Grupa LOTOS S.A.	**TECHNICAL SPECIFICATION**	Spec. N° 3220
	Fired heaters and boilers control and safety interlock system	

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1 Subject of specification

This specification used in conjunction with other technical specifications of LOTOS Group S.A., establishes minimal requirements regarding designing and execution of Control and Protections System for Furnaces and Boilers Supervision.

2 Scope of validity

This specification shall be used when preparing both quotations and Purchase Orders concerning planned LOTOS Group S.A. new investments and modernizations.

It shall also constitute a base for preparation of other detailed specifications and quotations relevant for package units or other equipment deliveries.

This specification relates only to furnaces and boilers fired with fuel oil and fuel gases, such as natural gas, refinery gas, LPG.

2.1 Deviations

Any deviation from this specification and the relevant specifications, standards and related documents including proposals, which the bidder claims to be economically and / or technically superior solutions, must be submitted in writing for review and approval by Grupa LOTOS SA. Non-approved exceptions are not acceptable by Grupa Lotos S.A.

The supplier must report in writing any ambiguity in this or any other specifications of Grupa LOTOS SA or non-compliance with the referred documents / standards and obtain a written explanation from Grupa Lotos SA.

3 Hierarchy of documents

In case of conflicts existing between this specification and other documents, the following order of precedence shall govern:

- The current Polish legislation
- Terms of purchase order / contract and other requirements agreed in writing with GLSA
- Data Sheets approved by GLSA
- This specification
- Other Specifications
- Drawings and other documents
- Standards

4 Definitions and designations

GLSA – Grupa Lotos S. A.

DCS - Distributed Control System

SIS-PLC - Programmable Logic Controller

SIS -Safety Instrumented System

SIL - Safety Integrity Level

I/O - Input / Output

DC - Direct current

AC - Alternate current

UPS - Uninterruptible Power Supply

BMS - *Burner Management System* – control system dedicated to starting-up, shutting-down and protecting of furnaces and boilers, consisting of:

- measuring instruments
- shut-off valves (block)
- protection system logic
- flame monitoring system
- system of igniters
- local control panels
- SIS-PLC controller, accomplishing safety functions
- operator interface in central control room, through DCS system or directly

CONTROL AND REGULATION SYSTEM

- for heaters / boilers with forced draught

Control system realized in central control room (DCS), including all adequate regulation circuits, in order to maintain proper ratio of air/fuel or air/heat (in range or above designed value of surplus air) for all used fuels and heater/boiler load conditions. The system also realizes pressure regulation in heater convection section in order to ensure adequate draught for flue gases, regulation of heated batch (process medium) streams, as well as regulation of air fan capacity for heaters/boilers. In case of boilers, the system accomplishes regulation of water level in boiler, pressure, temperature and all required functions related to them.

Furthermore, the system includes indication of all parameters and measurements related to BMS system, realized by means of data link, and also all interlocking signals coming from BMS through cable links (for example, in order to switch-off adequate control loops).

- for heaters/boilers with natural draught

Control system realized in central control room (DCS), including all adequate regulation circuits, in order to maintain proper fuel flow (pressure) for all used fuels and heater load conditions. The system also realizes draught regulation on the grounds of negative pressure value in radiation chamber of heater, as well as flow regulation of heated batch (process medium) streams. In case of boilers, the system accomplishes regulation of water level in boiler, pressure, temperature and all required functions related to them.

For both types of heaters/boilers, the system also includes indication of all parameters and measurements related to BMS system, realized by means of data link, and also all interlocking signals coming from BMS through cable links (for example, in order to switch-off adequate control loops).

AUTOMATIC – type of control, where all stages of heater/boiler start-up (leak-proof tests, purging, ignition of pilot and main burners) are executed, after being initiated with „START" pushbutton, in automatic sequence without operator intervention. Heater/boiler shutdown is foreseen in normal or

emergency mode, after initiation of the operation with „NORMAL STOP" or „EMERGENCY STOP" pushbuttons. START/STOP pushbuttons are located on LOCAL CONTROL PANEL (LCP). "START" and "EMERGENCY STOP" pushbuttons shall also be installed on control panel in central control room. BMS system ensures safe passing through individual stages of heater/boiler operation, while taking all stop interlocking into consideration.

SEMIAUTOMATIC, also called as OPERATOR SUPERVISED – type of control, where all stages of start-up (leak-proof tests, purging, ignition of pilot and main burners), as well as heater/boiler shut-down are executed sequentially, after being initiated by pushbuttons located on LOCAL CONTROL PANEL (LCP) and on BURNER CONTROL PANELS, conditioned by BMS systems with proper completion of previous stage, with consideration given to interlocking in force. In this type of control, adequately skilled operator is responsible for proper heater start-up and shutdown.

