PART III, APPENDIX A7
TECHNICAL SPECIFICATIONS FOR CONTROL AND MONITORING SYSTEM (CMS)

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CONTENTS

1. INTRODUCTION

This technical specification describes the basic minimum requirements of all Control and Monitoring System (CMS).

The ambition is to implement a common CMS with CMS equipment of the same make and type from the same basic manufacturer. In this way, all integration tasks can be solved by the basic manufacturer, although several sub-suppliers (system integrators) might be involved in the supply of the equipment.

The Line shall be controlled from one control room, from the same set of operator stations, and by one operator.

This is not a stand-alone document. The content of this specification shall be seen in the context of the remaining part of the Contract and Part III *Employer's Requirements*. Refer to Appendix A6 *Technical Specifications for Electrical Equipment* for technical specifications of electrical equipment. Appendix A6 *Technical Specifications for Electrical Equipment* is subordinate to this chapter.

The existing Siemens SPPA-T3000 CMS system, on level 2 and level 3 shall be used, where the hardware supply limit will be the redundant optical fiber cable connections to the two existing Automation Highway switches, as indicated in Appendix A17 *Concept Diagram for Automation (CMS Topology)*.

The Employer will deliver the SPPA-T3000 CMS system and the hardware on level 2 and level 3, but all engineering, design, programming, implementation, etc., for fully functional and operating system on all levels (including level 2 and level 3) is in the Contractor's scope of Contract Object, including all necessary license for Line implementing.

All level 2 and level 3 equipment will be used by the Employer to operate and maintain the Existing facility.

The Contractor shall as a part of the scope deliver all necessary level 2 and level 3 equipment and license etc. for engineering, programming, commissioning, testing and operating the Complete plant, as temporary engineering's station, temporary operator station, etc. all included, until Preliminary Take Over. A temporary control room shall be delivered as part of the Contract Object.

Move of the existing control room to the new control room shall be performed by the Contractor and coordinated with the Employer.

The existing CMS system will be upgraded to newest version by the Employer, minimum SPPA-T3000 Release R8.2.SP2, before start of the design of the Line.

1.1 Strategy for CMS

It is important to ensure an identical design and construction of the Electrical system and the CMS system, standardised and of the same product and type.

It is important that there is only one CMS product to secure a uniform construction of the operator stations and operation areas in the control room.

2. CMS TOPOLOGY AND CONFIGURATION

The CMS principles is shown in the CMS Topology included in Appendix A17 *Concept Diagram for Automation*.

The appendix indicates the structure of the total CMS that has to be implemented at Complete plant. The scale and extent of the CMS equipment in level 2 and 3 shall fit the size of the entire process system and the process stations in level 1.

All process information and actions to the process shall be supervised and controlled from a common control room for the CMS. The way of operating each object shall be equal irrespective of which part of the process the object refers to.

The control equipment in level 2 and 3 of the CMS topology shall be equal and of the same make and type, using the same programs and programming facilities.

All controllers shall be able to handle object programs from a common software object library (delivered by the Contractor). This is to ensure an identical way of operating all objects from the operator stations in the control room. Therefore, all controllers in level 1 of the CMS topology shall be able to handle the object programs.

It shall be avoided to use 'black boxes' and local control systems in the Line. "Black boxes", defined as local control by a PLC as well as boxes with relays, shall whenever possible, be avoided and only "black boxes" that are accepted by the Employer and listed in the Contract will be allowed.

2.1 Control room and Server room area and CMS configuration

The existing CMS equipment in the control room includes:

- 3 operator stations, each incl. 2 monitors, keyboard and mouse/trackball.
- 3 operator station, with 3 monitors, where 1 of them are big screens
- 1 colour laser printers.
- 1 operator stations incl. 2 monitors, keyboard and mouse/trackball for CCTV system

Contractor provides complete equipment for the control room of the Line based on requirement below.

The operator monitors size is 24" 16/9 with full HD resolution or higher. The screen resolution is 1920 x 1080.

Only the operator monitors are placed in the control room. The PC is placed in the server room.

The pixel resolution for the big screen shall be with full HD-resolution or higher. The size of the large screen will be 2 x 55".

All PC's/operator stations for the CMS shall be of the same make and type as the existing PC's and operator stations.

All vital servers shall be in a redundant solution, based on standard server technology facilitating the interface between the operator stations and the process station with redundant power supply.

It shall be possible to get access to the servers and workstations by means of a local keyboard and screen.

The concept for placement of the servers, is that the half of the redundant servers will be placed in the server room and the other half of the redundant servers will be placed in the CMS room.

2.2 System requirements for Servers

All servers for the CMS shall be equipped with:

- RAID 5 **R**edundant **A**rray of **I**nexpensive/Independent **D**isks
- Redundant Network
- Redundant power supply, two independent 230 V AC supplies
- Servers shall be Rack based version
- If standard servers are used the preinstalled RAM should be doubled

2.3 Installation in the server room

All servers and work stations shall be installed in racks which are lined up in the server room. The racks shall be placed in a straight line and with access from the front and the rear end.

Server racks shall be delivered with extra 50% spare capacity.

The heat developed in the racks shall be removed by natural ventilation. The temperature in the server rack and the server room shall be monitored and an alarm signal will sound in the event of the temperature being too high.

The partition between two adjoining racks shall be a steel plate wall without openings for cables or the like. Cable connections between two racks shall be led through the bottom of the cabinets and via the cable routing under the raised floor.

Each rack shall be equipped with:
- 2x230 V AC UPS supply from redundant system.
- One isolated 70 mm2 Cu EMC equipotential bounding connected to the frame of the cabinet
- 230 V AC service socket
- Light for orientation
- Installation of cobber cables shall as a minimum be a CAT 6 installation
- Space and room for documentation sheets

2.4 Networks and Connections to Other Systems

The CMS Process network shall be implemented as redundantly configured fibre multicore optical network with intelligent routers, switches and the necessary firewalls.

It is the intension that the network can be used for other purposes in the future and therefore the Process network shall be extended/extracted to local technical rooms and other strategically location in the process area for local Line operation and the Control network shall be extracted in a similar way for future needs. This means that the network may be spread to locations not needed for this project, but purely to have a fibre backbone for future purposes.

To extend the network to locations on the Line, four (4) cabinets and a redundant network shall be included. The fiber shall have 48 cores. If the Contractor is opposed to connect the extended network to the process network a cabinet "starting" the extended network shall be placed next to the racks with the process network. The network shall be connected in a ring connection.

Cable routing for the total extended network shall be included. A cable tray of 150 mm shall be used. Any deviations because of existing cable routing that can be used shall be regulated by unit prices.

The configuration shall be approved by the Employer.

HW and user SW for network configuration and supervision shall be included in the Contract Object.
The communication network shall be designed with an excess capacity of 100 %. All senders shall be provided with safeguards preventing a faulty unit from transmitting continuously, reducing the capacity of the network to transmit relevant data.

All Network components for all IP network shall meet the (SNMP) revision 3 standard or higher.

2.5 Cables

Refer to Appendix A6 *Technical Specifications for Electrical Systems* concerning technical requirements for cable routing, cable penetrations, cable requirements, installation of cables, fixing of cables, termination of cables and labelling of cables.

2.6 Process stations

The process stations shall be installed at location(s) in the process of Line.

Each process station shall be an autonomous processor-based unit configured in a redundant solution controlling and monitoring a specific main function group of the Line. The process stations shall exchange data with each other as well as with the equipment in the control room through the control net via the redundant servers.

Signal exchange between the CMS and the process Line and other Line equipment shall be solved via Input/output (I/O) modules. The I/O-modules shall be distributed in Remote I/O cubicles (RIO's).

The process stations and their associated I/O-equipment shall also be able to handle safety related signals from different areas in the Line via special safety PLC' s and associated safety I/O modules. The expected safety level is Safety Integrity Level (SIL) 2, but the necessary specific SIL level is up to the Contractor or the individual Sub-Contractors to decide. A description of arguments shall be provided by all contractors.

The process stations or the RIO panels must be able to handle explosive areas (ATEX directive). This shall be specified by the Contractor.

2.7 Spare Capacity and Expansion of CMS.

The following conditions regarding spare capacity shall be observed:

The CMS shall be of a scalable design allowing for an extensive expansion of the system. The expansion facilities shall comprise all levels of the system in a way that the CMS's technical capacity including performance as a starting point is provided in preparation for a future expansion of minimum 75 % (e.g. input/output-signals, associated software, process stations and operator stations)

This should be interpreted in the sense that the system can be extended with workstations, process stations etc. without the need to upgrade servers and software. This means that the extension does not have to be installed but the backbone and vital servers of the system should be ready for min. 75% extension.

