

Ambient air relative humidity: 20% - 80% (average), short periods of 100%

Altitude: Less than 150 m over sea level.

Outdoor installations:

In case where electrical equipment is located in an ambient environment with conditions outside the above ranges - for example outdoor installations, the Contractor shall take the necessary precautions in the design, equipment and installation.

3.4 Protection Classes

All electrical cabinets, equipment and devices shall be at least according to following protection classes, if no higher protection class is required by regulations and/or standards:

- Process areas (indoor) IP 55
- Sprinkled areas IP 55
- Electrical rooms sprinkled IP 55 / non-sprinkled IP 22
- Outdoors IP 65
- Equipment located in potentially explosive atmospheres according to regulation
- Motors IP 54 / IP 55 for terminal box

If cabinets fulfil IP 55 or higher, IP 22 is sufficient for components and devices inside.

3.5 Electromagnetic Compatibility (EMC)

The electrical and electronic equipment shall be designed in such a way that the electromagnetic disturbances from those items are limited and also that each item has an adequate level of immunity to the disturbances in its environment.

Special attentions shall be given to EMC compliant installation and configuration for power electronic systems.

The installation of all equipment within power electronic systems shall be suited for the purpose, for example via use of shielded cables and electrical/electronic filters.

More details will be described in the following chapters regarding the electrical cabling and installation.

It shall be possible to use mobile phones, portable radio communication equipment, etc. close to equipment in operation without disturbing it, also in the event of open cubicle doors.

3.6 Hazardous Areas

Equipment, devices and installations in hazardous areas shall meet standards, norms and special requirements for equipment and installations in explosion hazardous areas (ATEX).

Contractor shall provide hazardous area classification report, drawings and specification tables for the plant as well as ATEX report as stated in EU directives and EN standards and regulations.

3.7 Plant Coding System

Details about the plant coding system AKS and the grouping proposals for the new plant are written in document "Appendix D5 Plant Coding System".

The Contractor shall furnish the cabinets, desks etc. with labels indicating the necessary information for service purposes. All markings shall be consistent within documentation and the equipment.

More details will be described in the following chapters regarding labelling and marking of electrical components.

4 Voltage

4.1 Frequency and Voltage Variation

The electrical equipment shall meet their specified ratings and capability when operating within the specified continuous voltage and frequency variation ranges, which are considered as warranty conditions. During short-time voltage and frequency disturbances the electrical equipment must not be damaged nor be tripped by internal protections but operate normally - if necessary at reduced capability.

Voltage variations for plant electrical power systems may occur simultaneously when the frequency varies.

4.2 Low Voltage Distribution

General supply voltage:	400 V, 50 Hz, (TN)
Switchboard control voltage:	230 VAC and/or 24 VDC
CMS power supply:	230 VAC with individual or common UPS for PLCs and computer systems
I/O power supply:	24 VDC with individual or common UPS
Safety equipment power supply:	24 VDC with individual or common UPS

It is of high importance that the phase sequence is correct (in row of order: L1, L2, L3) and identical starting at the transformer, in all switchboards and throughout the installation to the final consumer. It has to be a clockwise rotary field.

4.3 UPS

An uninterruptable power supply (UPS) shall be included for the whole SCADA system, the PLCs and for the 24 VDC control voltage in the switchboard cabinets of the equipment. The Package Units will come with individual UPS systems to fulfil the requirements above.

The UPS shall be a central system, which delivers 400 VAC control voltage for all devices of the plant for at least 2 hours. Power adaptors with 400 VAC input in the switchboard cabinets will manage the protected supply with 230 VAC and 24 VDC control voltage.

The UPS rack and a battery extension rack have to be placed inside the MCC room.

5 Electrical Motors

5.1 Standards

The electrical shall comply with the requirements of the latest edition of appropriate IEC/EN Standards.

In addition, requirements concerning equipment class and temperature classification according to the atmosphere shall be observed.

Generally, requirements set forth in these standards will not be repeated in this specification. The requirements stated here shall be considered as additional or defining requirements to the provisions given in clauses of IEC standards.

5.2 Motor Voltage

Nominal operating voltages for motors shall be 400 V, 3 phase, 50 Hz.

Motors shall fulfil the voltage and frequency variation limits of IEC 60034-1 Zone B. When starting large motors, the voltage drop in the power supply system shall not exceed 15%. If the voltage drop is 15% or more, the motor starter shall be equipped with a soft starter to avoid exceeding voltage drop.

Electrical motors shall have sufficient torque to start with a voltage drop of 15%.

5.3 Cooling

Standard type cast iron electric motors fitted with air cooling (IC 411) shall be preferred. Motors shall be suitable for heavy industrial environments and operating conditions with due attention to the requirements of process fluids.

5.4 Rating

Motor rating shall comply with the duty type S1 (continuous duty) in line with required output and torque.

All motors shall be dimensioned at least four consecutive starts in any condition required for this type of plant.

The recommended rotation speed is 1000 ... 3000 rpm, 1500 rpm is preferred.

List of all electrical consumers shall be submitted by the Contractor. The Contractor shall give detailed information on power factor, motor loads/load factor, including load type, rated power, voltage, $\cos \varphi$ and quantity of phases.

5.5 Insulation Class and Temperature Rise

Frequency converter driven motors shall be provided with reinforced insulation suitable for the frequency converter drive.

5.6 Bearings

Lifetime of bearings of motors which are running continuously when the plant is in operation shall have a lifetime of 100 000 hours at least referring to ISO 281.