LOCAL CONTROL PANEL (LCP) – a panel serving for heater starting-up, furnished with adequate pushbuttons and pilot lamps, used in automatic and semi-automatic control.

BURNER PANEL – a panel serving for lighting-up of dedicated burner, furnished with adequate pushbuttons and pilot lamps, used only in semi-automatic control mode.

5 Description

5.1 General requirements

Supplier of heater or boiler is responsible for design compliance with process requirements and adequate standards.

Scope of heater/boiler supplier duties includes delivery of object equipment, and, depending on contractual adjustments, delivery of PLC/BMS as well as calibration and start-up.

Supplier of heater/boiler shall deliver complete documentation necessary for its erection and start-up, which always include all requirements related to PLC and DCS software.

Supplier of heater/boiler shall deliver separate set of documents, conforming to requirements included in specification GLSA 8500, necessary for submitting to Approving Body in order to obtain its approval.

5.2 Burner Management System – BMS

BMS system shall be designed for realization of heater/boiler start-up and shutdown in SEMI-AUTOMATIC mode of control.

-AUTOMATIC control is allowed only on the grounds of GLSA consent and approval.

BMS system shall be realized as fully independent of DCS control system, both as regards equipment and software.

Measuring and actuating devices shall be independent and connected directly to BMS system.

Actuating devices shall be of fail-safe design, i.e. in case of failure they shall set safe position.

Solenoid valves and other relay-type elements, during normal operation shall be in energized state (live).

BMS/PLC shall be an independent controller, connected with DCS systems by digital communication for informative purposes, and in cases where mutual transferring of signals is required for purposes of adequate regulation execution, the connections shall be hardwired.

BMS shall be designed according to requirements of PN-EN 746-1,2,3 and other standards referred to, PN-EN 61508 (IEC 65508) and adequate standards related to equipment installation in explosion hazardous zones. In case of boiler being designed according to PN-EN 12952 or PN-EN 12953 standards, BMS shall fulfil requirements of these standards, and standards referred to in them.

BMS system subjects to approval of independent body appointed for this purpose, for meeting requirements regarding the system operation and handling safety. Requirements concerning scope of documentation necessary for BMS approval are given in specification GLSA 8500.

5.3 Electrical requirements

Power supply of control and other system elements shall be delivered from Uninterruptible Power Supply – UPS, conforming to specification GLSA 3130.

5.4 Safety Interlocks System

For BMS system functions realization, only double or triple redundant, certified programmable logic controller with tolerance of single fault (fault-tolerant, fail-safe), can be used.

5.4.1 Segregation of hardware and software

Implementation of heater BMS logic can be realized in PLC/ESD that is common for other BMS or ESD only on the grounds of GLSA consent. Adopting of such solution shall be preceded by analysis of effects for whole plant in case of PLC/ESD failure and keeping of below listed conditions:

- separation of I/O modules for specific BMS
- separation of software implementation for specific BMS.

5.4.2 Sequence of logical safety interlocks system

Logical safety interlocks system shall realize automatic, or optional semi-automatic (supervised by operator) method of lighting up, as well as shall provide interlock heater shutdown, complete or partial, in case of exceeding foreseen process parameters.

Safety interlocks system must realize requirements of PN-EN 746-1,2,3 or PN-EN 12952/53 standard (in case of boiler designed according to this standard) regarding safe lighting-up, with consideration given to leak-proof tests of valve units and heater / boiler purging prior to lighting, as well as interlock requirements. Schemes of BMS logics shall be accomplished in negative logic, i.e. all interlocking signals shall be activated with logical state „0”, being understood as lack of signal (voltage).

Structure of BMS system logical schemes:

- processing of input signals, taking into consideration overriding switches of MOS and POS type
- interlocks with signalling of readiness to cancel
- start-up sequence
- actuation of outputs on valves
- additional services (logic of first shut-down, checking of valve states discrepancy as compared to command given, etc.)

Minimum interlocking requirements for heater/boiler, which shall be taken into account in system of safety interlocks:

- too low air flow to burners (for heaters with forced draught and boilers)
- too low / too high fuel pressure (fuel gas or oil)
- too low feed flow (process medium) through heaters, or water through monotube boiler
- too high pressure in flue gases chamber
- too high pressure in flue duct
- too high temperature in combustion chamber
- flame decay on pilot and main burners
- too low differential pressure between fuel oil and atomisation vapours pressure
- too low temperature of fuel oil
- too high temperature on heater outlet
- too low / too high water level in boiler drum
- too high pressure in boiler.

In order to determine all parameters that influence heater/boiler safety, one shall also take into account its interconnection with whole plant process.

5.4.3 Light-up sequence

Described lighting-up method of heater/boiler applies to control in AUTOMATIC mode, as basic method used in GLSA completions. Deviations from this mode present in SEMI-AUTOMATIC control will be clearly marked in description.