- At the time of Preliminary Take Over, the equipment in the server room and the communication network shall be provided with reserve capacity that allows at least a 75 % expansion of the number of variables without upgrading of hardware or software.

- The 75 % reserve capacity shall apply to all types of variables processed by the equipment: process variables, calculated variables, logged alarms and events, logged trend data, process displays, reports, trend graphs, etc.

- A 75 % expansion may not cause any degradation of functionality of the equipment in the server room, in particular concerning the performance requirements.

- Each process station shall at the time of Preliminary Take Over be provided with at least a 75 % reserve capacity to manage input/output signals, so it will be possible to connect 75 % more signals of all types including accompanying software.

The Contractor shall demonstrate that the spare capacities are kept and further provide documentation hereof.

2.8 Lifetime, Spare Parts and Software

All CMS components (hardware and software) shall be able to be supplied and supported in a period of minimum 10 years after approved end of Warranty period.

All CMS components (hardware and software) shall be able to be supplied and supported in a period of minimum 10 years after they have been announced obsolete.

The Employer's approved software versions shall always be used. The Contractor is obliged always to deliver and install necessary software and licenses. Hereafter the ownership belongs to the Employer.

All supplies shall include the necessary licenses, so that the number of spare available licenses is minimum 25%.

Beta versions are not allowed.

3. PLANNING, DESIGN, ENGINEERING AND DOCUMENTATION

In addition to the corresponding section in Appendix A6 *Technical Specifications for Electrical Systems*, the following items (not exhaustive) shall be regarded as being specifically important concerning planning, design, engineering and documentation:

- Operator/engineer interfaces
- Process descriptions
- Highest automation level
- Response times, performance and spare capacities
- Redundancies
- Uniform standard interfaces and controls
- Common object library
- Screen graphics
- Training and education

The Contractor shall develop the libraries and responsible for maintaining the libraries until end of Warranty period.

3.1 Functional Design Specification (FDS)

The Functional Design Specifications for the respective CMS delivery part, will be the basis for programming the CMS. The FDS is a document that will be used by various users in the organization for different purposes. Accordingly, a common structure for the document is required, to enable various readers to extract the correct information. The requirements of the document in relation to the structure and content shall be in accordance to the Employer's specification, Appendix A14.7 *Documentation*.

4. OVERALL CMS CONTROL REQUIREMENTS

4.1 Hierarchical Structure of CMS

The CMS shall be designed with a hierarchical structure with the following levels.

- Control room, operator level
- Line level
- Group level
- Single drive level
- Local operation level

This structure shall apply both to the control by the operator and control by the CMS automatic functions. Each level shall monitor itself and shall ensure that the level is controlled as intended. Whenever an error is detected, the level shall automatically be brought into a secure condition. A level may only be set into automatic operation if the subordinate level is ready for operation.
In automatic operation, the higher levels automatically control the subordinate levels. In case of a fault at a higher level, the operator control shall be automatically transferred to a subordinate

level. Safety of personnel shall be fulfilled at all levels of operator control and automatic control. The following requirements apply specifically to the individual levels:

Control room

The operation from the control room is the highest level of operation. The operators are making their decisions and actions from this level. The CMS must fulfil the operator commands, to ensure overall monitoring and supervision of the complete facilities of the Line. This also includes controlling activities from support/service laptops located remote e.g. operator staff members or supporters being on call.

Line level

The Line level function ensures the fully automatic control of the Line according to the requirements. The overall operational parameters for the Line are set by the operator and entered at the Line level.

Group level

The group level lies between the Line level and the single drive level. Each group is automatically controlled on the basis of commands, set points and other parameters provided by the Line level. Whenever this state cannot be maintained due to an error or a fault, the Line, or part of the Line, shall automatically be brought into a safe state. The groups should include (for example) the grate system, primary air supply, secondary air supply, ash conveyance, water treatment, ID fan control, heat exchanger control, etc.

Single drive level

At the single drive level, the operator can change the mode of operation for a component, with the modes being AUTO (automatic control from application program) / MANUAL (Operator controlled, where the operator starts and stops objects) / LOCAL (Local controlled objects, from a local control box). In AUTO and MANUAL mode, the internal CMS interlocks for TRIP and Process are still active, in LOCAL only the TRIP interlock are active. The Line can be operated in manual mode by the operators in the single drive level.

Local operation

Local operation is a mode of operation that can be done locally in the process area from the component. Local operation is required when the operator has to be close to the process for a special operation, for example local operation of conveyor belts, screw conveyors etc. At the local operation level, the operator can operate the component directly from a local operator panel located near the component. The commands given at the local operation panel shall pass through the CMS, so that any TRIP interlock will still be active during local operation. Local operation of a component shall only be possible after the operator in the control room has selected LOCAL from an operator station.

Master controller (block führer)

A master controller (block führer) sequence shall be established on the highest level.

The master controller shall control the sequence of functional groups so they start in the right order and help the operators if there are any manual tasks to be performed. In case of any fault or irregularities the sequence shall go to safe controlled mode (step 400-499)
The master controller sequence shall optimize the operation of Incinerator/Boiler, turbine and district heating (heat production).

The sequence shall automatically set the relevant set points ("blockregler", "sollwertführer") for controllers for the different operation modes.

The philosophy is inspired by electric power Lines. The details shall be discussed and agreed with the Employer. To help this process the Contractor shall supply "control loop diagrams with verbal description"(one for each loop) and functional design specification to give an overview and a starting point for detailed design.

4.2 Overall CMS Operation Philosophy

The following requirements regarding operation philosophy shall be observed:

- The Line shall be controlled and monitored from the operator stations in the control room. Under normal conditions it shall be possible for one operator to control and monitor the Line from one operator station in the control room.

- Independent of the chosen level of operation and control, the CMS shall ensure that the Line can be controlled and operated in a secure and satisfactory manner. This includes personnel safety, Line safety and operational reliability. All operator actions shall be subordinate to the safety systems of the CMS. In case of faults in the Line, or in the CMS itself, partially or totally, the CMS shall ensure that the faulty part of the Line is brought into a controlled and secure condition.

- The operator must have full information from the Line available in the CMS, to help with decision making and issuing commands through the CMS. The operator is the person in charge and it is the obligation of the system to provide adequate and correct information, presented in an operator-friendly and understandable way.

- The CMS system is required to be running 24/7 all year (100 % uptime). For this reason the system is made redundant as described elsewhere. This means that normal maintenance and service has to be performed during operation of the Line.

It shall be possible to analyse, optimize the operation and maintenance of the Line by means of exchanging data with the ERP system(s). This applies for the operation as well as the maintenance of the Line.

Any available system software that can optimize the process or operation of the Line shall be included in the Contract Object.

The overall CMS comprises the following main functional groups, but not limited to:

- Overall coordination ("master controller/blockführer")
- Waste equipment (waste cranes, IBA crane, etc.)
- Waste incinerator with auxiliary equipment
- IBA and ash handling and transport systems
- Steam Boilers with auxiliary equipment
- District heating system
- Water-steam cycle
- Component cooling system
- Flue gas treatment systems
- Low-Temperature Economizer and Flue Gas Condensation (Option 1)

- Compressed air system
- Central vacuum cleaning
- Chemical and process consumables supply and storage systems
- Turbine
- Steam system
- Condensate system
- Feed water system
- District Heating Condenser
- Air Cooled Condenser
- Generator
- Water supply and water treatment systems including drain systems
- Power supply
- Emergency generator system and safe power supply systems
- Building service systems

4.3 Reliability and Safety of CMS

The following requirements regarding reliability and safety shall be observed:

- The CMS shall include all equipment for control, protection, monitoring and operation of the Line. Thus, the integrity of the CMS shall be higher than the integrity of the process equipment that it controls. Accordingly, the CMS design shall be based on proven concepts and with error handling procedures limiting or eliminating the consequences of faults within and outside the CMS.

- The CMS shall be divided in functional groups structured according to the structure of the process Line. The aim of this division is to minimize the consequences of faults in a functional group with respect to the overall function of the Line.

- The CMS shall be designed with a high degree of redundancy in order to ensure the required high operational reliability and availability. This shall apply to the various levels of the CMS: process stations, communication network and equipment in the server room. Redundancy of the process equipment shall as a minimum be complemented by a corresponding redundancy in the CMS. The primary safety and protection systems shall be designed with redundancy in both hardware and software. The input signals used by the redundant channels may not originate from the same source.