No plastic bearing cages are allowed. The position of the bearing plate shall comply with the mounting arrangement.

Bearings in motors with frequency converter shall be equipped with suitable bearing insulation.

Motors with frame size IEC H160 and higher shall be equipped with lubrication devices.

5.7 Power Cables and Motor Terminal Boxes

The terminal box shall have enough room to allow proper connection of power cables and they shall be fitted with cable glands for power and control cables. The largest recommended cable gland with cable relief is M40. Larger cables have to be provided with additional clamps, etc. for fixing.

The recommended location of the motor terminal box is on the side of the motor with the cable glands at the bottom. It must be possible to turn the terminal box (90° - 180° - 270°).

All power cables shall be halogen free and low smoke. Power cables for frequency regulated motors shall have electrical shield for EMC.

The need for cable glands and cable boxes as well as terminal boxes according to EMC stipulations shall be determined specifically for each drive by the Contractor.

All six winding ends of 3-phase low-voltage motors shall be connected to the motor terminal box and must be equipped with solid metal jumpers for star or delta configuration.

Terminal markings and relation between terminal markings and directions of rotation of all motors shall be done in accordance with IEC 60034-8.

5.8 Accessories

Frequency converter-controlled motors >3 kW and standard motors above 75 kW shall be equipped with thermistors. Also, conveyor motors and motors in hazardous areas shall be equipped with thermistors (6 pcs. for alarm and protection).

All drives have to be equipped with a local maintenance switch which has to be connected directly in front of the motor to switch off the three motor phases at standstill. The rotary knob has to be in black colour.

For large motors (e.g., > 30 kW) small maintenance switches with the same features as described in here may be used. In that case, the Contractor has to take care in his safety circuit design that all valid safety requirements are fulfilled.

For additional safety reasons, the knob of the maintenance switches must allow to save the switch mechanically in the OFF-position against unauthorized operation with a padlock.

All maintenance switches shall have an additional contact to give a feedback signal about the switch status to the PLC.

Other accessories:

- Lifting and jacking facilities
- Earthing bolts in the terminal boxes and on the frame.

5.9 Gear Motors

Gear-mounted motors shall be standard electric motors (basic design according to EN standards) with standard design and fixing.

6 Frequency Converters

6.1 General

All frequency converters shall be designed in accordance with the applicable EMC requirements and efficiency shall be verified in accordance with IEC 60146-1-1. Mains filter in front of the frequency converter are mandatory. All-pole sine filters in case of long motor cables between the frequency converter output and the motor shall be foreseen to reduce supplementary losses and noise emissions from the motor. They shall also be used for minimizing leakage currents, providing best possible EMC performance for the drive and protect the motor insulation.

For machine drives which have a large follow-up time after a power cut-off due to their rotating masses (e. g. large fans), frequency converters in this case have to be able to restart with the rotating motor.

Special precaution shall be made to ensure that the capacity of the frequency converter output matches to the power input of the driven machinery.

6.2 Operation of Frequency Converters

Each frequency converter shall be provided with an intelligent removable local control panel mounted on the front of the device. The local drive operation shall include local/remote selection, start/stop, reset, direction of motor rotation and reference settings. The front display shall be a multilingual alphanumeric display with plain text in Norwegian language.

The frequency converters shall be provided with bus adapter modules and bus connection to the CMS. It must be possible to operate and monitor the converter from the local control panel and from CMS operator screens like described above. All operating parameters incl. heatsink temperature, error messages and alarms shall be transferred via fieldbus to the CMS for further evaluation.

The emergency stop function shall be fully integrated in the frequency converter design.

6.3 Installation of Frequency Converters

Frequency converters shall be installed in the MCC room, which are separated from other electronic and control devices to prevent any disturbances and for better centralised cooling capabilities.

7 Trace Heating

7.1 General

Trace heating may be used for water installation in the area of the dust filters, placed outside of the hall. A water spray or fog system shall prevent the filtered dust from flying around while it is transported to the waste containers.

All heaters, their accessories, installation materials and the way of installation shall meet the ambient conditions of the place of the installation.

7.2 Terminal Box

Each trace heater shall be equipped with dedicated terminal box with block terminals for external power supply and control circuit connections (thermostat or Pt100 for temperature regulating and limitation).

The terminal box shall be located near the place to be heated. Terminal blocks shall be clearly marked. Protection class shall be IP55 or better (IEC 60529).

7.3 Thermostat

The thermostats shall be of capillary tube type or Pt100. The thermostats shall meet following ambient and technical requirements:

- corrosion
- high temperature of the place or the structure to be heated
- limiting thermostat shall protect the heater element and the structure to be heated.
- capillary tube shall be protected with mechanically strong installation pipe
- ATEX areas.

7.4 Heaters

Heating elements and cables shall be selected according to manufacturer's instructions:

- rated maximum powers must not be exceeded
- potential high temperature of the place and the structure to be heated shall be considered

Heating cables shall be wired to the terminal blocks in the connection box with "cold" connection cables protected with mechanically strong installation tubes according to the given requirements.

7.5 Installation

The sensor of the regulating thermostat shall be installed in place where it can properly sense the influence of the heater.

The sensor of the limiting thermostat shall be installed on the heating element or cable or to a place where it can properly sense the maximum temperature.

Anti-condensation heating elements installed in devices and boxes shall be located and designed to provide a protection against touching live parts.

8 Other Electrical Loads

Contractor shall give detailed information on other electrical loads, including load type, rated power, voltage, $\cos \varphi$ and phase quantity (single-phase or three-phase load).

