Requirements for a burner system provided by the customer or a burner system provided by the customer with boiler control provided by the customer for the operation of oil-, gas- and dual-fired steam, heating and hot water boilers

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1 Firing design of the boiler system

For the use of the steam or hot water boiler in accordance with regulations, the technical data in the order confirmation of the boiler system in question must be complied with.

1.1 Fuels

The fuels used (according to the fuel standards specified in the order confirmation) and the combustion air must not contain any additives other than those specified in the fuel standard which cause corrosion, abrasion or scaling in the boiler or boiler components (superheater, flue gas heat exchanger, etc.), otherwise the boiler manufacturer will not accept any liability for the delivery, and there will be a reduction in boiler availability and service life, as well as an increase in the frequency of cleaning.

1.2 Burner output/back-pressure

Combustion performance and flue gas side resistance of the boiler system appear in the data on the offer or the order confirmation or the technical specifications under Index M in the operating instructions.

The burner fan must not apply a flue gas side pressure of more than 50 mbar.

In the case of high-speed steam generators, the combustion capacity must be controlled in conjunction with the water volume. The combustion capacity and the water volume must correspond exactly in all load stages.

2 Burner system provided by the customer and boiler control by manufacturer

The following requirements apply in the event that the boiler control is supplied by manufacturer and the burner system is provided by the customer.

2.1 Burner add-on and brick lining

The fitting of the burner system must not impair the functioning, intended design and operation of the boiler.

The following in particular is to be noted:

- Access to the inspection openings, such as for example the reversing chamber door, must be assured, and it must also be possible to swing out the burner and the front door/burner plate.
- In the case of boilers with pivoting doors, the maximum permitted door load must be observed in accordance with the data sheets on "Firebox dimensions and Burner fitting limits".
- When fitting a burner and firing valves to boilers with pivoting doors/burner plates, it must be ensured that it is possible to open and swing the boiler door as easily as possible (oil hoses and cables etc. to be laid with sufficient length, expansion fitting and possibly intermediate piece necessary in the gas line).
- The firing must not transmit any abnormal and excessive vibrations to the boiler at any load point (maximum vibration rate measured at the reversing chamber door or flue gas chamber/flue gas box: 60 mm/s). The characteristic / dominant frequencies for firing operation are frequencies around approx. 100 Hz and between 400 and 700 Hz). If the vibration rate is higher, it can cause damage to the boiler attachment parts (reversing chamber door, flue gas chamber, flue gas heat exchanger) and to the flue gas line.
- The brick lining of the burner (if provided by the builder) must be designed in such a way, that uncooled areas, particularly the floor-flame tube connection, are protected (minimum overlap of 50 mm).
- All thermally unprotected areas are to be provided with thermal protection. The gap between the brick lining and the burner flame head in particular must be filled with movable insulation material in accordance with the instructions of the burner manufacturer (not to be brick lined!).

- When fitting the burner, the infeed and outfeed lines with their valves must be taken into account
- The data sheets on "Firebox dimensions and Burner fitting limits" for the particular boiler type must generally be observed.

2.2 Operating behaviour of burners

2.2.1 Burn-out

It must be guaranteed that burn-out occurs within the combustion chamber (including reversing chamber) that is specified in the technical data sheet on burning. In U-fired boilers the flame must not veer prematurely into the reversing chamber at any load level, but must burn out completely in the flame tube. In quick steam generators burn-out must be complete before the first reversal at the end of the heating coil.

To ensure complete burn-out, flue gases at the end of the boiler system must be carbon monoxide-free (maximum CO content: 50 mg/ Nm3 for a 3% O2-content).

2.2.2 Requirements for the burner turn-down ratio

Irrespective of the fuel, the following **maximum permitted low loads** must be observed for standard mode, i.e. burner start from a "warm" condition (beginning of automatic mode and release for output control):

Max. **50 %** of the burner output in the case of burner outputs (corresponds to an actual burner control ratio of at least 1:2)	up to 1,000 kW
Max. **33 %** of the burner output in the case of burner outputs (corresponds to an actual burner control ratio of at least 1:3)	$< 1{,}000 \leq 8{,}000$ kW
Max. **25 %** of the burner output in the case of burner outputs (corresponds to an actual burner control ratio of at least 1:4)	$< 8{,}000 \leq 20{,}000$ kW

(these values apply to the main fuel; in the case of the emergency fuel, a maximum permitted low load of **33 %** is required for the range of $< 1{,}000 \leq 20{,}000$ kW (corresponds to an actual burner control ratio of at least 1:3).

In contrast to this, the following applies to quick steam generators:

The low load of the burner must not at any time fall below **25 %** of the burner output, while taking into account the water volume control.