- If, because of a fault in the CMS, any part of the process Line or a control function is unable to react to commands from the CMS, the system shall be designed to ensure that any resulting failure in part of the process Line or control function does not compromise personnel safety or Line safety. The CMS shall possess "self-check" facilities ensuring the detection of internal faults. Such faults shall be reported as alarms in the control room. The general principles are:

    - No single fault may cause disruptions of the function of protection systems.

    - No single fault in a measurement circuit (comprising transmitter, plug, branching cable, junction box terminals and I/O-channel of the CMS) may lead to a stop of the Line. Such measurement circuits shall be implemented according to the "2 out of 3" principle.

- No error in the CMS may stop a component and at the same time take a reserve component or a parallel component out of operation.

- No single fault may make it impossible to monitor the Line or to issue commands from the operator stations in the control room.

- Safety functions. Where the process demands SIL 2 rated (or higher) safety functions, this must be integrated as a part of the CMS. The safety approved CMS parts must supervise and give commands to the objects addressed into the safety part. The information and operator commands must be handled as all other control and monitoring functions in the CMS.

5. OPERATION OF THE CMS SYSTEM

The overall CMS shall be is a uniform type and existing Siemens SPPA-T3000 CMS system, on level 2 and level 3 shall be used, where the hardware supply limit will be the redundant optical fiber cable connections to the two existing Automation Highway switches, as indicated in Appendix A17 CMS Topology.

The Employer deliver the SPPA-T3000 CMS system and the hardware on level 2 and level 3, but all engineering, design, programming, implementation, etc., for fully functional and operating system on all levels (including level 2 and level 3) is in the Contractor's Contract Object, including all necessary license for Line implementing.

The existing CMS system will be upgraded to newest version by the Employer, minimum SPPA-T3000 Release R8.2.SP2, before start of the design of the Line.

All CMS parts will be installed in temperature controlled rooms, e.g. the server room. Only the RIO panels and field instruments may be installed in areas/rooms, which is not temperature controlled.

Below are the functional requirements described, and the limit is the capability of SPPA-T3000 CMS system.

5.1 CMS Operator Stations

The basis for the HMI and CMS Operator Stations is a design similar or as close as possible to the existing CMS system.

The following shall apply for the operator stations:

The operator stations shall function as parallel functioning computer based units so that all information is available on each of the operator stations. The operator stations shall be identical with respect to hardware and software configuration.

The operator stations shall as a minimum provide the following general functions:
- Presentation of the process
- Alarm handling/alarm lists
- Event log

- Trend curves
- Report facilities
- Information system for the operators
- User access (password and operation right)

Furthermore, it shall be possible for the operator to perform the following:

- Manual control of pumps, valves etc.
- Manual control of sequence program
- Switch from automatic control to manual control for all system components
- Switch between different operation modes for process components
- Control of all controlling parameters of the process components
- Alarm handling
- Process supervision
- Handling of maintenance activities
- Display and printing of screen pictures/screen dumps, reports, alarms and other events
- Planning and management of operation and maintenance routines as well as other planned operation.
- Report generation of operation reports, environmental reports and reports required by the authorities.
- Analysis of process trend curves, process and operator events as well as alarms.

All operator functions for the Line, including monitoring of operation and issuing of commands, shall always be available, even if only one operator station is in operation. A fault in one operator station may not cause a fault in the other operator stations or in other units of the CMS. If the system is designed in such a way that one unit functions as a master, for example because of time synchronization etc., then the system shall in case of a fault of the master unit reconfigure automatically so that one of the other units becomes the master.

5.1.1 OPERATOR PRESENTATION

The following shall apply for the presentation of the operator stations:

- A dynamic presentation of the process where the important information is clear, bright and visible. Lower information levels are to be presented as static drawings with a lower brightness and colour intensity. This to give the operator full instant information, where low-value information doesn't distract from the important information. White is not allowed for indications for more than a short time, as it attracts too much attention. Further, working environment and visualization according to the Employers requirements shall be observed.

- The process display, used to display the process.

- The control display to display the PID controllers belonging to the process (display). This display must indicate the implemented functionalities around a PID controller, calculations limiter and ramps etc.

- Help display. Behind the process display is a Help display. This Help display, one for each process display, must contain help for the operator in the form of written help commands and links to the documentation of the process.

- The presentation format shall be based on windows, which shall be possible to move/zoom/ change the size of.

- The dynamic part of a process display shall be able to include at least 100 analogue objects (analogue variables with indication of validity and with monitoring of limit values), 100 binary objects (for example sectioning valves) or any linear combination of these two object types.

- The state of the monitored and controlled objects shall be presented by a suitable combination of graphical symbols with varying shapes and colours, numbers and texts.

- Standardized (in accordance with ISO 10628 for example) symbols for pumps, valves, measuring points, flow directions etc. shall be used. The symbols shall be recognizable for personnel who have experience with the drawing documentation of the process Line.

- The state of an object may not be displayed by colour alone. The information displayed by colour shall be supplemented by information displayed by shape so that a colour-blind person can operate the system reliably.

- It shall be possible, on demand via the keyboard, to turn on and off the presentation of the Tag no. for all objects on the process displays.

- Each object should include a free format text field automatic pop-up upon positioning the mouse on the object on the process display.

- It must be easy for a trained operator to make changes to the process, via the implemented faceplates and HMI interfaces to the equipment.

- Faceplates/graphics objects for local control must be included (Control valves and traditional local panels).

- Alarm texts shall be shown in conspicuous colours. The same applies to texts showing critical operating functions, critical adjustable limit values etc. Critical functions shall in this context be understood to be functions having a direct impact on the operation of the Line.

- Analogue signals that are not valid (for example because they are outside the 4-20 mA range) shall be clearly marked. The same applies to calculated analogue variables that are not valid. Signals from bus connected transmitters must also be marked if the signal is not valid.

- From the operator stations it shall be possible to set limits for limit value monitoring, to adjust set points and to switch controllers between manual and automatic modes.

- The issuing of commands shall be a two-step procedure so that a command does not become effective until the operator has confirmed this command. This procedure shall prevent non-intended actions caused by operator mistakes.

- All information in the process stations concerning program and process status, including settings of analogue and binary parameters, shall be immediately available at the

operator stations. It shall be possible to view the code (view only) directly from the operator screen to help diagnose problems when executing the program.

- For automatic sequence programs, the presentation shall include the display of steps, commands and criteria including TAG no. and clear approved designation for the component in question. During the execution of a sequence program it shall be possible to show the criteria that remain to be fulfilled prior to transition from one step to another.

- All interlocks during execution of a sequence program shall inform the operator about the cause of the interlock by use of operator message.

- An operator display shall show in detail the start-up sequence of unit 1 and unit 2 respectively, including the status of all auxiliary facilities.

- An operator display shall show in detail the close down sequence of unit 1 and unit 2 respectively, including the status of all auxiliary facilities.

- All timers used in program shall be indicated on the operator display.

- Object face plates and signal faceplates must contain the required information for the operator. It must be possible to block signals and interlocks from the faceplates.

- Each dynamic process object shall be supplied with an individual field, available upon selection of the object in the process display, for on-line entering of a free-text, enabling the operator to enter a specific comment regarding the associated component. Objects for which a new comment is present shall be graphically marked.

- The state of the local control program modules for individual components, including each individual hardware and software error, shall be presented at the operator stations.

- Limit values (switch points) are used for interlock, alarm and event. The design and implementation of limit values shall be made only to include the necessary limits. This is in order to minimize the extent of superfluous limit values, which goes to the alarm and event log. These will disturb the operators and load the system unnecessarily. For example this means that standard macros/faceplates shall be completely adapted to the function in question. In case the macros/faceplates contain additional facilities beyond those required, they shall be removed or be dimmed in order not to disturb the operator. The following limit identifications must be used:

High & Low limit	Used for trigger levels, indication as event
HighHigh & LowLow	Used for alarm limits indicated as alarms
HighHighHigh & LowLowLow	Used for TRIP limits, indicted as alarm

The indications are used for Boolean and analogue values (see KKS manual for signal names).

5.1.2 AVAILABILITY DISPLAY FOR THE LINE

The availability of process parts/units must be indicated in process displays for the process Line. Displays of the availability of I/O modules, Process controller and network/network components shall as a minimum be provided. The process display layout must be uniform for each display, with the same information in same place. The information must also be available for the reporting system.