Both control modes force operator's presence during heater/boiler start-up sequence, because in both cases the sequence, or its individual stages (only in SEMI-AUTOMATIC mode), must be initiated by pushing adequate buttons mounted on local panel LCP (AUTOMATIC and SEMI-AUTOMATIC mode) and on burner panels (only in SEMI-AUTOMATIC control mode).

In both modes, BMS system monitors correctness (process parameters check) and safety (checking of signals causing interlock (emergency) shut-down) of start-up procedure execution, simultaneously providing local operators (on local panels) and operators in control room (on DCS system operators' stations) with necessary information about completion of individual stages of start-up sequence, by switching on dedicated pilot lamps located on above mentioned panels and visualisation screens. Layout of buttons and pilot lamps on panels shall correspond to logical stages of sequence.

In case of necessity, software switches overriding interlocks signals (POS – Process Override Switch) shall be defined in DCS system, for start-up sequence execution purposes. The switches shall be automatically cancelled by BMS system after adequate stage of start-up sequence completion. Override switches used for maintenance purposes (MOS) cannot be used during heater/boiler starting-up.

General start-up sequence shall consist of the following steps:

- check of initial conditions:

- correct setting of individual valves (flue stack damper open, automatic valves on fuel lines in safe position, i.e. shut-off valves closed, venting valves open, automatic valves on burners (or manual ones in SEMI-AUTOMATIC mode) closed.
- interlocking signals in inactive state

- resetting of protection system logic (by means of button on local panel or on operator's station screen in control room)
- switching on of forcing fan and suction fan (does not apply to furnaces with natural draught)
- leak-proof test of fuel line to pilot burners
- leak-proof test of fuel line to main burners

Both leak-proof tests can be executed simultaneously. Control valves on fuel lines shall be fully open during leak-proof test (action executed in DCS system).

- heater purging, adjustment of airflow intensity in order to achieve heater volume exchange according to PN-EN-746 (for heaters with natural draught, start of blowing fan). For boilers, according to PN-EN12952, PN-EN12953 standards.
- lighting of pilot burners:

- setting of adequate air flow in order to provide heater safety in case of lighting failure and gas inflow to chamber (does not apply to furnaces with natural draught)
- opening of fuel feed line (closing of automatic venting valve, and after closure is confirmed, opening of cut-off valves)
- opening of automatic (or manual, in case of SEMI-AUTOMATIC control) burner valve
- start of igniter (applying of energizing pulse)
- detection and monitoring of flame presence.

All timing relationships relating to flame detection, as well as number of burner lighting-up attempts taken into consideration in BMS system logic, shall meet requirements of PN-EN-746 or PN-EN 12952, PN-EN 12953 (in case of boilers designed according to this standard).

- lighting of main burners

- activation of feed flow, or water in case of monotube boilers; flow level must be higher than interlock set value for very low flow; start of boiler supply pump, water level in drum higher than interlock set value for low level.
- fuel gas and/or fuel oil pressure controllers are automatically set on value exceeding minimum pressure value for burners

  Remark: lighting of main burners with fuel oil can be done without gas firing, but with gas firing lighting will be safer with respect to oil spillage that can occur when oil is fired for the first times. In this case fuel oil pressure controllers are automatically set on value exceeding minimum operating pressure value for burners, atomising steam pressure controller is also automatically set.
- air flow controller is set in automatic mode, air flow higher than minimum necessary for heater lighting up (does not apply to heaters with natural flow)
- opening of fuel feed line (closing of automatic venting valve, and after closure is confirmed, opening of shut-off valves)
- opening of automatic (or manual, in case of SEMI-AUTOMATIC control) burner valve
- detection and monitoring of flame presence.

All timing relationships relating to flame detection, as well as number of burners' lighting-up attempts taken into consideration in BMS system logic, shall meet requirements of PN-EN-746 or PN-EN 12952, PN-EN 12953.

The tables below present minimum requirements regarding assembly of elements (pushbuttons, pilot lamps) on local panels, necessary for heater/boiler start-up sequence execution in AUTOMATIC control mode (Table N° 1), and SEMI-AUTOMATIC control mode (Table N° 2).

Table N° 1. Start-up sequence in AUTOMATIC control mode

STEP OF SEQUENCE	AUTOMATIC – assigned pushbutton	AUTOMATIC – assigned pilot lamps
Initial conditions		INITIAL CONDITIONS FULFILLED
Preparation to start	INTERLOCKS RESET	READY TO START
Fans switching on	FURNACE START	
Leak-proof test of fuel lines to pilot and main burners		LEAK TEST IN PROGRESS
Purging		PURGING IN PROGRESS PILOTS READY FOR IGNITION
Lighting-up of pilot burners		PILOTS IGNITION IN PROGRESS PILOT N^{o} X ON PILOT IGNITION FAULT
Lighting-up of main burners		BURNERS IGNITION IN PROGRESS MAIN BURNER N^{o} Y ON MAIN BURNER IGNITION FAULT