Loads 3 kW or more must always be three-phase loads.

9 Raised Floor in MCC Room

For the MCC room inside the technical building a raised floor system has to be delivered by the Contractor with a load capacity of 15 kN/m². The point load capacity shall be not less than 3 kN.

The surface of the floor panels shall be min. 0,8 m above the surface of the concrete floor of the room. The substructure shall be made from hot galvanized steel and must be permanently fixed on the concrete floor with bolts or bonding.

The entire steel construction must be connected at min. 4 points to the main equipotential bonding conductor connection of the MCC room with green-yellow insulated wire of min. 16 mm².

As a part of the substructure, mounting frames for the switchboard cabinets made of square profiles or a combination of C profiles shall be integrated in such a way, that the cabinets can be fixed on top of the frame without a plinth. That means that the top surface of the mounting frames must be up to 5 mm higher than the surface of the floor panels. The mounting frames have to be provided also for the spare places of switchboard cabinets for future extension of the plant. All not used openings in the floor after installation of the first step have to be closed with the same floor panels as used in the rest of the MCC room.

The floor panels shall be flame-resistant with a size of 600 x 600 mm and a min. thickness of 38 mm. The edges shall be protected against moisture, fire and decomposition with an appropriate coating. All edges, which will be trimmed on site during installation of the floor, shall be protected afterwards.

The bottom of the floor panels shall be protected with a layer of thin sheet metal. The top surface shall be covered with a standard plastic floor covering in an easy to clean grey marbled design. The min. thickness of the upper floor covering shall be 2 mm.

Two pieces of vacuum grippers for the raised floor panels have to be delivered by Contractor.

10 400 V (TN) MCC Switchboard Cabinets

10.1 Standards

The electrical equipment and accessories shall be designed, tested, installed and taken into operation in compliance with the requirements of the latest edition of appropriate IEC/EN Standards.

The individual components such as motor starters and fuse switches shall comply with the relevant device standards. The requirements stated in this specification supplement the requirements of the device standards.

All delivered equipment shall display the CE marking and corresponding declarations and certificates shall be available.

10.2 Electrical Main Values

LV switchgear must not operate incorrectly in case of a voltage disturbances caused by a switching or a fault occurring in the power supply system. LV switchgear shall maintain the normal operation automatically when the incident is gone.

10.3 Design and Construction

The switchboards shall be built for operation by trained personnel only. All equipment in the switchboard shall be protected against accidental contact when the cabinet door is open. A protection class not less than IP 22 is required.

All equipment, rail systems and cables shall be installed visible and easily available for inspection (thermo-graphic camera), maintenance and replacement. The installation of any equipment on side panels of cabinets is not allowed.

All switchboards shall have at least 20 % spare capacity for future expansion in each field.

Temperature inside cabinets and panels shall not exceed 40 °C. Boards mounted outdoors or in a cold environment shall have heaters or self-regulating heating cable to avoid condensation.

10.3.1 Basic Design Features

The MCC switchboard cabinets shall be built conventionally. Withdrawable-unit design is not required.

All switchboard cabinets except locally required boards and terminal boxes shall be installed in the conditioned MCC room on the raised floor provided by Contractor. The cabinets have to be fixed directly on top of the installation frames integrated in the raised floor.

Locally required boards and terminal boxes shall meet the conditions of the area where they will be installed.

The LV switchgears and switchboards shall be steel enclosed cubicle or multi-cubicle type of the following dimensions:

- Height: 2000 mm
- Depth: 500 mm or 600 mm
- Width: Makers standard module.

The MCC room will be equipped with an INERGEN gas fire extinguishing system. Due to the absence of water, a protection class of min. IP 22 is required. For all cabinets, which are placed locally in the plant, IP 55 is mandatory.

The cabinets placed inside the MCC room will be ventilated and cooled from the bottom with an airstream via the double floor. The warm air escapes through the 20 mm lifted cabinet roof.

All floor-mounted cabinets in sprinkled areas or locally in the plant shall be equipped with a cabinet base made of stainless steel.

Cabinets which are not placed in a ventilated and air-conditioned room (e.g., all cabinets in the field) must be closed systems without a fan or ventilation openings for cooling to prevent the intrusion of dust and debris. If cooling is needed an additional cooling unit must be installed on the top or at the side wall of the cabinet.

The cabinets shall be equipped with steel doors, suitable to the manufacturers system. The doors of larger floor-mounted cabinets must have hinged handlebars with push button release. Smaller cubicles may be equipped with simple double-bit key locks.

All doors of cabinets containing a PLC CPUs shall be equipped with foldable consoles at the inner side for a maintenance notebook.

A lighting device that turns on automatically when opening the doors and a double 16 A socket with PE shall be provided in each cabinet or panel. The 16 A sockets should not switch off when doors are closed. Local cabinets in the hall shall be equipped with a heating element for min. temperature of -10°C .

All personnel-used sockets shall be equipped with a ground fault protection (RCD: Residual Current Device) with a tripping threshold of 30 mA.

The final surface treatment shall be with colour code RAL 7035

10.3.2 Cable Entry

The cable entry shall always be from the bottom of the switchboard cabinets via the raised floor, delivered by the building contractor. Each cabinet has to be equipped with a bar for fixing the cables with appropriate cable clamps. Fastening with cable ties only is not allowed.

For each of the outgoing cables there shall be terminal blocks.

The cable entry to field mounted panels shall always be from bottom.

10.3.3 Internal Conductors, their Arrangement and Connections

The busbars shall be located and connected so that the phase sequence from left to right, from above to below or from front to back is L1, L2, L3.