5.1.3 TREND GRAPHS

The following requirements in relation to trend graphs shall be observed:

- The CMS must be able to generate trend curves for all analogue signals as well as their treated, normalized and summarised values. The system must also be able to trend at least 100 Boolean values.
- It shall be possible to configure up to 10 different values at a trend display. The necessary number of trend displays shall be preconfigured by the Contractor. The preconfigured trend displays, must be configured correctly according to the used working value range of the signal. For each PID controller, or similar object, a trend display must be directly available.
- All information must be available online for at least 5 years and be ready to be used by third party software.
- It shall be possible to display and print trend graphs of variables as a function of time, both dynamic trend graphs (based on on-line data) and historical trend graphs (based on data in the trend database).
- It shall be possible to have at least 5 trend graph displays open on an operator station simultaneously.

5.1.4 EVENT HANDLING / EVENT LOG

The following requirements regarding event handling shall be observed:

- The CMS must be able to record and indicate all events from the Line. The number of events might exceed more than 5 – 40,000 pr. hour. All events must be recorded in an online event log, where all information must be available for at least 5 years. The event shall not be shown unless requested by the operator. The events display must be filtered in a manner in which the operator only looks for the current problem or related process events.

- It must be possible to see events related to each object directly from the object faceplate.

- Events shall be logged on a short-term basis in the event log of the operator system. The logged data shall include, among others:
    - All changes of binary process variables (for example start/stop of pumps, opening/closing of valves)
    - Program-controlled status changes in the process stations (for example activation of sequence programs, transition from one sequence program step to another, switching of controllers between automatic and manual operation)
    - Operator Commands

- All operator inputs must be recorded as a part of the event log including the operator ID. It must be easy to find all operator changes via filters, recorded with operator id.

- For each event, the log shall comprise the following information:
    - Time stamp (resolution 10 ms, generated in the process station)
    - Tag-number (minimum 16 characters) and description (minimum 30 characters)
    - Status text
    - Fault
    - Priority
    - Operator ID
    - etc.

- It shall be possible to display and print the logged events as event lists. The events shall appear in the event lists in chronological order, according to the time stamp. It shall be possible to edit/sort selected parts of the event log on the basis of time, tag-number, status, group etc.

- All information must be available online for at least 5 years and be ready to be used by third party software.

5.1.5 ALARM HANDLING

Alarms should be useful and relevant to the operator. The alarms should require the operator's intervention, meaning he can correct the process or bring equipment/process into a safe state. This means that trip failures are in general not alarms because at that time it is too late for the operator to intervene (they will have a lower priority.) The Contractor must agree on a alarm philosophy, there shall be used on the Complete plant.

The alarm philosophy should follow the principles in EEMUA publication no. 191.The alarm list from the Contractor must reflect the above.

The following requirements regarding handling of alarms should also be observed:

- Alarms and events shall be structured in a number of process sections reflecting the Line areas and with the possibility of classifying in different priority (e.g. Severe priority/High priority/Low priority).

- The number of alarms shall be limited as much as possible

- All alarms for a process section shall be presented in an individual alarm list of the operator stations.

- All events for a process section shall be presented in an individual event list of the operator stations.

- The alarm list and the Event list shall present information in a uniform way.

- The system shall be able to indicate alarms from the process as important indications, where the operator has to take immediate action.

- The alarms shall appear in the alarm lists in chronological order according to the time stamp.

- An alarm shall be in one of the following states: Upcoming, disappeared, unacknowledged, acknowledged, manually blocked or automatically blocked. It shall be possible to unambiguously identify the state of each alarm. The history of the state of each alarm must be found in the event list.

- It shall be possible to block/release alarms from the operator stations.

- Each alarm shall be classified as belonging to one of four alarm groups with different priority. The alarm groups shall be distinguished via different colours in the alarm list.

- There shall be a potential free contact for each alarm group. The contact shall be flashing if there is at least one unacknowledged alarm in the group, closed if alarms are existing in the group. Otherwise the contact shall be open. The contacts can be used for different warning light information in the control room for unacknowledged alarms.

- It shall be possible to acknowledge alarms, individually or in groups, by the keyboard or alternatively by the mouse / the track ball.

- It shall be possible to print filtered alarms on request, including blocked alarms.

- The alarm groups shall also be clearly identifiable, when alarms are printed on a printer.

- It shall be possible to establish attention alarms, for example an attention alarm being generated once an hour as long as a specific alarm remains blocked.

- Sum/common alarms are not accepted.

- It shall be possible to differentiate between CMS system alarms, process alarms and maintenance alarms.

- Alarms shall contain a "what to do text" if the system supports this.

Alarm Suppression

Alarms suppression shall be extensively applied, e.g. for:

- Alarms resulting as a direct consequence of a preceding alarm.

- Alarms resulting from transient conditions during normal start and stop sequences for the Line or parts of the Line.

- The alarm system must be performed so it is possible to block groups of alarms during maintenance, of function in the Line, in order to minimize amount of undesired alarms.

Alarm suppression shall be described in the functional description.

5.1.6 OTHER CMS OPERATOR STATION ITEMS

Additional items for the CMS are described in the following section.

Information for operators and other users
The CMS shall include:

- The possibility of viewing process and Line documentation from the CMS via link between the CMS objects and the associated documentation located in the O&M system.
- Interactive documents
- Short procedure explanations
- Other procedure explanations

CMS time synchronization
The CMS shall include time synchronization for the Line. The CMS system shall adjust the internal clock against an external clock (regional time) and shall do an internal time synchronization in the system.

Maintenance information
For the purpose of facilitating maintenance, the CMS shall register all running hours, and number of operations (start - Open/Close) for all essential components and equipment, including all rotating machines. The data shall be logged and made available online for the Operation and Maintenance system (CMMS).

5.1.7 LOGBOOK/NOTEBOOK SYSTEM FOR OPERATORS

The system shall include a logbook/notebook function. The operators shall use the logbook as a medium for logging important information and as an "Operation Journal", to ensure sharing of information and knowledge between the operators and supervisors.

- Input
    - Shift information (replace the existing shift log function)
    - Log of problems with a keyword, + later solutions to the problem
    - Log of safety barriers (incl. lockout-tagout)
    - Log of modifications, replacements
    - Log of ideas with keyword
    - Comments can be added to all entries.

All input shall have a keyword, which can be selected from a lookup index table.

- Output
    - Shift information per day, week and selected time interval
    - Problems sorted by keyword and time interval
    - Modifications sorted by KKS and time interval
    - Ideas with time interval

    All outputs shall also be printable.

The logbook system shall be accessible from all the operator stations.

The keyword shall be a simple identification text, for example "shift staff info", item function name, or a KKS no. In this way it will be possible to filter on previous entries concerning the same problem or related problems.

The information notes shall be collected in a common database and access able from the entire network.

Logbook information from the previous week must be retrievable and be available for printing on request.

5.1.8 REQUIREMENTS FOR SOFTWARE

The system software shall include the operating system and those compilers that are necessary. The operating system shall be a commonly used standard system, and it shall be continuously supported and developed further by the Contractor so that it can support later changes of hardware and software without the need for special programming works. External access to the CMS system shall be protected against virus if necessary by use of anti-virus software. Use and maintenance of anti-virus software must not influence the operation availability.

User software shall comprise the following functions, among others:

- Basic definition of dynamic elements (analogue and binary objects)
- Configuration of process pictures with facilities for display and operation
- Change of control loop parameters / set points
- Alarm definitions (alarm classes, alarm texts etc.)
- Definition of logging in the trend database
- Configuration of trend graph displays and reports
- Forcing of signals facilities.

5.1.9 PERFORMANCE REQUIREMENTS

When the CMS has been fully implemented, with all signals and functions, it shall meet the following performance requirements.

Time for evocation of a process display, a report or a signal list
Time from activation of the selection button until the static part of the process display has been fully drawn: Max. 1 second.

Further time for updating of all objects in the dynamic part of the process display: Max. 2 seconds. Total time for evocation of a process display from activation of button until the display is fully updated: Max. 3 seconds.

Time for update of a variable in a process display
Time from a change of the value of an analogue or binary input signal at the I/O-unit until the changed value is correctly indicated in the process display at an operator station: Max. 1 second.

Time for issuing of command
Time from activation of the command button at an operator station until activation of the output signal at the I/O-unit: Max. 1 second.

In situations of high load on the network, for example during transfer of configuration data over the network, the above requirements still apply.

5.2 Engineering Station

The CMS shall include an engineering station. It shall be possible to engineer for two persons at the same time. For instance, by using floating licenses or a special logon procedure. From the engineering station it shall be possible to configure, name and supervise the entire CMS.

The engineering, design and documentation of the application code shall be based on IEC 61131-3. The programming and documentation language shall be of type graphic language Function Block Diagram (FBD).