Table N° 2. Start-up sequence in SEMI-AUTOMATIC control mode

STEP OF SEQUENCE	SEMI-AUTOMATIC – assigned pushbutton	SEMI-AUTOMATIC – assigned pilot lamps
Initial conditions		READY TO INTERLOCKS' RESET
Preparation to start	INTERLOCKS RESET	READY TO LEAK-PROOF TEST
Leak-proof test of fuel lines to pilot and main burners	START OF LEAK TEST	LEAK TEST IN PROGRESS LEAK TEST COMPLETED
Purging		PURGING IN PROGRESS PILOTS READY FOR IGNITION
Lighting of pilot burners	OPENING OF PILOT VALVES	PILOT VALVES OPEN PILOT N^{o} X ON PILOT IGNITION FAULT
Lighting of main burners	OPENING OF MAIN BURNERS' VALVES	LIGHTING OF BURNERS IN PROGRESS MAIN BURNER N^{o} Y ON MAIN BURNER IGNITION FAULT

EMERGENCY HEATER/BOILER SHUT-DOWN and NORMAL HEATER/BOILER SHUT-DOWN pushbuttons shall be mounted on the panels.

Normal heater shutdown shall effect in main burner switching off. After pressing of pushbutton, the system closes slowly control valve on fuel/fuels line.

Hypothetic logical diagrams of analogue input, shutdown interlock and first-out logic handling, are given in specification GLSA 3640.

5.5 Equipment

5.5.1 Field equipment

5.5.1.1 Input signals

BMS input signals can come from hardwired pushbuttons or limit switches, pressure signalling devices, and analogue transmitters. All input signals' instruments shall fulfil requirements of adequate standards and regulations as to design for explosion hazardous zones in which they will be installed.

5.5.1.2 Output signals

SV valves control

Solenoid valves shall be in flameproof design, supplied with 24 V DC voltage.

Solenoid vales shall be made in high temperature resistant design, coil insulation of H class, viton sealing, and continuous operation capability.

5.5.1.3 Signals' overriding

Control override switches (MOS) shall be configured in DCS in order to enable maintenance activities. This function is accessible for authorized personnel only. Status of individual MOS switches will be passed to ESD-PLC by means of communication link.

It is foreseen to use single hardware switch (MASTER MOS – hardware switch with key), which setting will enable selection of MOS in DCS.

Maintenance Override Switches – MOS are foreseen for inputs of BMS system, which would cause trip-out during normal plant operation, when the input functionality check is in progress.

Signals used as initial conditions during start-up and 2 out of 3 voting, or such that are of critical significance during start-up, for example, instruments involved in leak-proof testing and purging, cannot be overridden by MOS switches.

Signals coming from emergency shutdown pushbuttons, which are initiating complete shut-off, can never be overridden by MOS switches.

MOS does not block alarm function for specific signal.

5.5.2 Igniters

The igniters shall operate with intermittent releasing of ignition energy and be powerful enough to light-up burner immediately. Igniters with continuous release of ignition energy shall not be used.

The igniters shall be stationary mounted, according to heater/boiler supplier guidelines, in a way enabling their easy use. In multi-burner systems (reformers, for example), use of portable igniters is allowed only for SEMI-AUTOMATIC control mode. Devices limiting fed fuel volume during ignition stage shall then be used.
Each pilot burner shall be furnished with individual, high-voltage igniter.

5.5.2.1 Ignition system

Igniters shall be supplied by electric branch with mains voltage. Permission for applying voltage on igniter electrode comes from BMS on adequate completion stage of lighting-up logic.

Location of igniters' operation control in local junction boxes is preferred solution.

5.5.2.2 System of gas feeding to pilot burners – according to PN-EN 746 standards

Gas pipeline to pilot burners (sub-header) shall be connected to main burners' gas pipeline (header), upstream first shut-off valve on this pipeline.

Each heater/boiler shall be furnished with own, independent system of pilot burners' gas supply system. Pilot burners shall be fed with gas of stable parameters (natural gas, for example) if possible.

Each pilot burner shall be individually connected to sub-header through automatic (or manual, in case of SEMI-AUTOMATIC control mode) shut-off valve equipped with device signalling the valve position – closed/open, of proximity switch type (closed contact at fully closed or open valve position), connected to interlock system.

A sub-header shall be provided with filter located upstream first shut-off valve.

A header shall be equipped -with self-acting pressure controller, in order to ensure required pressure of gas.

The header shall be equipped with two shut-off valves, fabricated and certified according to PN-EN 161 standard, and one vent valve, remotely controlled by BMS.

The valves will be controlled by three-way solenoid valves, certified to use in safety systems and equipped with device signalling the valve position – closed/open, of proximity switch type (closed contact at fully closed or open valve position), connected to interlock system.

