INSTALLATION AND OPERATION MANUAL

SMOK-4 boiler control cubicle

Client: Moderator

Project No: PR/ZA/5-2009/1

Manufacturer:

estyma
electronics

Project name: SMOK-4 boiler process control	
Client: Moderator	Prepared by: Piotr Kajpust
Printed: 04.09.2009	Approved by: Arkadiusz Baranowski
Last modified: 27.08.2009	Title page

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1   TECHNICAL DESCRIPTION

1.1   Subject and scope of the manual

The manual describes the power supply circuit control system, including monitoring devices, for the SMOK-3 boiler installation to be operated by Moderator in Hajnówka.

1.2   Key references

The manual is based on the following:

- consultations with the Client
- applicable regulations and standards
- process design guidelines

1.3   Technical specifications

The control cubicle allows to operate the SMOK-3 boiler, equipped with the following:

- exhaust fan   M7 - single phase
- air blower   M6 - single phase
- room heating circuit pump   M4 - single phase
- feeder I   M1 - three phase
- feeder II   M2 - three phase
- hot tap water circuit pump   M3 - single phase
- ash removal   M5 - single phase

Ambient temperature? $[0 \div 60]\,°C$

Humidity? $[5 \div 95]\,\%$

Temperature measurement accuracy? $\pm 4°C$

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1.4   Control cubicle surge protection

According to the Polish Standard PN93/E-5009/443, the cubicle requires Category IV protection against lightning surge and switching surge. A class C overvoltage protection device should be used in order to protect the cubicle.

2   CONTROL CUBICLE POWER SUPPLY

The control cubicle is an IP66 rated device made of sheet steel, conforming to EN 5029. In the cubicle, there is a terminal strip for external devices required to control the combustion process in the boiler. Three phase voltage is supplied to the cubicle via the switch Q0. The presence of voltage is indicated by the light H0 on the front panel. The cubicle is equipped with a safety cut-out switch (S), which should be pressed in case of any emergency, indicated by the red alarm light HA. Once the cause of the emergency is eliminated, the cut-out switch S may be reset in order to restore power supply to the cubicle.

The cubicle must have a main fuse with a fuse link type gB BiWts 25 A.

2.1   Wiring regulations

Regulations concerning lightning protection of buildings and structures and lightning and switching surge protection are contained in PN-38/E-05003 and PN-93/E-05009/443. Adequate design of external and internal lightning protection is required in order to ensure the safety of people and flawless operation of equipment, and to prevent damage to buildings.

Power supply cables for the control cubicle should be in conformity with PN-93/E-05009/443, in order to ensure 1st degree surge protection (i.e. to limit surges to less than 4 kV). The entire cable route should be accessible and should not be exposed to external factors that could damage the cable. 5x2.5 mm^2 cable should be used to supply power to the control cubicle.

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The manufacturer reserves the right to modify the product for better quality and performance.

3   PROCESS CONTROL DESCRIPTION

3.1   Turning on the power supply

The control system becomes energized when the main switch Q0 on the front panel is turned on. The light H0 indicates the presence of voltage in the control system.

3.2   User interface – system control

The control panel PO, located on the front panel of the cubicle, allows the operator to monitor key measured parameters and control parameter settings which define the functioning of the process control system. The user interface consists of the following elements:

- MAIN SCREEN
- BOILER
- HOT WATER
- BURNER
- MEASURMENTS
- LANGUAGE
- MANUAL OPERATION (OFF) – only when the control unit is in the OFF mode
- MAINTENANCE MODE (OFF) – only when the control unit is in the OFF mode
- OUTPUTS TEST (OFF) – only when the control unit is in the OFF mode

The menu navigation rules are as follows:

- **OFF** button
    - < end parameter edition without saving
    - < move one level up in the menu
    - < switch to the OFF mode of the control unit (press the button down for about 3 sec.)
- **UPWARD ARROW** button
    - < increase the value of the edited parameter
    - < browse parameters – up the list

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➢ **DOWNWARD ARROW** button

    < ' ecrease the value of the edited parameter

    < browse parameters – down the list

➢ **ENTER** button

    < start editing parameter value and save the set parameter value

    < move one level down in the menu

    < switch to the ON mode of the control unit (press the button down for about 3 sec.)