The programming tools shall be self-documenting so that the programs drawn on the screen fully conform to the actual control and monitoring functions, and so that the programs can be printed out directly in understandable graphical form. The programmer shall insert programming comments into the program to improve understanding when reading the printouts. When programs are modified, the engineers must also modify the "process descriptions" to ensure that the process descriptions are always updated and describe the current functionality.

From the engineering station it shall be possible to carry out on-line and off-line programming of application software in the operator system and control system (for example in the process stations). The introduction of changes/updates in parts of the system may only affect the changed/updated parts. The rest of the system shall continue to function independently of the activities in connection with the change/update. The operators at the operator stations shall be automatically notified of changes/updates of application programs related to the process Line.

The program structure shall reflect the functional and hierarchical structure of the process Line. Programming shall be carried out by using fully graphical programming tools. Programming shall be carried out by functional blocks and macros drawn by mouse directly on the fully graphical screen. The control and monitoring functions are defined by placing function blocks and macros, defining their inputs and outputs and drawing the functional connections between them.

From the engineering station it shall be possible to configure the functions of the operator system in an easy and simple manner. Configuration activities may not interfere with monitoring and issuing of commands at the operator stations.

From the engineering station it shall be possible to access all bus connected objects in the CMS. It shall be possible to upload configurations from all instruments (transmitters), all frequency converters, all intelligent MCC controllers, and all other intelligent components in the system that communicate via communication bus.

The local control program modules for individual process components and standardized software functions shall be implemented as macros in the programming of the process station. For each object/instance in the operator station there shall be a corresponding function block in the coding.

It shall be possible to carry out a complete check of the entire program by simulation of input states, variables etc. directly on the screen. By means of the debug functionality it shall be possible to simulate directly and change the values of variables in the process stations.

The engineering station shall be provided with a CD read/write device or another suitable medium for creating back-up copies of its programs.

5.2.1 ANALYSIS OF PERFORMANCE

From the engineering station it shall be possible to analyse the performance of the communication networks, the process stations and the operator stations. Facilities enabling the system administrator to carry out performance measurements for different configurations, for example for a process station and an operator station or for the entire CMS, shall be included in Contract Object.

It shall be possible to freely define a time period for the performance measurements. It shall also be possible to carry out a number of simultaneous performance measurements on the same part of the CMS, but with different time periods.

A performance parameter that shall be available and documented by the engineering station is the Uptime. The Uptime is defined as the time during which the CMS or a certain part of the CMS functions correctly in relation to a defined total time period. The Uptime is calculated on basis of the total Downtime in the defined total time period as follows:

Downtime/Uptime calculation:

$$\text{Downtime (in \%)} = D/T \times 100$$

D = Total downtime (in minutes)
T = Total time in the month (in minutes)

The Uptime can be calculated from the formula:

$$\text{Uptime (in \%)} = 100 \times [1 - D/T]$$

Please note that the uptime for the CMS shall be 100 %.

5.2.2 FAULT DIAGNOSTIC OF ENGINEERING STATION

The engineering station shall include a system capable of monitoring and interpreting faults in the CMS and providing proposals for how to remedy the faults. The system shall be able to monitor and analyse all faults in the communication networks, the operator stations and the process stations. It shall be possible to sort faults according to various criteria, for example "importance", Line components or process stations.

5.3 Trend Database

The CMS system shall facilitate Trend curve design/configuration, editing and displaying of full graphic dynamic Trend curves (data from online database) as well as historic Trend curves (data from Historic Trend database system located at Historic/Report Server).

The system shall have a dedicated trend logging system (trend database) with capacity capable of logging any analogue variable together with the calculated values, and any counter value. It shall be possible to configure the trend database on-line, and configuration activities shall not prevent data logging and aggregation for variables that have already been configured for logging.

It shall be possible to freely reconfigure the above-mentioned blocks.

All values in the trend databases shall be in SI-units. Every recorded value shall among others contain:

- Tag-number
- Name
- Time stamp
- SI-unit
- Recorded value
- Quality index
- Operator ID

5.4 Historic/Report database server, general requirement

The function of the Historic/Report database server is to gather and store data related to operation and environmental impact and to facilitate reporting. Furthermore, it shall support both administrative and operational tasks.

Data and trend curves shall be stored in an SQL relational database and shall be accessible from both the CMS as well as administrative PC's applications (e.g. MS Access or MS Excel) connected to the Employer's administrative system.

The Historic/Report database server shall be provided with software and equipment for creating backup of data as well as archive data for later use. The backup media can be any suitable media for creating backup of the data files.

5.4.1 LAYOUT OF HISTORIC/REPORT DATABASE

The Historic/Report database shall be designed for the same number of signals as described in sections trends and section events.

5.5 Backup server and restore

The backup server shall be provided with storage (NAS) for creating full image backups and incremental backups, including all application software, trend databases, event logs, etc. The backup server shall be provided with programs enabling manual and automatic backup of all databases and other relevant data.

The backup server shall be prepared for integrated with a cloud-integrated system or with a local remote backup system, for daily, weekly and monthly backups.
From the backup server it shall be possible to make a full restore of the CMS system from scratch. It will be a part of the test.

Archive capability must also be available where recorded information is taken as a copy of the online records. The online records can be overwritten after 5 years. The archived data must be accessible for 3rd party software.

5.6   Report generation functionality

Report generation from the CMS shall be performed based on the data acquisition/logged historical values (including processed data values) from the Trend database system and from the O&M system.

The Report generator shall enable report generation by application of standardized templates and shall facilitate operators design of own ad hoc reports.

The report generator shall be able to produce reports and trend graphs automatically for a predetermined reporting period of time for example a generation of a day report every day at 02.00 h, generation of a monthly report and/or a trend graph of specified values measured on the previous month. This applies for quarterly and yearly reports as well.

Many reports will come as Daily / Weekly / Monthly and Yearly reports, with the same layout and information sources.

Furthermore, the CMS shall facilitate report generation in user defined periods by means of start time and stop time.

The report generator system shall in manual mode be able to produce the same reports and trend graphs as in automatic mode for a period of time that is specified by the operator. It shall, for example, be possible to produce a 24h-report and/or 24h–trend graph based on values from "today or any day".
A report/trend graph display shall at any time reflect the contents of the relevant part of the database of the report/database server.

It shall be possible to initiate the generation of a pre-defined report manually by a simple command. There shall be no restrictions in the number of times a certain report can be generated.

Each report shall comprise a number of process values including various calculated values. Manual configuration of simple temporary online type reports shall be possible at any time. The procedure and interface for report creation must be user friendly. An Operator must be able to create a report with a little training.

It shall be possible to print out reports to a printer.

Some of the reports may have attached process displays indicating report related calculated variables.

The Contractor will configure a number of different report types (determined by the Employer), each with the needed variables. Each of these report types shall be configured for four time intervals: day, week, month and year.

The following type of reports shall form part of CMS:

Operation Reports

A number of operation reports and predefined filtered event log reports shall be generated, e.g. in relation to:

- Material consumption
- Material balance
- Alarm log for the day
- Alarm suppressed items
- Blocked or frozen items
- Objects in manual mode, where auto mode would be expected
- Operator parameter and set point changes
- Event for operator actions

Availability Reports

Report for uptime of Line and Line parts.

Production manager's reports

A number of predefined production/consumption reports shall be generated, e.g. in relation to:

- Production information (Different kind day/week/month)
- Consumption of electricity, energy
- Efficiency (Different kind day/week/month)

Purchase reports

A number of predefined purchase reports shall be generated, e.g. in relation to:

- Material tank levels (for various tanks on a daily/weekly/monthly basis)
- Material used (for various materials on a daily/weekly/monthly basis)

Maintenance reports

A number of predefined maintenance reports shall be generated.

Financial reports

A number of predefined Financial reports shall be generated, e.g. in relation to:

- Production reports (on a daily/weekly/monthly basis)

Environmental Reports

The following shall apply to the Environmental reports:

- A number of environmental reports shall be established. The design, methodology and layout shall be in accordance with the requirements from local Authorities and the Employer.
- Raw values used in the various environmental calculations shall also be available and be presented on the operator stations if so required.

Energy and Mass Balance Reports

The following shall apply to the Energy and Mass Balance Reports and the energy and mass balance calculations:

- Evaluate the total efficiency of the Line operation.
- Evaluate the efficiency of any sub-system of the Line.
- Evaluate the total input/output balance (energy and mass).
- Evaluate the input/output balances (energy and mass) on any sub-system of the Line.
- Evaluate a number of key figures on consumption (power, materials, chemicals, etc.).
- Recognize any changes over time of the above, as indications of possible defects and wear and tear.

The operator facilities shall as a minimum include the same as for the operation reports.