Shut-off valves and vent valve shall be of ball type with pneumatic actuator, tightness class VI according to ASI/FCI 70.2. Design of valve shall enable its full actuation by turning valve spindle by 90º. Internal parts of valves shall be made of AISI316 steel. Shut-off valves shall be opened with air pressure and closed with spring, while vent valve shall be closed with air pressure and open with spring.

Shut-off valves and vent valve shall close within 1 second of time.

Instrumentation of pipeline supplying gas to pilot burners is shown in Attachment N° 2.

5.5.2.3 System of gas feeding to main burners – according to PN-EN 746 standards

Each main burner shall be individually connected to header through automatic (or manual, in case of SEMI-AUTOMATIC control mode) shut-off valve equipped with device signalling the valve position – closed/open, of proximity switch type (closed contact at fully closed or open valve position), connected to interlock system.

The header shall be equipped with two shut-off valves, fabricated and certified according to PN-EN 161 standard, and one vent valve, remotely controlled by BMS.
The header shall be provided with filter located upstream first shut-off valve.

The valves will be controlled by three-way solenoid valves, certified to use in safety systems and equipped with devices signalling valve position – closed/open, of proximity switch type (closed contact at fully closed or open valve position), connected to interlock system.

Shut-off valves and vent valve shall be of ball type with pneumatic actuator, tightness class VI according to ASI/FCI 70.2. Design of valve shall enable its full actuation by turning valve spindle by 90º.

Internal parts of valves shall be made of AISI316 steel. Shut-off valves shall be opened with air pressure and closed with spring, while vent valve shall be closed with air pressure and opened with spring.

Shut-off valves and vent valve shall close within 1 second of time.

Instrumentation of pipeline supplying gas to main burners, is shown in Attachment N° 3.

5.5.2.4 System of oil feeding to burners

Pipeline supplying oil to burners must be equipped with two shut-off valves, fabricated and certified according to PN-EN 230 standard. Tightness class and remaining requirements for these valves are the same, as for gas valves.

Atomisation vapour shall also be delivered to burner. Minimum signal threshold of oil and vapour differential pressure is embedded in interlock system logic.

Instrumentation of pipelines supplying oil and vapour to burners is shown in Attachment N° 4.

5.5.3 Flame detection system

Flame detection system shall be adequately selected to type of media fired by pilot burners and main burners.

Flame detection system shall meet requirements of specification GLSA 3230.

5.6 Operator's tools

5.6.1 General

Operator's interaction with BMS system during lighting-up of heater/boiler proceeds by means of local panel LCP and operator's interface in control room.

In semi-automatic lighting system – with operator's participation – where he/she separately lights-up each burner, additional burner panel furnished with adequate pushbuttons and pilot lamps is required at each burner.

5.6.2 Local control panel LCP (AUTOMATIC and SEMI-AUTOMATIC control)
On local LCP panel pilot lamps, pushbuttons and indicators shall be mounted that are necessary to carry out complete procedure of heater/boiler lighting up and shutting down, with assisting actions executed in control room. In case of plants that can burn various fuels, the lamps of firing fuel type shall be mounted on LCP panel, like gas – gas + oil – oil, heavy oil / light oil etc. Selection of fuel type operator can make from control panel or DCS workstation graphic in control room.

All pushbuttons, switches, lamps or LEDs have to be hardwired to BMS system.

Arrangement of instruments on the panel and their specification subjects to GLSA approval.

All designations on local panel must be prepared on Polish language.

Emergency shut down button shall be located in exposed place of local panel LCP, as well as on heater platform. The button must be equipped with cover precluding its accidental use.

5.6.3 Burner local panel (only in SEMI-AUTOMATIC control mode)

For purposes of heater/boiler lighting up, each burner shall have separate panel with pushbuttons and pilot lamps necessary for sparkler activation and safe burner lighting up. The lamp detected flame by BMS shall be provided. Depending of ignition logic, the optic or sound signalling of allowable overflowing light-up time for burner shall be generated in order to inform operator of immediately cutting gas to burner necessity.

All pushbuttons, switches, lamps or LEDs have to be hardwired to BMS system.

All designations on local panel must be prepared on Polish language.

5.6.4 Operator's tools in control room

Operator's actions in control room are executed by means of operator's station connected through software with BMS/PLC and DCS systems, as well from control panel with installed "START" and "EMERGENCY STOP" pushbuttons and fuel type selector switch. Hardwired emergency shut down pushbutton shall be provided in control room within operator's reach. The button must be equipped with cover precluding its accidental use. All designations on local panel must be prepared on Polish language.

Operator has to his disposal on-screen active graphics with indication of all BMS devices and signalling of set parameters exceeding, as well as improper instruments' functioning.

Each heater BMS has to be connected to memory system and sequence of events recorder (SOER), featuring time resolution of 100 milliseconds at least.