3.2.1   Main screen

BOILER TEMP.	65°C
HOT WATER	60°C
FEEDERTEMP	29°C
ON WP HP fee	fa 30

The main screen shows the current values of selected measurement data, i.e. boiler, hot water and feeder temperatures.

The main screen's footnote shows information on the current status of individual devices:

- **ON/OFF**:   tryb pracy systemu (OFF – gotowości, ON – pracy)

- **WP**?   praca pompy obiegowej ciepłej wody użytkowej

- **HP**?   praca pompy obiegowej centralnego ogrzewania

- **fee**?   praca podajnika

- **fa 30:**   praca dmuchawy z określona mocą np.: 30

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3.2.2   Main screen → BOILER

			MIN	MAX
			60	85
boiler progr.		70°C		
hysteresis		0	0	10

The set boiler temperature is the most important input parameter for the burner power control algorithm. When the temperature of the heating medium in the boiler falls 5ºC below the set value, the burner power level setting changes from 2 (high) to 1 (low). When the temperature of the heating medium exceeds the set value by 5ºC, the burner is turned off. The extinguishing of the burner is a two-stage process, in order to minimize carbon monoxide emission. In the first stage, the fuel feeder is turned off and next, the blower is turned off gradually. The *hysteresis* parameter is of relevance for the ignition of the burner, as the burner reignites when the following is true:

$$BOILER\ TEMPERATURE < boiler\ progr. - hysteresis.$$

3.2.3   Main screen → HOT WATER

		MIN	MAX
progr.h.w.	45°C	0	70
priority	tak	no	yes
hysteresis	2°C	2	10
boiler h.w.	70°C	50	80

The *HOT WATER* menu includes *set temperature* (set hot water temperature), which should be set by the user. The default value is 45 ºC.

The *priority* parameter may be used to select the control unit mode so as to give hot water heating priority (recommended) or not. When hot water is given priority, only the hot water pump operates when there is need to raise the temperature of the hot water. Thanks to this, the hot water reheats much quicker.

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If the hot water pump runs for more than 10 min (default setting) and the hot water fails to reach the set temperature, the room heating pump restarts to run for 2 min. (default setting), in order to prevent room temperature from dropping too much. The following parameters are available in maintenance mode: "room heating standstill/hot water priority" and "room heating run time/hot water priority".

3.2.4   Main screen → BURNER

burner power	+	MIN	MAX
burner power	+	+	2
fuel	typ 1	+	3
start1)201 [1,2]	2	+	100
stop1)201 [1,2]	6	+	100
fan 01	20	10	100
start1)202 [1,2]	3	+	100
stop1)202 [1,2]	5	+	100
fan 02	25	10	100
fan at light	90	10	100
s-by still1min] [2]	5	+	90
s-by fee[sek] [2]	20	5	240
s-by fan[sek] [2]	120	30	240
fan at s-by [2]	30	10	100

$\mathcal{O}^{1,2)}$ items visible when fuel feed modes 1 and 2 are selected, respectively

The *BURNER* menu contains parameters crucial for optimizing burner performance and shows the current burner power level.

Fuel feed modes:

- mode 1 – fuel fed by feeder, no upkeep phase,

- mode 2 – fuel fed by feeder, upkeep phase present,

- wood – fuel fed manually, without feeder, to the hopper, no upkeep phase.