In addition to this, the following conditions apply depending on the type of burner control:

- Stage burners:
  - **Required number of stages = burner output / low load of the burner (rounded to whole numbers)**
  - Equal distribution of the stages
  - At least a two-stage design
- Burners without stages:
  - Maximum permitted **b**urner **o**utput **c**hange **s**peed **BOCS [kW/s]**

    BOCS = 0.025 [1/s] x burner output [kW]

    The BOCS must be observed between low load (LL) and high load (HL), and it applies to both positive and negative changes in the burner output.

    All the above mentioned burner outputs are based on the actual thermal output of the boiler.

    The relevant operating instructions of the boiler manufacturer are to be observed when adjusting the output control of the boiler.

2.3 Interface between boiler control and burner control

If the customer's burner control allows the possibility of on-site manual operation, the appropriate instructions of the burner manufacturer must be observed before using this manual operation mode. The individual operating options are not interlinked or locked in the boiler control system. The boiler manufacturer accepts no liability for faults caused by incorrect operation of the burner control unit. Data transfer from a customer's burner to the boiler control system (e.g. transfer to a central process control system) is not possible. The boiler manufacturer accepts no liability for faults arising from the central control system that are caused by tampering with the burner control.

The following points are required for burner regulation at the interface of the boiler control/burner control:

- The burner control unit is fitted to the burner or is built into a control cabinet of the customer.
- All control and power components are fitted on the burner at the respective burner components (fan, burner oil pump station, etc.) or are built into a control cabinet of the customer. Control and power supply with fuse protection for the burner with AC or three-phase is provided by the boiler control cabinet.
- Burner data, notifications and faults regarding the burner are shown at the burner control unit.
- Power control of the burner is provided from the boiler control cabinet.
- Unblocking of the burner control unit takes place at the burner or the control cabinet of the customer.
- With dual fuel burners the gas/oil fuel switch-over takes place via the boiler control (if there are several gaseous or liquid fuels, the switch-over of the various gaseous/liquid fuels is done at the burner control).

The necessary signal exchange between burner control and boiler control depends on the fuels used and the type of burner control (whether it is regulated over a staged, constant or 3-point step signal). Details of the signal exchange can be found in the appendices, appendix 1 is relevant in any case.

Annex 2-5 applies depending on the type of burner design. If a dual fuel burner is operated with different control types for gas and oil operation, the respective signals per control type are transferred.

Dependent on the situation of the system, it is necessary to have a signal indicating the burner load level (see appendix), e.g. when combining several boilers via a boiler sequence control. A boiler sequence control is generally not possible for staged burners.

The power supply shown in appendix 7 is provided if the burner requires it.

The terminal designations represented in the annexes apply to one single flame tube boiler respectively to the left-hand burner of a double flue boiler. The right-hand burner of a double flue boiler will be be assigned the terminal designation X20/X21/X23.2 (e.g. burner requirement of the right-hand burner at the double flue boiler: X20.2, terminal 3/4).

If the cable connection between boiler control and the customer's burner control is part of the boiler manufacturer scope of delivery, the cables are connected by means of plugs (see appendices 8- 10). The specification shown describes the plugs at the boiler control (provided by boiler manufacturer). The PIN allocation to plugs corresponds to the respective terminal numbers.

If the cable connection between boiler control and the customer's burner control is **not** part of the manufacturer scope of delivery, the cables are connected by means of connecting terminals (see appendices 8-10) at both ends.

3 Burner system provided by customer with boiler control provided by customer

The following requirements apply in the event that both the boiler control and the burner system are provided completely by the customer.

The requirements mentioned in chapters 2.1 and 2.2 apply likewise.

3.1 Performance regulation of boilers

To protect the boiler from overload and excessive alternating stress, the boiler must be used in accordance with the regulations in the respective operating instructions (C003 saturated/hot steam shell boiler, C014 hot water shell boiler, C018 saturated steam shell boiler).

It must be ensured through the power control that the boiler is operating in low load before it is switched off. If this is not complied with, it can amongst other things lead to a triggering of the safety shut-off valve (SAV) in the gas control system.

3.2 Gentle start-up with time delay

The burner and control equipment must be selected so that the boiler is started gently with a time delay from the cold state or from the kept-warm state.

After the burner request, for example, an automatic timer should limit the burner load to low load over a period of approx. 180 seconds. This means that, with a limited heat requirement, any uncontrolled switching on and off of the burner is prevented. This automatic system also prevents unnecessary pre-ventilation losses and protects the boiler and burner components.

3.3 Keeping the boiler warm (does not apply for quick steam generators)

To avoid boiler cold starts, we recommend that the boiler is kept warm. This must be done in such a way that the boilers are operated carefully in such cases as well. Particular care should be taken to ensure that there is no temperature layering in the boiler (cold base – warm crest).