It must be possible to connect and tighten the connections of the busbars and conductors without loosening the fixed parts of the LV switchgear. The connections have to be placed in such a way, that thermography controls (IR check) are easily possible.

An IR check of all cabinets and cable connections has to be made by Contractor after warm commissioning during a phase of continuous operation under designated load.

The cross sections of the insulated conductors shall be at least $1,0 \text{ mm}^2$ and rated voltage of the conductors at least 750 V. The conductors connected to turning doors or covers shall be of multi stranded type or flexible single wires in a hose, fixed at both ends. The ends of multi stranded conductors shall be provided with cable clamps.

The conductors (<math> < 10 \text{ mm}^2 </math>) shall mainly be fixed by locating them in wiring ducts, however, not more than 50% of the volume must be filled. The conductors of the primary circuits and those of the secondary circuits must not be installed in the same ducts. The conductors of control circuits between the primary conductor and over-current protection device shall be as short as practically possible (<math> < 0.5 \text{ m} </math>), and they shall be located one by one separated from other conductors and construction parts in order to minimize the possibility of short circuit.

10.3.4 Wirings

All outgoing control circuits and the main circuits up to 16 mm^2 may be wired from the components of the units to terminal strips. In each functional unit the terminals shall be arranged in numerical order and consistently according to circuits, located so that the outgoing cables can be connected. The conductors of the outgoing cables are connected to the outgoing cable side of the terminal strips.

Inside the outgoing units of the switchgear part the connections between the components may be wired directly from component to component. Inside the functional units of the control gear part of the LV switchgear the connections may also be wired directly, but between the units the connections shall be wired through the terminal strips.

The connections between the outgoing units, or between the outgoing and control unit shall be wired through terminal strips in each unit.

There shall be at least 15% reserve places in the fixing base of terminal strips for further extension.

10.3.5 Earthing of Switchboard Cabinets

The protective circuit is used as protection against electric shock in case of a fault. The LV switchgear shall include a protective earthing busbar (PE), which connects the structural parts of the casing to each other. The 400 V switchgears shall include a neutral busbar (N) insulated from the frame. The PE-busbar has to be connected to the N-busbar only at the infeed point nearby the main switch. This connection must be accessible and easy to loosen for measuring purposes. The PE-busbar shall also provide two terminals in the infeed cabinet field for the system earthing conductor coming from outside.

Each outgoing unit shall include a PE terminal for the PE-conductor and an N terminal (if N is needed) for the N-conductor of the cable.

Inside switchboards, where separated ground rails for regular PE connection and signal ground rails are needed, the rails shall be connected with jumper cables. For measurements of the signal ground the rail should be isolated from the common PE rail by disconnecting the jumper. The signal ground rail has to be marked with red and yellow colours.

The N-conductors of the control voltages 230 VAC shall be connected to the N-busbar. The 0 V-conductors of the control voltages 24 VDC shall be connected to the PE-busbar of the cabinets.

The devices shall comply with the relevant IEC standards. The types, standards and rated values shall be informed.

10.3.6 Devices

10.3.6.1 Selection Principle of Devices

All devices, such as contactors, intermediate relays, time relays, overcurrent protections, etc. shall be selected so that few types, preferably only one, of each device is used. The devices shall be designed for heavy industrial use.

The devices shall comply with the relevant IEC standards. The types, standards and rated values shall be informed.

10.3.6.2 Switches

All switchgear cabinets shall be provided with a main breaking switch with over current protection. For each plant group and the PLC cabinet a separate main breaking switch shall be provided.

The main breaking switches shall have sufficient breaking capacity and reliable position indicator.

The handles of the switches shall be located on the doors and without interlock to allow to open the door when the switch is closed. This is only valid for cabinets inside the closed MCC room, where access is granted only to trained personnel. It must be possible to lock the handle in open position.

For the overcurrent and short circuit protection of drive group circuits and power supplies no melting fuses are allowed. All circuits must be provided with power switches with adjustable overcurrent and short circuit protection or with miniature circuit breakers (MCB) in case of single phase or low power circuits

All switchgears, electronic fuses and circuit breakers shall be fully isolated and must fulfil the protection requirements. This concerns circuit breakers up to 63 A. Circuit breakers in circuits with electrical sockets has to fulfil characteristic C. All circuit breakers shall be marked with engraved signs indicating adjusted or factory-set values.

A complete or partial selectivity between overload protection and fuse circuits in the plant may be required under certain conditions and has to be clarified with Client. If selectivity will be executed, the lists and calculations shall be a part of the project documentation.

10.3.6.3 Motor Starters

Motors < 7,5 kW without frequency converters shall be started direct on line (DOL). For larger motors > 7,5 kW or if the driven machine requires, that starting torque must be limited in order to avoid mechanical stress or to reduce the current peak during the start, an electronic soft starter shall be applied.

A star-delta starter shall not be used as a soft-starting device. It is only permitted after approval of Client.

All standard drives without frequency converter shall be equipped with an intelligent motor starter combination, consisting of motor circuit breaker, contactor and control unit with fieldbus interface for controlling, protecting and monitoring the drive.

The control unit shall perform the following functions:

Protection Functions

- Protection against overcurrent
- Protection against thermal overloads with choice of trip class
- Protection against ground faults
- Protection against phase imbalances
- Protection against mechanical jams during or after the start-up phase
- Protection against idling
- Tripping of the starter via an external signal

Measuring Functions

- Analog current measurement

All messages from the control unit and the measured current shall be transferred via the fieldbus to the CMS for further evaluation.