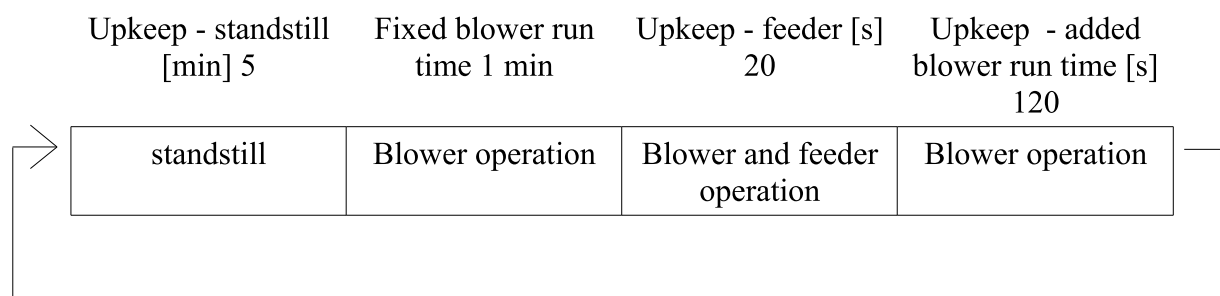|		
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In order to ensure that the burner works properly, the amounts of fuel and air fed to the system must be adjusted for each of the two burner power levels. These amounts are adjusted using the following parameters:

- **feeding [s] 01** and **feeding [s] 02** –fuel feeder operating time, in seconds, for power levels 01 and 02, respectively

- **standstill [s] 01** and **standstill [s] 02** – fuel feeder standstill time, in seconds, for power levels 01 and 02, respectively

- **blower 01** and **blower 02** – blower power level for burner power levels 01 and 02, respectively

NOTE: the parameter only affects blower operation when the blower is directly connected to the output of the semiconductor control unit.

Below is a diagram of the burner's operation in the upkeep phase:

Upkeep - standstill [min] 5	Fixed blower run time 1 min	Upkeep - feeder [s] 20	Upkeep - added blower run time [s] 120
standstill	Blower operation	Blower and feeder operation	Blower operation

The upkeep algorithm only refers to fuel feed mode 2.

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3.2.5   Main screen → MEASUREMENTS

boiler temp.	65°C
hot water temp	45°C
feeder temp.	25°C

The *MEASUREMENTS* menu contains three key temperature values available to the operator.

3.2.6   Main screen → LANGUAGE

selected	English

The control unit menu is available in the following languages:

- Polish (default setting)
- English
- German
- French
- Lithuanian
- Russian

3.2.7   Main screen → MANUAL OPERATION (OFF)

feeder	no	no / yes	
blower	no	no / yes	

The *MANUAL OPERATION* menu allows to manually control the feeder(s) and blower via the control unit. Note that this option is available only when the control unit is in OFF mode.

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3.2.8 Main screen → MAINTENANCE MODE

			MIN	MAX
min.pumps temp.	35°C		5	90
Talarm feed.	80°C		0	150
Talarm boiler	90°C		75	108
Tmin boiler	60°C		60	75
stop HP/hwp	20		3	120
work HP/hwp	5		+	120
pumps rundown	10		0	60

The *MAINTENANCE MODE* menu is only available when the control unit is in OFF mode. The parameters included in this menu refer to alarm functions, to run times included in the control algorithm, and to enabling and disabling certain control unit options.

The *MAINTENANCE MODE* is protected using a variable password:

Tzkr + 77

Tzkr – set boiler temperature

- **minimum pump temperature** – minimum heating medium temperature at which the control unit may turn on the boiler pumps

- **feeder alarm temperature** – feeder temperature above which the feeder alarm is activated

- **boiler alarm temperature** – heating medium temperature above which the boiler alarm is activated

- **minimum boiler temperature** – minimum boiler temperature that may be set by the operator

- **room heating standstill/hot water priority** – room heating pump standstill time [minutes] when the hot water pump is running and hot water priority is on;

- **room heating run time/hot water priority** – room heating pump run time [minutes] when the hot water pump is running and hot water priority is on

- **pump shutdown time** – time [minutes] for which the pump remains on after the heating of hot water ceases, when there is no need for the room heating pomp to run.

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4   ALARMS AND SAFEGUARDS

If any of the safeguards is tripped or if the safety button (S) is pressed, power supply to the electric circuits will be cut off. The system goes to alarm mode, indicated by the light H1. If the failure is caused by the tripping of any of the safeguards, maintenance personnel needs to intervene by pressing the safety button, opening the cubicle, identifying and fixing the problem. The system may be restarted once the safety button (S) is reset, after which the light H1 should no longer indicate an alarm.