If the boiler is kept warm via the burner, a time limitation to max. 72 hours is necessary if no steam is given off whilst the boiler is being kept warm. For keeping warm by burner, the burner output must be limited to the burner's low load.

4 Approval of boiler and burner system

Insofar as the burner system and possibly the boiler control is provided by the customer, any requisite CE certification and CE acceptance procedures and/or requisite certification and acceptance procedures according to national and/or regional regulations must be performed by the parties ordering these components. Due consideration must also be given to the respective interfaces.

5 Liability

If the above points and the requirements given in the corresponding operating instructions are not followed, damage may be caused to the boiler and boiler components, as the boiler manufacturer, will accept no liability in such cases.

If the boiler control is not supplied by the manufacturer, any liability for damages which are caused by incorrect connection of the boiler technology is excluded.

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Appendix 1: Signals independent of the type of regulation (basic signals)

Control signals							
Boiler Control						Burner	
Designation	**Terminal designation**	**Terminal connection**	**Input signal**	**Output signal**	**Technical data**	**Input signal**	**Output signal**
Safety chain OK	**-X20.1**	1/2			230VAC/50-60HZ max. 4A		
Burner request	**-X20.1**	3/4			230VAC/50-60HZ max. 4A		
Burner fault	**-X20.1**	5/6			230VAC/50-60HZ max. 4A		
Burner operation	**-X20.1**	7/8			230VAC/50-60HZ max. 4A		
Control voltage on	**-X20.1**	9		X	230VAC/50-60Hz max. 6A	X	
Zero conductor	**-X20.1**	10		X	230VAC/50-60Hz max. 6A	X	
Preselection gas operation [1]	**-X20.1**	11/12			230VAC/50-60HZ max. 4A		
Preselection oil operation [1]	**-X20.1**	13/14			230VAC/50-60HZ max. 4A		
Safe start prevention gas-fuelled [2, 3]	**-X20.1**	15/16			230VAC/50-60HZ max. 4A		
Safe start prevention oil-fuelled [3, 4]	**-X20.1**	17/18			230VAC/50-60HZ max. 4A		

1 Signal only exists in dual burners.

2 Signal only exists if burner is designed for gas-fuelled operation.

3 The "Burner demand" signal is used for shutting down the burner.
The signal for "Start delay of gas/oil operation" is used for safe start delay and also for safe shutdown of the burner and fan (value according to the "Safety chain OK" signal). When the burner is operating, discontinuation of the "Start delay" signal must cause the burner to shut down immediately. If the burner is started subsequently, the program sequence must take place in the same way as a previous case with the safety chain.

4 Signal only exists if burner is designed for oil-fuelled operation.

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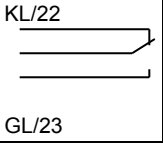
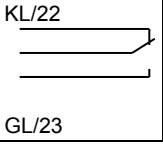
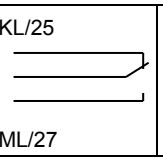
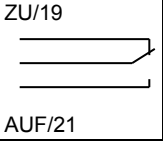
Appendix 2: Type of regulation: two-stage

Control signals							
Boiler Control						Burner	
Designation	**Terminal designation**	**Terminal connection**	**Input signal**	**Output signal**	**Technical data**	**Input signal**	**Output signal**
High load request	**-X20.1**	22/23/24			230VAC/50-60HZ max. 4A		

Appendix 3: Type of regulation: three-stage

Control signals							
Boiler Control						Burner	
Designation	**Terminal designation**	**Terminal connection**	**Input signal**	**Output signal**	**Technical data**	**Input signal**	**Output signal**
High load request	**-X20.1**	22/23/24			230VAC/50-60HZ max. 4A		
Medium load request	**-X20.1**	25/26/27			230VAC/50-60HZ max. 4A		

Appendix 4: Type of regulation: infinitely variable (load request via 3-step signal)

Control signals							
Boiler Control						Burner	
Designation	**Terminal designation**	**Terminal connection**	**Input signal**	**Output signal**	**Technical data**	**Input signal**	**Output signal**
Load request	**-X20.1**	19/20/21			230VAC/50-60HZ max. 4A		

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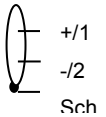
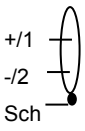
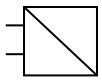
Appendix 5: Type of regulation: infinitely variable (load request via continuous signal)

Control signals							
Boiler Control						Burner	
Designation	**Terminal designation**	**Terminal connection**	**Input signal**	**Output signal**	**Technical data**	**Input signal**	**Output signal**
Load request	**-X21.1**	1/2/3			4- 20mA Load impedance: max. 500 Ω		