For fast identification of the emergency states BMS system shall realize maximally wide diagnostic of the controlling devices and process parameters.
As minimum it shall include:

- monitoring of exceeding of process parameter thresholds (interlocking alarms and used in control sequences)
- diagnostic of measurement lines
- monitoring of consistence between actual shut-off valves position and system command with separate alarms for open and closed positions
- correctness of control sequence steps, for example leakage of the concrete valve in leak test, purging failure alarm, etc.
- for interlocking signals each BMS must have logic of interlock occurrence first reason (first-out logic) implemented. This logic will be reset via separate software switch from DCS operator workstation, optionally it can be done via interlock reset pushbutton.

All alarms shall be sent to DCS via communication link for indication.
Additionally on the dedicated DCS graphics shall be shown status of BMS logic and start-up sequence steps.

5.7 Capacity adjustment for forced draught furnace

Heater capacity adjustment system shall be based on calculation of heater heat demand in relation to calorific value of combusted fuels. The system shall be fast, reliable in operation and safe.

5.7.1 Combustion air

In order to force air circulation, it is necessary to use fans of adequate capacity. Airflow measurement shall be accomplished with measuring method adequate to capacity. One shall consider use of fans enabling capacity adjustment with application of rotation speed controller (inverter).

In order to prevent surges in case of high capacity fans, it is necessary to use system of airflow regulation on fan inlet, with adequate blow-off valve on its outlet. Such fans shall also be protected with vibration sensor of seismic type, included in BMS system.

Pre-heating of burner's air in heat exchanger with use of flue heat up to optimum temperature is recommended. Air temperature shall be controlled.

5.7.2 Combustion control system

The task of combustion control system is to maintain air/fuel ratio (or rather air/heat) on level required for specific fuel in range of heater load. The system have to ensure adjustment of air/heat ratio in such a way, that air is the leading parameter at combustion heat demand increasing, while fuel is the leading parameter at combustion heat demand decreasing.

The control system must accomplish minimum and maximum fuel flow limitations that exceed range allowable for the burner.

All necessary remote measurements shall be doubled with local measurements.

On supply decay the valves on fuel and air lines shall set the following positions:

- Fuel line valve – closed
- Air line valve – last (recent) position.

In order to ensure optimum utilization of combusted fuel heat, signals from calorific value analysers, both for gas and oil, shall be used in combustion control system.

Simplified diagram of combustion control system is shown in Attachment N° 5.
Presented system of heater capacity adjustment is based on calculation of heater heat demand in relation to calorific value (signal from analyser) and density (optional) of combusted fuels.

Controller of heater load imposed by process determines total heat demand. This is usually controller (TC-1) of heated medium temperature, measured on heater outlet.

Outlet of this controller is connected in cascade with fuel pressure controllers and airflow controller, through two signal limiters. The selector's task is to carry out function of leading parameter selection in dependence on heat demand variation direction (known as lead/lag function).

The first TY-1A limiter (MAX selector) compares heat volume required by process with current heat capacity JI-1, computed from heat balance of combusted fuels, and passes the greater value as heat volume parameter to air/heat ratio controller FFC-1. Signal from this controller computes required airflow to heater. Set point value of the controller shall be corrected by signal coming from analyser of oxygen concentration in flue gas, AT1. The TY-1A selector forces, that at increased heat demand air volume will immediately increase without waiting for fuel flow increase, while at declined demand air flow will not change till fuel flow decrease.

The second TY-1B limiter (MIN selector) compares heat demand required by process with current heat volume resulting from air flow with consideration given to air/heat ratio controller set point value, and passes the lower value as set value for JC-1 heat controller. Current furnace capacity JI-1 subjects to regulation. The TY-1B selector forces that fuel quantity will not be increased until air flow increase. Output signal of JC-1 controller determines required firing capacity.

Fuel flow to burner shall be adjusted by means of pressure regulation system, where set point value of controller shall be computed basing on burner output curve (fuel pressure as function of burner output), depending on required firing capacity.

5.7.3 Combustion quality

In order to ensure effective and not hazardous to atmosphere combustion process, it is necessary to use analysers of O_2 and CO concentration in flue gases. Both analysers shall be stuck into combustion control system with possibility of correction. Possibility of manual input of O_2 and CO values in case of the analysers' failure shall be provided.

5.7.4 Flow of heated medium through heater

Adjustment of heated medium flow through heater shall ensure uniform flow through all coil pipes.

5.8 Capacity adjustment for natural draught heater

5.8.1 Combustion (capacity) control system

The task of combustion control system is to maintain proper flow intensity (pressure) of fuel, for all used fuels and conditions of heater load.

The control system must accomplish minimum and maximum fuel flow limitations that exceed range allowable for the burner.

All necessary remote measurements shall be doubled with local measurements.

On supply decay the valves on fuel supply lines shall set the closed position.