An emergency thermal circuit breaker (STB) protects the boiler against overheating. Its tripping results in unconditional shutdown of the control unit and in cutting off of the power supply; when this happens, the light H1 indicates the alarm mode.

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4.1   Control unit alarms

In automatic mode, the following alarms functions of the control unit are enabled:

System alarms:

- FEEDER OVERHEATING – triggered by the signal from the feeder temperature sensor; this alarm starts up the feeder in order to push out burning fuel
- BOILER OVERHEATING – triggered by the signal from the boiler temperature sensor; this alarm starts up the pumps
- MOTOR PROTECTION – this alarm indicates that a motor safeguard has tripped
- HOPPER OVERLOADING – triggered by the tripping of the limit switch (BK)
- FEEDER NO. 2 BLOCKED – triggered when the capacitive sensor (B) shows the presence of fuel after 90 seconds of operation of feeder no. 1.

The alarms are indicated by flashing display illumination of the control panel.

4.2   Cancelling alarms

Push the ENTER button of the control unit to cancel the system alarm. The screen will display the type of alarm that has been activated. Press the ENTER button again to cancel the alarm. The system will restart provided that the cause of the alarm has been removed.

Before proceeding to remove the cause of the alarm, press the safety button (S). Only then you may open the cubicle to find out which motor safeguard has been tripped and whether the emergency temperature sensor (STB) is active.

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5   LIST OF FRONT PANEL FEATURES

Lp.	Opis	Symbol
	Main switch	A#
+	"Emergency stop" switch	S
3	Control panel	PO
-	"POWER" Indicator light	E#
3	"ALARM" Indicator light	E2
4	Control panel	PO

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6 LIST OF AUTOMATIC CONTROL SYSTEM COMPONENTS

No.	Symbol	Automatic control system component	Type
	A	Control unit module	Pellets Control M RS
+	KPOD1	2.2 kW power contactor	LC1K0610P7
3	KPOD2	2.2 kW power contactor	LC1K0610P7
-	A2	Manually controlled, triple pole motor switch	PKZM0-4
3	A"	Manually controlled, triple pole motor switch	PKZM0-4
4	F	10A circuit breaker	CLS6 B10
6	KDW	230VAC 8A relay	2 CO 8A 230VAC FINDER
9	KBT	230VAC 8A relay	2 CO 8A 230VAC FINDER
:	E#	Yellow indicator light	CL523Y 230VAC
;	E2	Red indicator light	CL523R 230VAC
	Tk	Boiler temperature sensor	NTC 10K
+	Tpod	Feeder temperature sensor	NTC 10K
13		Fuel capacitive sensor	PCPD-15ZN
-	A#	Main switch	ŁK16R 0-1
3	S	Safety button	XB7ES545P