6. PROCESS STATIONS (PLC'S OR CONTROLLERS)

The process stations shall be based on a reliable and thoroughly tested standard system. They shall be designed and installed for use in power stations and waste incineration Lines. The process stations shall be reliable, maintainable without interruption of operation, of a modular type with standard components, provided with good facilities for fault identification and shall be easy to repair.

The process stations shall be designed to include:

- Redundant CPUs
- Redundant connections to the communication networks
- Redundant power supplies
- Space and room for documentation sheets
- Spare capacity of minimum 20 % hardware (physical spare capacity)

The process stations cubicles and hardware shall be standardised and identical.

The process stations are fully integrated into the CMS. Each process station shall be an autonomous processor based system, which controls and monitors a part of the Line. It shall be provided with hardware and software for communication with the operator system and with the other process stations. If the communication is interrupted, then the process station shall continue to function. The entire CMS shall include a number of process stations functioning independently of each other so that the consequences of a fault in a process station will be limited to that process station.

The CMS shall be designed to ensure that in case of a fault in the CMS, the process Line is automatically brought to a safe state of operation. After a failure of the supply voltage, the process stations shall start automatically when the supply voltage returns, without issuing erroneous commands.

The process stations shall have a structure corresponding to the functional structure of the process Line so that control functions belonging to the same functional group are executed by the same CPU. All units belonging together shall be placed in the same rack.

The requirements above relating to the functional structure do not apply in the case of redundancy in the process stations resulting from redundancy in process equipment (e.g. redundant pumps etc.).

The individual functional groups shall be able to function as independent units so that a fault in a functional group will only affect the control functions that are related to that functional group.

It shall be possible to exchange a CPU/PLC during operation.

6.1 Safety Functions of Process Stations

Safety functions shall be implemented in the CMS using proven safety concepts and equipment acceptable to the authorities. The signals used for safety functions shall be available for the CMS. If safety functions are implemented by hard-wired circuits, then they shall also be implemented in the coding of the process station to make trouble shooting easier.

The safety equipment shall be implemented so that in case of a fault the equipment in question goes into a predefined safe state.

6.2 Equipment Functions of Process Stations

6.2.1 GENERAL

The automatic functions shall be carried out by processor-based process stations. A process station may consist of more processor based units intercommunicating over an internal bus. The process station must be connected to the process equipment to exchange information. The process stations shall be able to carry out the functions as:

- Communication with the process by bus interface.
- Communication with the process by analogue and binary input and output signals, where bus communication is not possible, including filtering of analogue input signals and suppression of contact bounce for binary input signals.
- Logic control, including automatic sequences, interlock, and other control functions based on logic criteria.
- Calculation of analogue and binary variables.
- Exchange of data with data servers and other equipment in the control room through the communication network.
- Self-monitoring of all units, by watch-dog or other methods.
- Analogue variables shall be represented as a minimum by 11 bit + sign, and the numbers representing the values shall be in SI-units.

6.2.2 ANALOGUE AND BINARY SIGNAL PROCESSING

The following facilities are required for analogue signal processing:

- The signal processing shall be divided functionally according to the function groups of the Line, and it shall be taken into account that redundancies in the Line are reflected in the signal processing.
- Analogue input and output values shall, if not transferred by bus, be represented by SI-units and the resolution shall as a minimum be 11 bit + sign.
- All analogue measurements in the process shall, unless transferred by bus, be 4 - 20 mA signals.
- The process station/remote I/O-unit shall provide supply voltage and fuse protection for each individual transmitter.
- Monitoring of signal quality (for example monitoring that analogue signals are within the 4 - 20 mA range).
- Simulation between 0 and 100 % of signal range.
- Linearization.
- Calculations (for example square root extraction or enthalpy calculations).
- Limit value monitoring.

- Monitoring of internal faults including blown fuses and simulation for each individual transmitter.

The following facilities are required for binary signal processing:

- The process station/ remote I/O-unit shall provide supply voltage for the signal source, including fuse protection.
- Monitoring of signal quality through "Cable cut philosophy" where "0" is the active signal or the faulty signal information.
- Monitoring of internal faults, including blown fuses in signal circuits, and simulation.

6.2.3   FUNCTIONS FOR BINARY AND ANALOGUE CONTROL

The following facilities are required for binary and analogue control:

- The basic functions for binary and analogue control shall be implemented as standard programme macros.
- If multi-channel input/output modules are used, then the signals shall be allocated with a view to the safety of the controlled processes in case of faults. Multi-channel input/output modules will only include signals for control elements within the same functional group, but they will not include signals for control elements providing redundancy for that functional group.
- Switching between local-remote, auto–manual and vice versa operation shall be bumpless.
- As a minimum it shall be possible to choose the following types of controller: P, PI, PD and PID.
- It shall be possible to introduce a gradient limitation in the controllers that do not affect the other time-related parameters of the controller.
- If the process output is 4 - 20 mA control signal, then the controller shall be provided with an analogue memory, a hard-hold, in order to hold the output signal in fault situations. Bus communication for flow measurement (ultrasonic).

6.2.4   SINGLE DRIVE CONTROL MODULES

Single drive control modules constitute the lowest level of control. All interlock functions shall be implemented at that level.

The standard type single drive control modules developed as part of the object library shall include, but not be limited to:

- Motor with constant speed
- Motor with two speeds / reversible motor
- Motor with VSD < 100 kW
- Motor with VSD > 100 kW
- Motor valve (control valve)
- Motor valve (on/off valve)
- Solenoid valve
- Heater
- MV panel (MV circuit breaker)

6.3   Programming/Coding

It shall be possible to code the process stations from a centrally placed engineering station.

6.4   Overall Signal Specifications

Signal specifications for the I/O-modules used by the system are as follows:

Analogue Input Signals, 4 – 20 mA,
- Individually configurable low pass filter
- Resolution 15 bit + sign
- Absolute accuracy < ± 0.5 %
- Sample frequency min. 10 Hz

Analogue Output Signals, 4 – 20 mA, bus communication will be preferred
- Supply voltage for each channel from process station
- Galvanic isolation
- Resolution 15 bit + sign
- Absolute accuracy < ± 0.5 %
- Min. load 500 Ohm

Resistance Temperature detectors (4 wire) is allowed to use for the cable distance lower than 10 meters between the instrument and the RTD INPUT module
- Supply voltage for each channel from process station
- Galvanic isolation
- Resolution 15 bit + sign
- Absolute accuracy < ± 0.5 %

The absolute accuracy of an analogue signal shall be understood as the overall deviation (root mean square) between the value in the CPU and the value at the electrical terminals.

Binary Input Signals
- Sensing the position of an external potential free signal contact
- Indication of logic state of inputs
- Supply voltage from process station: 24 V DC ± 10 %
- Load current min. 1 mA
- Suppression of contact bounce

Binary Output Signals
- Activation of an external potential free relay
- Supply voltage from process station: 24 V DC ± 10 %
- Load current up to 50 mA
- The external relay shall be provided with a recovery diode

Impulse Counter Inputs
- Binary input as described above
- Pulse frequency up to 5 Hz
- Pulse length: min. 100 ms

MCC signals

The motor control in the MCC shall be established with intelligent motor controllers.

All signals shall be available for the CMS system.

Refer to Appendix A6 *Technical Specifications for Electrical Systems* for further details.

6.5 Remote I/O-signal interface

All process interfaces, I/O-signal interfaces or bus interfaces must be installed in RIO panels in RIO cabinets

No process interfaces, I/O-signal interfaces or bus interfaces must be installed in switchboard cabinets as e.g. MCC cabinets, ACC cabinets.

6.5.1 RIO PANELS AND CABINETS

RIO panels shall be equipped with remote I/O-modules and I/O-units, All RIO panels must be of standard type throughout the Line and accommodate the required number of I/O-units for the given process area.

The connection of process components (which are not connected with a bus communication) shall be carried out through locally positioned remote IO panels in the process field area. This, in order to minimize the length of the branch cables to the local positioned process components. In case there is a local room near the process field area in question, the RIO panels may be positioned in this room in order to facilitate better ambient conditions for the panel and the IO modules.

RIO panels placed more than 50 m away from the process station cabinet shall be connected via a redundant fibre optic connection.