In order to ensure optimum utilization of combusted fuel heat, signals from calorific value analysers, both for gas and oil, shall be used in combustion control system.

Simplified diagram of combustion control system is shown in Attachment No 6.
Presented system of heater capacity adjustment is based on calculation of heater heat demand in relation to calorific value (signal from analyser) and density (optional) of combusted fuels.

Controller of heater load imposed by process determines total heat demand. This is usually controller (TC-1) of heated medium temperature, measured on heater outlet.

Fuel flow to burner shall be adjusted by means of pressure regulation system, where set point value of controller shall be computed basing on burner output curve (fuel pressure as function of burner output), depending on required firing capacity.

For low capacity heaters it is allowed to use simple cascade, where signal from TC-1 load controller constitutes set point value for PC-1 fuel pressure controller.

5.8.2 Flow of heated medium through heater

Adjustment of heated medium flow through heater shall ensure uniform flow through all coil pipes.

5.8.3 Combustion quality

In order to ensure effective and not hazardous to atmosphere combustion process, it is necessary to use analysers of O_2 and CO concentration in flue gases. Both analysers shall be stuck into combustion control system, enabling correction. Possibility of manual input of O_2 and CO values in case of the analysers' failure shall be provided.

5.9 Control of boiler operation

5.9.1 General

Equipment and control system of boiler operation must conform to:

- PN-EN 12952 for water – tube boilers
- PN-EN 12953 for drum boilers

These requirements apply to all steam generating boilers operated in systems of natural and forced circulation, as well as water boilers.

Combustion control system shall be based on calculation of boiler heat demand, according to principle described in p. 4.7. The system shall be fast, reliable in operation and safe.

5.9.2 Steam boilers

5.9.2.1 Water level monitoring

At least two glass level indicators shall be provided, which indications will be visible in control room through local camera sending picture to control room. One of the level indicators can be replaced with two level transmitters, which indications will be referred to control room.

Water level in boiler shall be adjusted in automatic way, with application of low water level safety limiter and function of firing system shutting down in case, when water level in boiler drops below allowed value. After high water level in boiler is exceeded, water feed shall be shut-off.

Level regulation (feeding water inflow) shall be of continuous type. Regulation accomplished with use of both control valves and by means of pump rotational speed control is allowed.

Use of two-position regulation type (ON/OFF) is impermissible.

5.9.2.2 Pressure and temperature monitoring

Boiler shall be equipped with local and remote measurement of pressure and temperature.

Pressure is the leading control parameter for heat delivery to boiler. Two independent safety circuits are shutting down firing system if set value of pressure is exceeded. Independent measurement of temperature serves as indicator.

It is necessary to provide temperature measurement on outlet of superheater first stage, as well as on inlet / outlet of each subsequent stage.

5.9.2.3 Boiler water quality monitoring

It is necessary to provide continuous monitoring of boiler water salinity, by means of its conductivity measurement, as well as systems for automatic desalination and desludging.

In each place, where hazard of undesirable substances penetration exists (for example, oil contaminations), condensate return monitoring systems shall be used.

5.9.2.4 Regulation of burners' capacity

Regulation of heat input delivered to boiler is led on the grounds of steam pressure in drum and auxiliary signals, such as stem flow on boiler outlet, feeding water flow, etc.

5.9.3 Water boiler

Temperature is the leading control parameter for heat delivery to boiler; independent safety circuits are shutting down firing system if set point value of temperature is exceeded.

Two independent safety circuits of pressure measurement are shutting down firing system, if allowable value of pressure is exceeded.

6 Relevant documents

Any "Technical Specification" issued by GRUPA LOTOS S.A. listed in Contract Files.

7 Standards and regulations

Designing, fabrication and erection shall conform to the latest editions of standards and regulations listed below.

This specification quotes standards and regulations directly related to control and protection systems for furnaces and boilers. For remaining standards and regulations, refer to specification GLSA 3010.