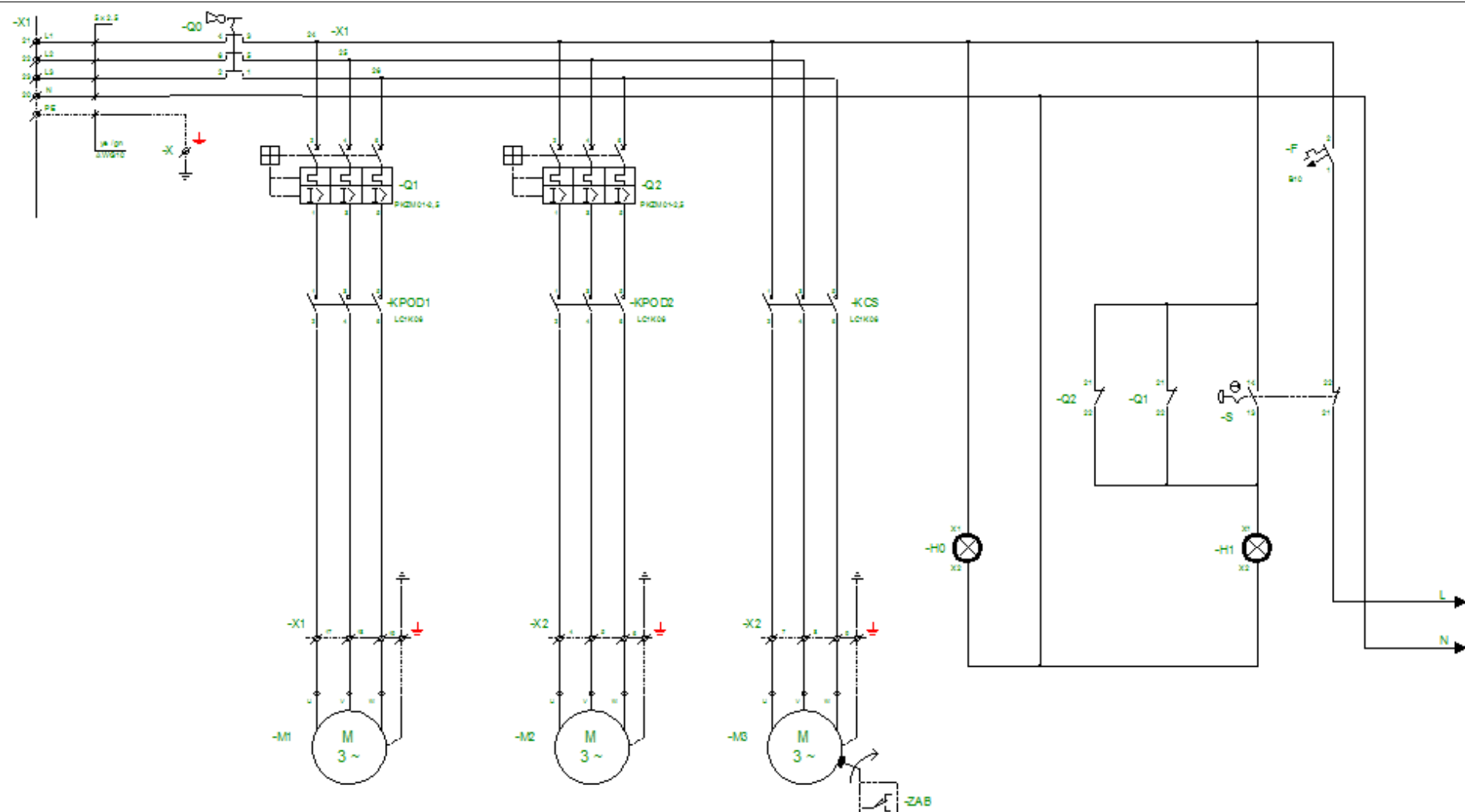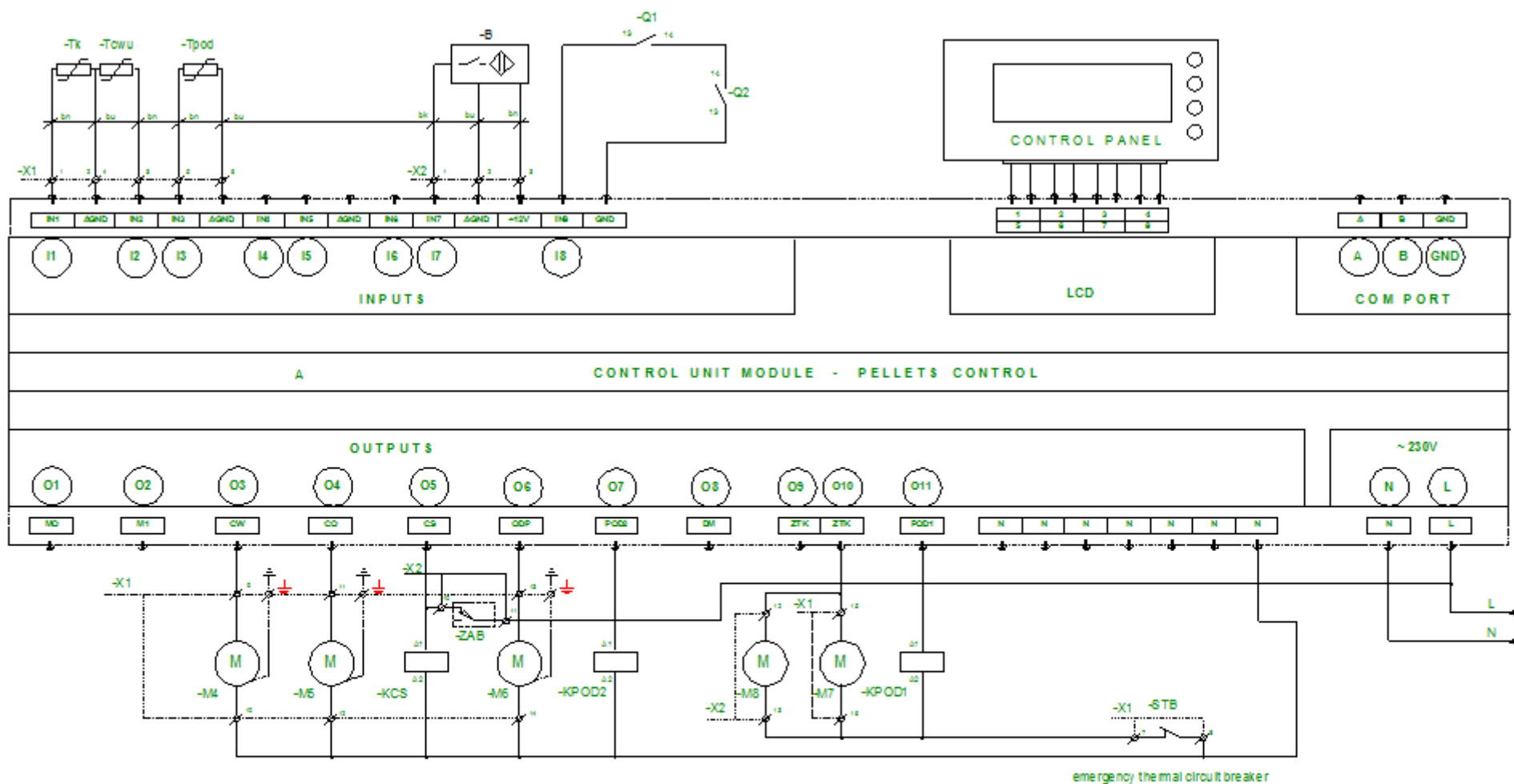|	
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7 LIST OF ELECTRICAL DIAGRAMS