Each conveyor and every part of the conveying system without a frequency converter and an installed power up to 3 kW shall be equipped with an appropriate reversing contactor.

Contractor is responsible of selecting apparatus according to the criteria specified by the application.

Only reliable, internationally available products of well-known manufacturers shall be used.

10.3.6.4 Contactors and Thermal Relays

Contactors shall be classified in reasonable groups in respect of rated currents and selected so that designed lifetime in utilization category AC 3 is at least 10^6 operation cycles.

The thermal relays shall be provided with accelerated tripping, in case one phase voltage is lacking. The thermal relays shall be adjusted into manual reclosing position at the factory. Each individual device shall have remote alarm.

For control signals, plug in relays with LED indication shall be used.

10.3.6.5 Terminal Strips

Terminal strips for the connection of outgoing cables with cross sections up to 16 mm², and control signals shall be used. Larger cables shall be connected directly to the component or at a fixed plug.

Terminals for phase and N conductor for the same circuit shall be placed next to each other. For all terminals only one single wire in each block is allowed.

For control current it is allowed with two leaders in each block by a strapping of terminals and the connection to the component.

Terminal strips shall be mounted with enough space between them for future expansion.

For control signals, multi-stranded cables with flexible wires shall be used. For connection to terminal blocks and components, wire-end sleeves shall be used.

There shall be at least 15% reserve space in the fixing base of terminal strips for further extension.

10.3.7 Tagging and Labelling

The LV switchgear shall be provided with engraved (white plastics, black letters) nameplates, fixed at the exterior side, showing the tag number corresponding to the coding system and the documentation and a descriptive clear text.

All switchboard cabinets and distribution boards must be CE marked.

The busbars at the main breaker and the outlet poles (unless terminal blocks are provided) shall be marked: L1 (= brown), L2 (= black), L3 (= grey), N (= light blue) and PE (= Green / Yellow striped).

All devices and terminal blocks shall be marked with identifications according to circuit diagrams by means of reliably fixed symbols.

The LV switchgear shall be provided with a rating plate showing the manufacturer, type, rated operational and insulating voltages, rated current, short circuit strength and degree of protection of the LV switchgear in addition to the requirements of EN 60439.

LV switchgear shall have label with information regarding supply source.

Engraved plates shall be used for all labelling of equipment that is mounted at the exterior side of the cabinet door.

All plates have to be attached to equipment with a permanent fastener. Labels made of tape are not acceptable at the exterior side of the switchboard cabinets.

Components and terminal blocks inside the cabinets shall be clearly and permanently marked with printed labels. Each device has to be labelled directly on the casing and additionally on the mounting surface of the cabinet. In this case, if a device is removed from the cabinet, the place where it belongs is marked.

10.3.8 Tests

Contractor shall perform the inspections and tests, factory acceptance test (FAT) and site acceptance test (SAT) according to the standards and submit the reports to Client. The representative of Client may attend the tests.

11 Package Units

Some units / components of the plant, like shredder, baler, etc. and sub-systems de-dusting plant and the compressor units, may be delivered as a complete machine together with its own switchboard cabinet, electrical equipment and control system by subcontractors. For these so-called package units all standards written down in this document have to be considered. In case of deviations, Contractor has to give a list to Client for confirmation.

In the following are listed individual requirements for each type of package unit, which have to be followed by Contractor.

Shredder

- Normal switchboard cabinet for package units shall be placed in the MCC room.
- If this is not possible due to special drive and frequency converter requirements, the cabinets shall be placed nearby the machine at a safe place and must be built protected against intrusion of dust and debris. The cooling of cabinets and drives must be considered and delivered. If the cabinet should be placed nearby the machine, Client has to be informed and he has to confirm the layout.
- Local operation via control panel at the machine. From this local panel, it must be possible to do all operations needed during maintenance of the shredder.
- Power supply directly from low voltage main distribution (provided by Client) inside the MCC room.
- The shredder shall be equipped with frequency converters for regulation of the throughput capacity can be regulated via a control element. The throughput of the device must be adjustable from the superior control system via fieldbus.
- Control interface connection to the superior PLC and SCADA system for complete data exchange and remote operating facilities from the control room of the plant via a PN/PN coupler.

Baler

- Switchboard cabinet with integrated local control panel has to be placed nearby the machine for local operation. From this touchscreen display, it must be possible to do all operations needed during adjustment and maintenance of the baler.
- Power supply directly from low voltage main distribution (provided by Client) inside the MCC room.
- Control interface connection to the superior PLC and SCADA system for complete data exchange and remote operating facilities from the control room of the plant via a PN/PN coupler.

NIR Machines

- Switchboard cabinet with integrated local control panel has to be placed nearby the machine for local operation.
- Power supply from switchboard cabinets of Contractor inside the MCC room.
- OPC control interface connection to the superior PLC and SCADA system for an extended data exchange with clear text and remote operating facilities from the control room of the plant. A signal exchange list has to be elaborated and confirmed together with Client.

De-dusting Plant

- Switchboard cabinet placed inside the MCC room.
- Power supply directly from low voltage main distribution (provided by Client) inside the MCC room.

Compressor Unit

- Switchboard cabinet with local control panel placed inside the compressor room.
- Power supply directly from low voltage main distribution (provided by Client) inside the MCC room.
- OPC or Profinet control interface connection to the superior PLC and SCADA system for complete data exchange and remote operating facilities from the control room of the plant.