All RIO field cabinets shall be equipped as follows:

- Steel cabinet min. IP 65.
- One isolated 70 mm2 Cu EMC equipotential bounding connected to the base plate of the steel cabinet.
- 2 x 230 V AC UPS supply (redundant) and incoming over current protection.
- Service light with separate over current protection.
- Redundant switch mode 230 V AC / 24 V DC supply.
- Redundant Communication module.
- Remote I/O-modules as required.
- Supervision of important components in the power supply and I/O-units.
- The input/output signals shall be connected to the remote I/O-units through disconnection terminals with test jacks.
- A terminal strip with component KKS and labelled sections for in- and out-coming signals for each component.
- Each process component has one cable connected to the separate KKS section in the terminal strip.
- Each separate KKS section in the terminal strip has one plus terminal with a 0.5 A fuse with LED indication, one minus terminal and the necessary terminals for I/O-signals.

- The terminal strip has one common plus terminal and one common minus terminal for trouble shooting and testing.
- Copper bus bar for termination of shielded and spare wires in instrument cables.
- One process network socket RJ45 to be used for trouble shooting and testing.
- The terminal strip and has 20 % spare space.
- 20 % spare terminals delivered separately.
- 20 % spare socket for I/O-modules.

6.5.2   CONNECTION TO SUB CONTROL SYSTEMS ("BLACK BOXES") IN GENERAL

Black Boxes are defined as local control by a PLC as well as boxes with relays. In other words, some control of the Line is taking place in the "black box" that could have been integrated in the CMS system.

Wherever possible sub control systems "Black Boxes" shall be avoided.

If not possible to avoid "black boxes" it shall be ensured that the CMS is able to manage/ interact with sub control systems. (The blackbox shall be designed for remote operation). As all information and control must be handled from the control room, all alarms, events status signals etc. shall be available for the CMS system.

The black box shall be equipped with two communication cards and a redundant network connection to the CMS controllers. The technical solution of the redundant communication shall be part of the acceptance criteria for allowing the PLC.

Black boxes must be documented in the same way as the rest of the Line. That means the same type of documents as for programming the CMS must be produced.
Black Boxes shall not be allowed to install without the Employers acceptance.

To ensure this is incorporated only black boxes that are explicitly listed in the Contract will be allowed.

6.5.3   LOCAL OPERATION PANEL

In general local control panels in the form of black boxes shall be avoided, since a full integration in the main CMS is envisaged. However, the Line may be equipped with some local panels in order to facilitate local operation and local maintenance routines.

The following requirements shall be observed:

- The local operation panels shall be connected to the CMS. Local control is only allowed after the panel has been enabled from the control room.
- After this a switch named "Místní ovládání ON/OFF" can be operated ("Local Control ON/OFF" in English). A LED lamp indicating enabled and switch for "Místní ovládání " shall be included on the local operation panel.
- All necessary operation and indication facilities shall be available, for example emergency stop, push-buttons, lamp indications, lamp test and switches.
- LED lamps shall be used.
- Labels and signs with text in Czech to be included in accordance with.
- Drive motors for hoppers, snails etc. shall have a reverse switch for maintenance purposes."

7. CCTV SYSTEM

An independently autonomous operational CCTV system including a CCTV network shall be provided in the contract delivery. Independently of the CMS system, the CCTV system shall manage the video-based supervision of the process of the Line. The system shall enable the operators to control and monitor the online operation of the Line. Further, it shall enable the personnel to execute various tasks and simple trouble shooting procedures.

Reference is made to Appendix A13 *Process and Design Data* for details on the total number of cameras to be included in the Contract Object. The Contractor shall as a minimum include following cameras:

- 2 cameras with zoom, pan and tilt for new waste bunker (remote control from waste cranes)
- 2 cameras fixed for waste hopper
- 1 camera fixed for water gauge on steam boilers.
- 6 cameras fixed for IBA transport
- 2 cameras with zoom, pan and tilt for consumables loading
- 2 cameras fixed for flue gas cleaning
- 5 cameras for other purposes.

Cameras for monitoring tasks concerning building areas are included in the Contract Object and shall be calculated on unit price.

As a part of the Contract Object Contractor shall replace existing cameras on the Employer's existing CCTV system and connect all cameras to the new CCTV system and thereby covering the Existing facility as well. A complete installation, with all necessary equipment, as cables, switches, power supply from the new Line, etc. are a part of the Contract Object, except existing cable trays there can be reused.

The Employer's existing CCTV system is described in Appendix E4 *Specifications for Employer's existing CCTV System.*

The CCTV system may comprise the following functional units:

- A video management server (hereinafter called VMS unit) for recording, processing, data archiving and visual presentation of the supervisory tasks
- A number of CCTV cameras matching the respective tasks
- A number of colour monitors in compliance with the current legislation requirements and in respect to the Employers wishes to the supervisory task independent of the CMS
- Operation terminal interface for data source management enabling switch between CCTV cameras and the associated positioning (direction, zoom)
- Management of the VMS unit (copy, delete, or other editing of the video recording)
- Network between the video cameras, VMS unit and the monitors. The network shall be based on fibre optical multicore cables and the network infrastructure shall be prepared for extraction for future needs.
- The system shall support split up function.

The fibre optic network "backbone" shall be redundant. This means that the connection from the cameras to the switch can be a single connection.

For the cranes the Contractor shall supply the monitors situated locally as well. For the waste cranes four (4) monitors placed near the crane seat should be included.

The cranes images must be available in the control room on the operator stations like any other images from the other cameras.

For monitoring of process, the Contractor shall include eight (8) screens as part of the Contract Object. These are to be placed in the control room. All mounting, mechanical as well as electrical, is included in the Contract Object.

8. CMS FACTORY ACCEPTANCE TESTS (FAT)

Please refer to Appendix A11 *End of Assembly, Commissioning, and Testing*.

The actual FAT shall be carried out for all single functionalities, for group of functionalities and for all process parts and may involve participation of the Employer, if requested.

9. CMS SITE ACCEPTANCE TESTS (SAT)

Please refer to Appendix A11 *End of Assembly, Commissioning, and Testing*.

The SAT shall be carried out for all single functionalities, for group of functionalities and for all process parts and may involve participation of the Employer if requested.

SAT for total CMS including must be performed. The SAT shall document that the CMS system and CCTV are properly installed and that the intended functionality is working. For instance, that all applications are working, all nodes are communicating properly, printers are working etc. A main part of SAT will be a performance test. For the O&M system it should be checked and documented that interfaces are working, parallel with all function in the O&M.

The SAT must be documented by test sheets and a report.

10. DOCUMENTATION

CMS documentation shall follow the requirements described in Appendix A14.7 *Documentation*.

Please note that the KKS numbering shall be used thoroughly in the documentation.

Changes during programming and commissioning must be an integrated part of the documentation.

The programming manual shall be prepared and the Contractor is responsible that the entire plan is design uniform and in accordance programming manual.

The programming manual shall contain subjects as outlined below, but are not limited to:

- System architecture/CMS description
- CMS Hardware description
- CMS hardware design manual
- CMS engineering and programming manual
- CMS failsafe engineering and failsafe programming manual
- CMS HMI manual
- Network Configuration/HW network components/Network supervision and operator presentation
- HMI layout
- Naming convention
- Operation groups/access level/privileges
- LogOn/LogOff/safety
- Single screen/Large screen display layout
- Screen picture layout and hierarchy
- Screen picture and navigation
- Description of Standard Objects/Object faceplates
- Alarm philosophy
- HMI, description of basic functions and special functions
- Data Logging/data storage
- Trends/Reports
- Data export/import
- PLC interfaces
- Reporting parameter syntax

11. CMMS SYSTEM

The Contractor shall provide a Computerized Maintenance Management System (CMMS) as part of the Contract Object.

11.1 General overall requirement

The CMMS system shall be a commercially available state-of-the art system, with a documented and verified successful track record of system development and maintenance on similar large process Lines.

The general objectives and requirements are to ensure maximum optimal throughput and production with the fewest possible outages and to allocate, control and to optimize the operation and maintenance activities on the basis of a best value-for-money concept.

The CMMS system must be a tool for rational management of the Complete plant maintenance tasks to secure a high operational availability to the lowest possible maintenance costs.

The CMMS system shall contribute to securing and optimizing:

- Rational planned maintenance, with optimized maintenance to reduce the number of unscheduled stops

- Ongoing improvements of the Complete plant and individual units and equipment based on the experiences achieved from the operation after maintenance and repairs
- Development and improvement of repair methodologies based on the lessons learnt and experience from previous repairs
- Centralization of technical instructions and documentation
- Optimization of planning, including resource, personnel and material planning
- Optimization and adjustment of the frequency of inspections/checks and maintenance
- Budgeting, financial control and follow-up
- Optimization of store inventory for reduction of investment in stock and increased inventory turnover
- Analysis of data to allow the preparation of reports and presentations
- Reduction in repair time while maintaining quality and safety standards

The CMMS system shall consist of a numbers of standard database modules, e.g.:

- Maintenance and work order module
- Logbook and notification module
- Classification/code module
- Supplier module
- Component and plant module
- Project and planning module
- Resources module
- Permit to work module
- Stock control module
- Spare parts module
- Purchase module
- Counter and time registration module
- Document database module
- Reporting database module
- Calibration module

All relevant Line documentation is presupposed to be implemented in the CMMS system.