- PN-EN 161 Automatic shut-off valves for gas burners and gas appliances
- PN-EN 1643 Valve proving systems for automatic shut-off valves for gas burners and gas appliances.
- PN-EN 298 Automatic gas burner control systems for gas burners and gas burning appliances with or without fans.
- PN-EN ISO 23553-1 Safety and control devices for oil burners and oil-burning appliances -- Particular requirements -- Part 1: Shut-off devices for oil burners
- PN-EN 746-1 Industrial thermoprocessing equipment. Part 1: Common safety requirements for industrial thermoprocessing equipment
- PN-EN 746-2 Industrial thermoprocessing equipment. Part 2: Safety requirements for combustion and fuel handling systems.
- PN-EN 746-3 Industrial thermoprocessing equipment. Part 3: Safety requirements for the generation and use of atmosphere gases
- PN-EN 12952 Water-tube boilers and auxiliary installations
- PN-EN 12953 Shell boilers.
- PN-EN 61508-1 Functional safety of electrical/electronic/ programmable electronic safety-related systemsGeneral requirements.
- PN-EN 61508-2 Functional safety of electrical/electronic/ programmable electronic safety-related systemsRequirements for electrical/electronic/ programmable electronic safety-related systems
- PN-EN 61508-3 Functional safety of electrical/electronic/ programmable electronic safety-related systemsSoftware requirements
- PN-EN 61508-4 Functional safety of electrical/electronic/ programmable electronic safety related systemsDefinitions and abbreviations
- PN-EN 61508-5 Functional safety of electrical/electronic/ programmable electronic safety related systemsExamples of methods for the determination of safety integrity levels
- PN-EN 61508-6 Functional safety of electrical/electronic/ programmable electronic safety related systemsGuidelines on the application of IEC 61508-2 and IEC 61508-3
- PN-EN 61508-7 Functional safety of electrical/electronic/ programmable electronic safety related systemsOverview of techniques and measures

- PN-EN ISO 12100 Safety of machinery -- General principles for design -- Risk assessment and risk reduction.
- PN-EN 1050 Safety of machinery. Principles for risk assessment
- PN-EN 50156 Electrical equipment for furnaces and ancillary equipment.
- Dz.U. No 163 pos.1584 Minister of Environment Regulation of 4.08.2003 on emission standards from industrial plants (Official Journal of 18.09.2003r.)
- Dz.U. No 283 pos.2842 Minister of Environment Regulation of 23.12.2004 on requirements concerning measurements of emission worth (Official Journal of 30.12.2004r.).

Directives of European Union:

- 2009/142/EC - Appliances burning gaseous fuels
- 2006/42/EC - Machinery
- 97/23/EC - Pressure equipment
- 2006/95/EC - Electrical equipment designed for use within certain voltage limits
- 2004/108/EC - Electromagnetic compatibility (EMC)
- 2004/22/EEC - Measuring instruments

7.1 Enclosures

Enclosure N° 1 – Requirements regarding documentation

Attachment N° 2 – Pilot burners' supply line

Attachment N° 3 – Main burners' gas supply line

Attachment N° 4 – Main burner' oil supply line

Attachment N° 5 – Simplified combustion control diagram in heater with forced combustion air flow

Attachment N° 6 – Simplified combustion control diagram in with natural combustion air flow and high capacity

8 Record of changes

No.	Date	Description	Introduced by
1	4.05.2011	1.Correction of item 2.1. 2.Logic control of heaters are changed from AUTOMATIC to SEMI-AUTOMATIC and vice-versa – item 4.2. 3.Fuel oil in light-up sequence are considered – item 4.4.3.	M. Baryła
2	30-11-2013 (rev. 2)	Review, update, standardize and changes to the Standard within scope of order No. OK/990/2012	Editorial board coordinated by T.Wróbel
-	31-08-2015	Page layout corrections, no contents changes.	T. Wróbel

Grupa LOTOS S.A.	**ATTACHMENT N° 1**	Spec. nr
	Requirements regarding documentation	3220

	WITH BID	WITH DELIVERY	NOTES
MANUFACTURER'S DATA SHEET	Yes		
LIST OF DEVIATIONS TO INQUIRY SPECIFICATIONS	Yes		
LIST OF SPARES RECOMMENDED FOR 2 YEARS OPERATION WITH ITEMIZED PRICES	Yes		
LIST OF SPARES RECOMMENDED FOR COMMISSIONING AND PROVISIONAL ACCEPTANCE TEST	Yes		
TEST CERTIFICATES		Yes	If specified
MATERAIL CERTIFICATES ACCORDING TO EN-10204 3.1		Yes	If specified
CERTIFICATES ISSUED BY OFFCIAL ORGANIZATIONS FOR EQUIP. TO BE UTILIZED IN HAZARDOUS AREAS	Yes	Yes	If applicable
CERTIFICATES ISSUED BY OFFICIAL ORGANIZATIONS FOR EQUIPMENT TO BE UTILIZED FOR CUSTODY TRANSFER		Yes	If applicable
OUTLINE AND DIMENSIONAL DWGS, ELECTRICAL ARRANGEMENT	Yes		
ELECTRICAL DIAGRAMS		Yes	
INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTION MANUALS		Yes	
DOCUMENTS IN ELECTRONIC VERSION ON CD		Yes	
INSPECTION BOOK		Yes	If specified
FABRICATION QUALITY CONTROL PLAN		Yes	If specified
MANUFACTURERS STATEMENT OF COMPLIANCE WITH EU DIRECTIVES (CE MARK0		Yes	
MANUFACTURING CERTIFICATES		Yes	If specified
CALIBRATION CERTIFICATE		Yes	If specified
HYDROSTATIC TEST REPORT		Yes	If applicable