Generally, Contractor has to deliver the cabling for power supply and required cabling for network and communication for each package unit.

Local cabinets of the package unit machines shall be placed protected against mechanical damage.

12 Control Equipment

12.1 General

The protection degree and material of local control desks, operation panels and terminal boxes shall comply with ambient conditions. All cabinets, desks and boxes must be manufactured of steel and have a degree of protection at least IP 55 or better. They shall be equipped with steel doors with a double-bit key lock and removable key.

In case of installation directly on the floor, all control cabinets and desks have to be equipped with a stainless-steel base.

All cable entries shall be made always from the bottom side by the use of cable glands, which shall be self-sealing when tightened. A tightened cable gland has to fulfil protection class min. IP 65.

Temperature inside cabinets and panels shall not exceed 40 °C. Boards mounted outdoors or in a cold environment shall have heaters or self-regulating heating cable to avoid condensation.

Wall mounted panels shall be fixed with 20 mm spacers to the wall.

The final surface treatment shall be with colour code RAL 7035.

The component wiring shall be led to terminal boards, to which also external cables are connected. About 15% of reserve terminals shall be supplied. Fastening bars shall be reserved for external cables.

Desks, panels and cabinets shall be so designed, that they contain about 30% available space for additional equipment for future use.

Control circuits shall be protected with miniature circuit breakers in suitable groups. Each miniature circuit breaker has to be equipped with an additional contact to signal the status to the PLC. Overcurrent protection of the control circuits shall be designed to meet the following conditions:

- in case of a fault, only the faulty circuit will be disconnected
- successive protection steps have to work selectively

Control equipment in the field, such as limit switches, level sensors, pressure switches, etc. shall be located so that they can be serviced and set when the machines are running. The vibration or temperature rise caused by the machinery must not affect their operation. Minimum degree of protection shall be IP 65 (note ATEX standard if required).

Automation equipment, including PLC, relays, static control units, etc. shall be centralized in control cabinets. The design of the cabinets for the control equipment in the switchboard cabinet room has to follow the specification described in the basic design features for the MCC switchboard cabinets (see chapter 10.3.1).

12.2 Electronic Equipment

Contractor is solely responsible that the electronics provided will function reliably. Due to this fact Contractor shall state:

- Permissible ambient temperature: max., min. and 24 h average
- Requirements of air humidity
- Sensitivity of equipment to vibration
- Requirements of location e.g. with respect to high voltage or high current equipment
- Earthing requirements

Necessary voltage stabilizers, isolating transformers etc. shall be included in the supply.

13 Installation

13.1 General

All installation materials and accessories shall be selected to be resistant to heat and corrosion. The overall standard of installation shall be according to requirements of heavy process industry.

For outside installations, necessary rain covers shall be provided by taking operation and service aspects into consideration. Gatherings of rain or condensed water to any place or hole of equipment have to be prevented.

All the cabling and cable tray materials, earthing materials, marking materials, fixing materials and the related work are included within the scope of delivery.

Procedures shall be in accordance with IEC, EN, and Norwegian standards and regulations.

13.2 Cable Ladders and Trays

Cable trays, its suspension and extension pieces have to be delivered in hot galvanized finish, suitable for the environment at the place of installation. All leading and cutting edges shall be treated with liquid zinc paint before assembly. Where necessary, local cable installation shall be performed with stainless steel cable trays or pipes. All screws and bolts must be of the same material quality as the cable tray system to prevent galvanic corrosion.

There shall be a maximum distance of 2,0 m between each mounting bracket of the horizontally mounted cable trays. Additional mounting brackets shall be used at all level changes and changes of width. All cable trays have to be dimensioned for carrying the cable weight plus 15 % without deflection.

All cable trays in the process area shall be mounted vertically to prevent the power cables from overheating as a result from dust etc. Special attention shall be paid to max. distance between fixing brackets to prevent sagging or deflection.

For installation of cable trays prefabricated intersections, bends and junctions shall be used. This shall also apply, if adjacent trays at the junction are mounted in different height or distance to the wall. This is to prevent the cables remain bent over the side panel of the trays. All cable trays shall be provided with plastic end caps.

Cables on sharp edges shall be protected by the use of end caps and other adequate edge protection. Lower end caps at vertical profiles shall be provided with draining holes to prevent corrosion due to the possibility of standing water.

Cable bridges shall not penetrate the recesses in walls and floors, but shall end about 10 cm before the recess.

All cable trays, which are fixed on the floor, shall be mounted with levelling feet to the ground. The space between floor and cable tray must be not less than 100 mm.

With regard to future extensions all cable trays must have at least 115 % of spare capacity after the cable installation is completed.

Fasteners on water pipes shall only be installed on the pipe flanges and only in agreement with Client or his construction manager.

Medium voltage power cables (>1000 V), low voltage power cables (<1000 V) and instrumentation/automation cables (<60 V) shall be installed on separate cable trays which shall be taken into consideration with the cable tray supports included in the delivery.

13.3 Cable Installation

Contractor has to apply the following cable types:

- Power supply: NYY-J or NYY-O for single core cables
- Installation cables: Ölflex; with electrical shield where required
- Motor cables: Ölflex; with electrical shield when a frequency converter is used
- Control cables: Ölflex; with electrical shield where required
- Instrument. cables: Ölflex; with electrical shield where required
- Data cables: Double shielded Cat. 7 network cable for industrial installation and special PROFIBUS cable (only if needed)

Power cables with coloured wires shall be connected in the following phase order:

L1 brown
L2 black
L3 grey

For the N-conductor in a five-core cable light blue shall be used. In a four-core cable for motor connection light blue may be used for the W1 connection. Green/yellow is mandatory for the PE conductor.