11.2 Specific functional requirements

The CMMS system shall be capable of managing preventive, corrective, condition based maintenance, work orders, permit to work, incident reports, shift log book, resource planning, time registration, material registration, project management, stock control, barcoding, calibration, Line structure, tools management, system registration and recommendation for stock/purchases, document management, financial control, budget and forecasting, ERP integration, etc.

For the purpose of facilitating maintenance, the CMS shall register operational data such as hour counter, differential pressure measurements, instrument diagnosis, component activation counter, cycle times, power supply monitoring, vibration monitoring, equipment efficiency data, number of starts/stops, warm/cold starts, etc., for all essential components and equipment and the operational data shall automatically be transmitted from the CMS to the CMMS system for calculation of condition planned maintenance. The accumulated usage of raw materials and consumables such as limestone, active carbon, ammonia etc. shall be transmitted to the CMMS system from the CMS to facilitate ordering of new materials in time.

The system shall be capable of handling all system and component numbering, in accordance with the structure of the tag numbering system for the Complete plant.

All data records shall be provided with a date stamp as well as the name of the person who entered the data or last modified it.

The system shall have a common system register, to allow the retrieval of information such as object designation, location, make, type etc.

It shall be possible to perform searches for all data in the system.

The report generator shall be provided with hierarchical access control so that generation of certain reports is restricted to certain users. It shall be possible to generate reports on the basis of predefined templates. It shall be possible to generate periodic reports on defect frequencies, divided into category, system, section, make etc. generating periodic reports on maintenance costs, divided into section, category, system, job type etc.

The system description shall have a hierarchic structure with a minimum of eight levels, reflecting the structure of the tag numbering of components, systems and Lines.

It must be possible to unambiguously identify components in the system, irrespective of the tag number designation, so that the complete track record of a specific component can be followed from installation to rejection.

The system shall include functions designed to handle preventive, corrective and condition-based maintenance. Preventive maintenance work orders can be schedule based on calendar time and operating time. Corrective maintenance can be based on unplanned or/and planned work orders. Condition based maintenance work orders can be based on manual or automatic data registration, transferred from CMS, as operation time or object counted detection or other equipment condition.

The system shall be capable of handling any shutdown requirements. Detailed planning of maintenance activities during planned operational stops is required.

Financial analysis including cost-benefit analyses of each maintenance activity or group of activities must be possible.

The system shall have a job code register in which standard job codes are recorded. It must be possible to assign an optional alphanumeric structure to the job code.

The system shall be capable of handling not less than twenty different job types including but not limited to Mechanical, Electrical, Operations, Incineration Line support team, Laboratory, etc.

A standard job code shall have assigned information as job interval, job description (detailed), standard time for execution, materials/spare parts/tools needed, etc.

The Permit To Work (PTW) must be an integrated function in the maintenance planning and execution of maintenance job or work order, to ensuring that works is done safely and efficiently. This include all necessary safety precautions, safety equipment, tools, checklists, etc., including isolation of mechanical and electrical equipment for secure the part of Complete plant.

The PTW includes the total process, based on the plant condition, from isolation to normalisation of all activities (lock out and tag out).

It shall be possible to generate the PTW automatically or manually on the basis of the information from the CMS, for planned and unplanned work.

All actions events for PTW shall be recorded and logged in the system.

The system shall include functions for document management. The system must be capable of handling documents such as photographs, drawings, service manuals and video clips.

It must be possible to assign documents to system parts, components, preventive maintenance jobs or work orders.

The system shall have a logbook function which shall serve as a platform for sharing information and knowledge on the plant between shift operators and maintenance staff. Shift information from one shift to the next shall be a part of the logbook function. Records of, for example, faulty items, rectification, replacement and similar events shall be recorded into the logbook. Other information can be entered in the logbook, from personnel at different levels to comment, to solve a problem or an explanation of what has been done.

In the logbook function all entries shall have an identification text, for example shift staff information, item function name, or a TAG number. In this way it will be possible to filter on previous entries concerning identical or related problems.

The logbook information notes shall be collected in a common database, so that all entered information can be saved and tracked.

In the logbook it shall be possible to upload photos into the logbook, from a minimum of 10 dedicated devices. The design and engineering of the CMMS system shall take place in parallel to the other project activities. The CMMS system shall be ready for use, programmed with measurements, reports and functions and data, at the start of the commissioning of the Line. The CMMS data shall be updated to include all "As Built" information following the successful completion of the Trial operation period, but before Preliminary Take Over.

11.3   IT System requirements

The Computerized maintenance management system (CMMS), shall be placed on the office network side, with connection between the CMMS and the CMS, that enables signal exchange between the CMS and the CMMS and between the CMMS and CMS.

The CMMS system shall be supplied as a Client/Server solution, with interface to more than 30 PCs on the office network, where up to 15 users can be logged on to the CMMS system simultaneously. The office network and computer systems on office network are based on Microsoft infrastructure, and the CMMS will be integrated in the Microsoft infrastructure.

The CMMS server and all CMMS system software included software for Client, and all need license is included in the scope.

11.4   Data in the CMMS system

A part of the scope of Contract Object is to provide all necessary data for the CMMS system for fulfilling the objective of the CMMS system.

The CMMS data are related to all information concerning physical units of the Complete plant, such as aggregates, components, pipes, mechanical equipment, electrical equipment, CMS equipment, building equipment, etc., where all are numbered with a KKS number. This also entails design data for individual aggregates, component, pipes, etc.

Furthermore, CMMS data includes information required to determine maintenance on an overall and detail functional level. This includes design and capacity data on an overall functional level, detail functional level and secondary functional level.

Data must be delivered for all parts, and all parts must have a unique KKS number.

All aggregates, components, and units included in PIDs must have KKS numbers.

All data must be delivered for all KKS numbers.

A part of the Contract Object is to deliver a data manual, whose purpose is to state the requirements for delivery of CMMS data to the CMMS system and uniform data import to the CMMS. The data manual shall be made in a form that data can be electronically imported to the CMMS system. The purpose is also to be a tool for the Contractor, to specify the requirement for CMMS data, from the suppliers.

The Data Manual shall describe the requirements for:
- maintenance plans (week, month, half-year, 2, 5 years) down to aggregate level.
- data for all maintenance works, with detailed information such as work description and instruction (how to do), materials, tools, safety instructions and equipment, documents, drawings, skills, time interval, etc.
- data for all aggregates, components and units, etc.
- that all aggregates, components and units, etc. must have "Classes".
- that all "Classes" must have design data, including process design data and component design data, for normal, minimum, and maximum design/operational data.
- that all data must be delivered for all aggregates and units with KKS numbers.
- that all classes must have Master data as KKS number, bar code, description, location, overall KKS, supplier, manufacturer, serial number, dimensions, weight, etc.
- that all Classes must have class specific data as, shaft seal, axle diameter, actuator type, protection class, etc.
- Detailed supplier information and detailed manufacturer information for all data
- Detailed spare parts information for all data, included spare part numbers, spare part number from manufacturer, documentation, dimension, weight, delivery time, etc.

12.   CMS SERVICE CONTRACT

The Contractor shall include a service contract for the CMS system delivered as a part of the Contract.

The service contract shall cover the first two years after Preliminary Take Over. The service contract shall include, but not be limited to:

- The response time after reporting a problem shall be max 2 hours (by phone or dial in).
- The response time after reporting a problem to be present on site shall be max 4 hours.
- The service contract shall include a telephone service available 24 hours per day all year round.
- A remote support via VPN connection or similar shall be included
- The service contract shall include information about:
    - The components etc. that have to be purchased in connection with the service contract. Information on the price of these components.
    - Information on repair procedures and prices
    - Delivery time for spare parts
- The service contract shall as a minimum include two visits on site per year for maintenance, preventative maintenance and general support.

The visits shall as a minimum include:

- Data back up and check of back up procedure
- Data base check, size and any problems
- Check of events files for system
- Visual HW check and cleaning
- Check of spare parts
- Needed software upgrades
- Check of alarms (most common and does this call for any action)

The visit shall be completed with a check sheet/report.

The Contractor shall assess the needed service intervals for each item listed above, which is part of the maintenance cycle.