| L.p.	Tytuł	Strona schematu
	Feeder and safety power circuits	1 z 3
+	Boiler process control unit	2 z 3
3	Layout of automatic control system components and front panel features	3 z 3

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-Tk -Tcwu -Tpod

-B

-Q1
-Q2

CONTROL PANEL

-X1

-X2

IN1 AGND IN2 IN3 AGND IN4 IN5 AGND IN6 IN7 AGND +12V IN8 GND

I1 I2 I3 I4 I5 I6 I7 I8

INPUTS

1 2 3 4
5 6 7 8

LCD

A B GND

COM PORT

A   CONTROL UNIT MODULE - PELLETS CONTROL

OUTPUTS

~ 230V

O1 O2 O3 O4 O5 O6 O7 O8 O9 O10 O11

M0 M1 CW CO CS ODP PQD2 DM ZTK ZTK PQD1 N N N N N N N

N L

-X1

-X2

-ZAB

M M M M M
-M4 -M5 -KCS -M6 -KPOD2

-X1

M M
-M8 -M7 -KPOD1

L

N

-X2

-X1 -STB

emergency thermal circuit breaker

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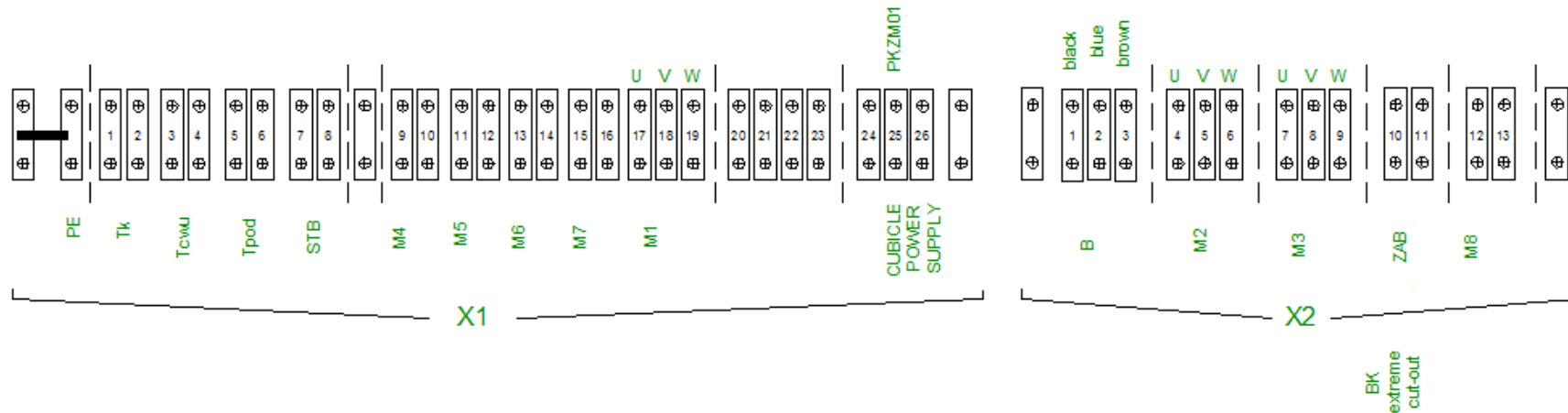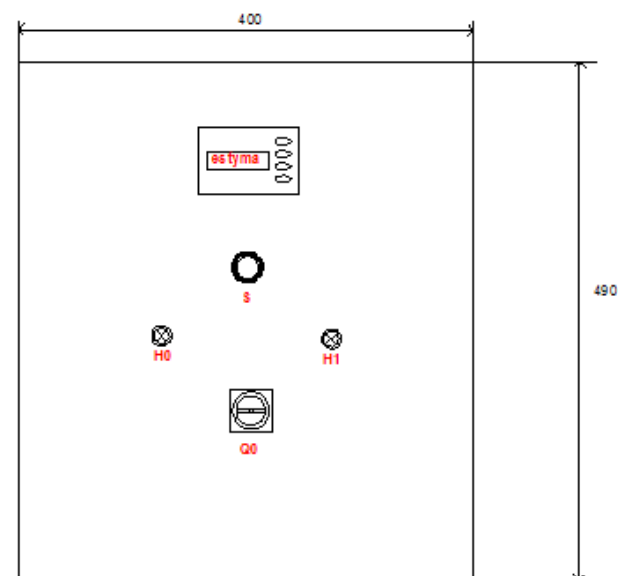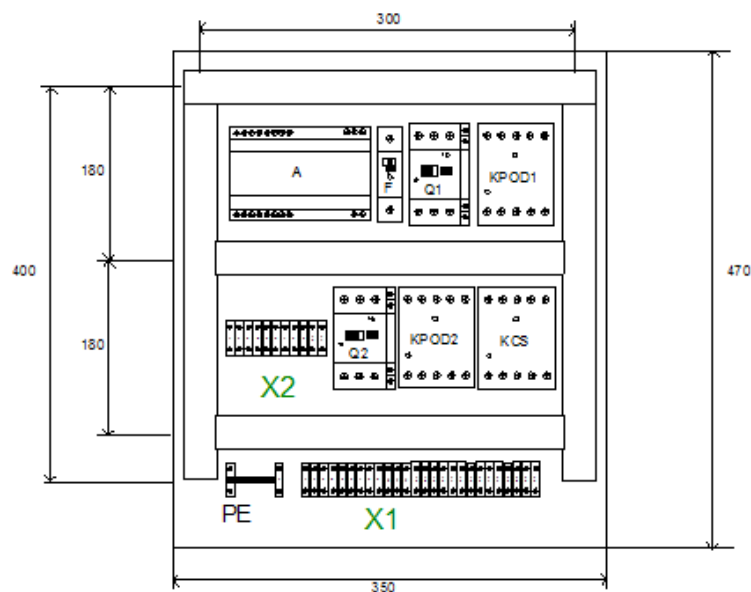
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