Appendix 6: Load position feedback (optional signal)

Control signals							
Boiler Control						Burner	
Designation	**Terminal designation**	**Terminal connection**	**Input signal**	**Output signal**	**Technical data**	**Input signal**	**Output signal**
Load position feedback	**-X21.1**	4/5/6			4- 20mA load impedance: max. 500 Ω		

Appendix 7: Total power supply, burner

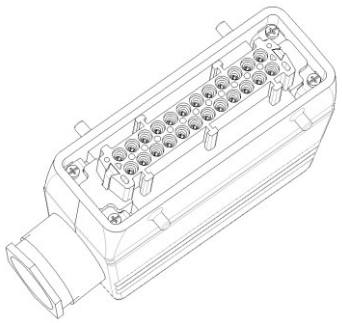
Boiler Control					Burner	
Designation	**Terminal designation**	**Terminal connection**	**Input signal**	**Output signal**	**Input signal**	**Output signal**
Power supply 400V/AC L1	**-X23.1**	1		X	X	
Power supply 400V/AC L2	**-X23.1**	2		X	X	
Power supply 400V/AC L3	**-X23.1**	3		X	X	
Power supply 400V/AC PE	**-X23.1**	PE		X	X (PEN)	

Appendix 8: Plugging of the cable connection between boiler control and burner control: identification of terminals -X20.1

The specification shown describes the plug at the boiler control (boiler manufacturer).

The customer is required to supply the fitting socket.

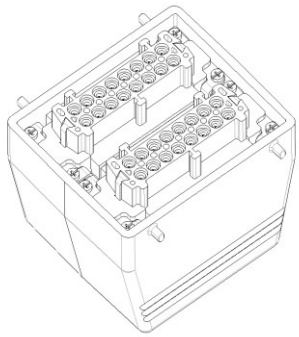
a) Control type: unequal three-phase



Design:	Industrial plug-in connection
Series:	B
Use:	Female insert 24P +PE; 16A
Housing:	Socket casing for transverse locking strap

Figure on the left: Example of an industrial plug-in connection

b) Control system: three-phase (see appendix 3)



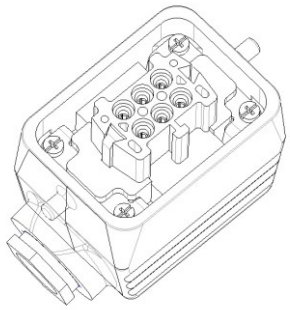
Design:	Industrial plug-in connection
Series:	B
Use:	Female insert 32P +PE; 16A
Housing:	Socket casing for transverse locking strap

Figure on the left: Example of an industrial plug-in connection

Appendix 9: Plugging of the cable connection between boiler control and burner control: identification of terminals -X21.1

The specification shown describes the plug at the boiler control (boiler manufacturer).

The customer is required to supply the fitting socket.



Design:	Industrial plug-in connection
Series:	B
Use:	Female insert 6P +PE; 16A
Housing:	Socket casing for longitudinal locking strap

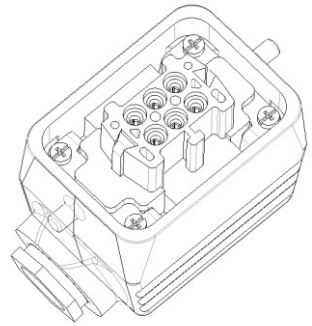
Figure on the left: Example of an industrial plug-in connection

Appendix 10: Plugging of the cable connection between boiler control and burner control: identification of terminals -X23.1

The specification shown describes the plug at the boiler control (boiler manufacturer).

The customer is required to supply the fitting socket.

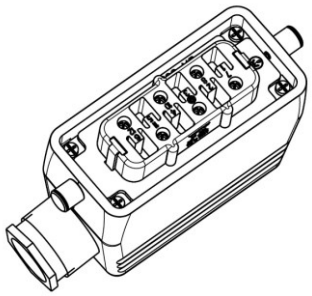
a) Fuse protection of the power supply ≤ 16A



Design:	Industrial plug-in connection
Series:	B 6
Use:	Female insert 6P +PE; 16A
Housing:	Socket casing for longitudinal locking strap

Figure on the left: Example of an industrial plug-in connection

b) Fuse protection of the power supply ≤ 35A



Design:	Industrial plug-in connection
Series:	B 16
Use:	Female insert 6P +PE; 35A
Housing:	Socket casing for longitudinal locking strap

Figure on the left: Example of an industrial plug-in connection

c) Fuse protection of the power supply > 35A

Design:	No plug, pre-assembled and labelled