All cable glands including extensions and reductions shall be supplied and installed by Contractor. For shielded cables the use of cable glands according to the EMC directive are required.

The cables included in the delivery shall be brought to equipment and devices using a conduit or a branch of cable tray for mechanical protection.

The cross-section of power cable conductors shall be selected according to:

- current-carrying capacity at actual mounting location and ambient temperature (correction factors accounted)
- voltage drop of motor supply cables max. 10% at starting and 3% when running
- co-ordination with the fuse rating
- In all cases wiring shall be in conformity with the rated accuracy requirements of Electrical Safety Code

For horizontal cable trays mounted vertically (standing), all cables or bundles of cables must be fixed every half a meter with steel brackets or ruggedized cable ties made of UV-resistant plastic.

On vertical cable trays and ladders all cables or bundles of cables must be also fixed every half a meter with steel brackets. The steel brackets shall be delivered in the same design as the cable trays and ladders.

All cables with a large diameter shall be mounted and separately fixed on cable trays in one or more layers, if possible. Smaller cables may be tied in separate bundles to save space on the cable trays. Overfilling of cable trays, excessive cable crossings and knots will not be accepted and have to be avoided.

In general, power cables and control and instrumentation cables have to be mounted on separate cable trays.

The control and instrumentation cables may be installed on the other edge of the power cable tray if there is no special tray for these types of cables. In this case a separator made of hot-galvanized steel must be provided.

Connections of control cables with flexible conductors always require the use of cable connection boxes made of aluminium with protection class IP 65.

When the cables are brought into connection boxes, the sealing shall be done according to the protection degree of the original equipment. Cable entries are only permitted from the bottom of the casings. If approved, lateral cable entries may be used in special cases. All cables shall be installed with a cable bend to achieve a drip edge. Moveable cables shall be installed with cable glands with solid stainless steel strain relief.

No joints shall be allowed in any cable run.

13.3.1 Cable Marking / Labelling

All cables from boards / panels shall be labelled at both ends with a permanent marking system. Tape-based labelling of cables is not acceptable. Marking text has to be made in accordance with the internal coding system and applied cable lists and has to show cable number, starting place and target place.

All cables running through a wall shall be labelled at both sides of the wall. Upon request from Contractor, Client may refrain from this requirement on a case-to-case basis.

All wires of external cables connected to a cabinet have to be marked at both ends. See also chapter 10.3.7.

13.3.2 Cable Routing

Where cabling pass through the floors, the cables shall be protected up to a height of 1,5 m from the floor level.

The routes of all cables shall be arranged to have an adequate clearance from other services. Cables shall generally be routed to avoid hot or fire risk areas and to minimise the risk of damage from any source. Where necessary, protection from solar

radiation shall be provided. The cable installation shall not limit free access for personnel or machines.

All apparatus connections and cable installations shall be designed and installed to minimise the risk of fire and any damage which may be caused in the event of fire. Wherever cables pass through floors, walls or other partitions, a suitable and certified method of sealing shall be used. This sealing (fire sealing) will be carried out by Client / the Civil Contractor.

Every cable shall be securely supported near its termination point and, in places where vertical runs pass through the floors, immediately above the floor. The type of installation to be used for the support system shall be described in the offer.

For single core cables carrying alternating current, brackets or clamps shall be of non-ferrous metal or other non-magnetic material fixed in such a manner that no magnetic circuit is maintained through any ironwork supporting or forming part of the rack.

Where cables are exposed to mechanical damage, sheet steel guards shall be provided to protect them.

Cables for instrumentation have to be installed with a so-called "pig tail" that facilitates the assembly/disassembly of the instrument. Cables for analogue signals shall be twisted-pair and shielded types.

All cables for signal and instrumentation have to be connected with wire-end sleeves.

13.3.3 Cable Screens

Control cables, which incorporate metallic screens, shall have the screens earthed at one end only. Otherwise, all screens have to be connected properly to protection earth at both sides according to the EMC regulations.

Earth connections formed from wire braid screening shall be sleeved with green or green/yellow shrink tubing. Cable type earth connections shall use green/yellow coloured insulated cable.

13.3.4 Data and Network Cable

A measurement with a measuring protocol has to be done for all data and network cables of the automation network of the plant. Contractor has to guarantee full functionality and data transmission speed for the whole automation network.

13.4 Field Devices

Dedicated field devices are included in the delivery, and they shall meet technical and environmental conditions stated in the specifications.

All panels, sockets and safety switches shall have engraved plates indicating the tag code of the supply board and the circuit number. The marking of safety switches must also show the descriptive clear text of the equipment they serve.

Plates of instrumentation and equipment shall be marked with the tag code and descriptive clear text of the device.

All engraved signs shall have black text on a white background. All plates have to be firmly attached to equipment with double-sided adhesive tape or a permanent fastener.

13.5 Emergency Stop Devices

The plant has to be equipped with an emergency stop circuit, which contains emergency mushroom pushbuttons, pull-cord switches and the safety devices for monitoring the emergency stop system.

All pushbuttons and pull-cord switches must have a yellow housing and a red knob or lever.

Special safety devices have to be provided for monitoring the emergency stop circuits. Safety devices for package units shall be properly integrated in the overall emergency stop system of Contractor.

The shutdown of the main circuits is done via hardware-based switching off the control voltages for the motor contactors in the switchgear of the sorting plant and by using hardware-based emergency stop interfaces in the control cabinet of the package units.

The entire emergency stop system has to be designed by using programmable safety devices with fieldbus connection, which has to be certified according to the safety standards and regulations. These components may be part of the PLC or of a peripheral I/O station of the PLC. Otherwise, the formerly common system designed by using hardware contacts is also possible.

The master PLC and the PLCs of package units shall not be switched off at shutdown by emergency stop. Rather, the status message 'emergency stop actuated' has to be transmitted to each PLC, so that on the one hand, a shutdown of the system in a safe operating condition, and on the other hand, a reset of all parameters in preparation for a quick restart is guaranteed. A restart of the plant or of individual units shall only be possible after unlocking the emergency stop switch and its acknowledgment of the process control system.

The design of the emergency stop system has to meet the valid EN standards and regulations.

The emergency stop devices of the package units have to be properly integrated into the emergency stop circuit of the entire sorting plant. So, Contractor has to ensure that the safety devices inside the switchgear of his subcontractors are compatible to his designated devices.

The emergency stop system has to be designed as a 2-channel system at least. For that reason, all emergency stop switches shall be equipped with two parallel N/C contacts for the emergency stop circuit itself and one N/O contact for the status message to the main PLC, if the use of a hardware contact is needed. Otherwise, the status message has to be generated in the safety devices of the PLC.

The emergency stop system must be designed so that it is easy to identify where to find the emergency stop device in use.

Further details will be fixed in an emergency stop concept and the risk analysis which has to be made by Contractor. See also chapter 3.2, Safety.

13.6 Earthing and Equipotential Bonding

All metal structures and electrical equipment outdoors and indoors shall be earthed.

In outdoor areas the structures shall be connected to the area earthing grid by the Contractor.

Contractor must prepare a dimensioned earthing plan for his equipment and structure in time, where connection points to the primary earthing grid are needed.

The equipotential bonding in Contractor's scope of supply shall be connected to the primary earthing system and shall include the bonding between all exposed parts throughout his entire process plant.

There shall be used earth cable marked yellow/green with a cross section of 25 mm² for the main cable trays. Local connections to pipes, fittings, smaller cable trays and junctions may be wired with a reduced cross section.

There shall be used earth cable marked yellow/green with a cross section of 6 mm² on flanges on electromagnetic flow meters and other instrumentation if provided. All bolts and fixing screws shall be secured with spring washers. By attaching the flanges only screws and fasteners made from stainless steel are allowed.

All earthing connectors shall be labelled with the cable marking system at the PE rail.

Bonding shall be made between conductive parts such as:

- Construction steel parts
- Steel reinforced foundations of building and machinery
- Building steel parts (platforms, stairs, etc.)
- Pipe systems
- Machine parts, machine components
- Ventilation ducts
- Cable trays
- Switchgear cabinets, panels, raised floor in switchgear cabinet room, control room etc.
- Steel profile supports for control panels, junction boxes, actuators, etc.
- Instruments (if required)
- CMS equipment

One Main earthing bar, provided by Client, will be placed in the room for MCC. Earth conductor of main supply cable shall be connected to the Main earthing bar. Earthing bars of MCC and other cabinets shall be connected to the Main earthing bar.

13.7 Common Lighting and Socket Installation

Electrical installations and LV switchgear for common lighting and socket installation of buildings will be provided by Client.

Lighting inside machines has to be included in the scope of work of Contractor.

13.8 HVAC Switchgear and Installations

Electrical installations and LV switchgear for HVAC of buildings will be provided by Client. A signal interchange between the sorting plant and the provided heating and ventilation system has to be prepared by Contractor.

13.9 Lightning Protection

Lightning protection of sorting plant building will be provided by Client.

13.10 Sprinkler and Alarm Systems

The fire alarm, sprinkler system and other alarm systems will be provided by Client. A fire detection and deluge system for the shredder with outgoing conveyor and baler shall be included in the Contractor scope, refer Appendix A6.

Contractor has to regard the signal exchange between the fire alarm and sprinkler system and his control and monitoring system of the plant to activate an emergency stop in case of an alarm. This has to be done in accordance with the fire prevention document.

14 Documentation

Contractor shall prepare all documentation for electrical installations that are part of the delivery.

Short circuit calculations shall be carried out and documented with an appropriate software.

Updated final documentation must be submitted electronically in their original format (e.g. AutoCad, Microsoft Word-/Excel and Eplan project) and PDF data file format.

Documentation shall include:

- Installation Drawings with plans and sections
- Arrangement drawings of switchboard cabinets
- Complete circuit diagram for switchboards main and control current circuits
- Switchboard cabinet documentation in accordance with EN 60439
- Electrical equipment list with all electrical loads
- Cable Lists
- Fuse and circuit register
- Photos of switchboards taken in workshop. Photos of switchboards shall show front and interior arrangement.
- Operating and maintenance manuals
- Full short circuit calculations and documentation of selectivity
- Report of the Risk Assessment incl. calculations

- Report of the Final Inspection
- Declarations of Conformity for installations, switchboards and equipment

Additionally:

- Complete list of all electrical consumers with all data filled in.
- Complete instrumentation list with all data filled in

Native files shall be updated and sent Client when changes are made. Updated and valid Eplan files (or similar) have to be kept at Client at all times. Therefore, the Contractor has to assure an update service for the guarantee period and make an offer for an annual update after the guarantee period.

15 Attachments

Att. 1 Drawing “Supply Limits Electrical Equipment and CMS”