Requirements for Boiler Installation Rooms - Notes on the installation of boilers and boiler house components

TI024
Version 12 (09/19)

1 General

This technical information describes the requirements for boiler installation rooms and contains notes on the installation of boilers and boiler house components for steam, superheated steam, warm and hot water boiler systems. It is intended to provide assistance to planners of installation rooms and buildings. All the relevant national and local regulations and applicable standards should also be followed.

2 Basic requirements for the installation room

The following basically requirements for the boiler room must be met:

- The boiler system may only be installed in a room that meets the local regulations for the installation of boiler systems.
- The installation room must be kept clean and free of dust and dripping water (if the air is filtered, filter class E11 of EN1822-1 or filter class F9 of EN 779 must be used). The inside temperature must be between 5 °C and 40 °C.
- The installation location for the control panel must have a minimum temperature of 10 °C. In the case of temperatures greater than 40 °C, an air conditioning unit must be provided for the control panel.
- If the air contains salt (proximity to the sea), the maintenance intervals of the boiler system may be shortened.
- Unauthorised persons must be forbidden to access the boiler room through permanent, clearly visible notices.
- Depending on the boiler parameters(water content, pressure, capacity), less strict installation or supervisory regulations may be applicable, depending on the national regulations.
- Sound insulation requirements must be met in accordance with local regulations.
- The control cabinets must be installed in such a way that no vibrations or shaking of the system components can be transmitted to the control cabinets. Installation must be carried out in areas which protect the control cabinets against excessive radiated heat and which safely allow access in situations which could be dangerous.
- Free access to inspection openings on boilers and plant components must be ensured.

2.1 Requirements on the building

The following requirements on the building must be met:

- The place of installation must be designed in such a way, in terms of construction, that vibrations caused by the process cannot cause any damage to buildings or neighbouring systems.
- The structural loading of the building shell must be taken into consideration for all fixings.
- Every boiler installation room should have an exposed and, as for as possible, continuous outer wall or ceiling surface area which is at least 1/10 of the floor space (or according to local requirements) that yields considerably more easily than the remaining enclosing walls in the event of overpressure in the boiler installation room. The national and local regulations and applicable standards must be observed when defining the pressure-relief area.
- The opening for brining equipment into the boiler installation must be made in accordance with the dimensions of the individual components. Suitable lifting equipment must be provided in the boiler installation room for moving heaving equipment.
- The internal height and width of all walk-on surfaces must be sufficient. The internal clearance above the maintenance platform should be at least 2 m. Access to the system must be ensured in accordance with local regulations. If the internal height of the installation room is lower than required for structural reasons, the minimum height must be established in conjunction with the responsible local authorities.
- Suitable, clearly marked emergency rescue routes must be provided.
- The boiler installation room, especially in the area of the valves and safety equipment, and the emergency rescue routes must be well lit.
- The parts of the system that are to be operated must be easily accessed and there must be sufficient space to pen doors (including inspection openings).

2.2 Recommended minimum clearances

When installing the boiler and its components, the following minimum clearances must be observed (the regional statutory regulations (including those for escape routes) must be followed):

- To walls at the side: at least 300 mm (as long as no valves, sensors, inspection openings or electrical control panels have to be operated or serviced), or at least 800 mm from the outer edge of the particular controls to be operated or serviced.
- To walls at the rear and front: at least 500 mm (as long as no valves, sensors, inspection openings or electrical control panels have to be operated or serviced), or at least 800 mm from the outer edge of the particular controls to be operated or serviced. In the case of boilers, there must be sufficient space available in front of the boiler to be able to clean the heating surfaces of the boiler with the cleaning device intended for the purpose.

2.3 Requirements for the combustion air

The combustion air must be free of foreign bodies, and it must not contain either dust or corrosive components such as for example solvents or refrigerants. In the case of waste heat boilers in conjunction with a unit generating the waste heat (CHP system or gas turbine), the additional notes from the manufacturer of the unit generating the waste heat must be observed. The relative humidity must be a maximum of 80 % (without condensation). The maximum temperature fluctuation must not exceed 30 K.

Combustion air temperature:	Minimum:	+ 5 °C or in accordance with the burner manufacturer's specification
	Maximum:	+ 40 °C or in accordance with the burner manufacturer's specification

If the maximum permitted temperature fluctuation is exceeded, oxygen control for the burner system is required.

The area (1 m) around the suction cross-section of the burner fan must be kept free, and access must be shut off.

2.3.1 Frost protection

Measures must be taken to prevent frost in the boiler house and/or to preheat the supply air (e.g. by a heating element in the air opening):

- Where there is a risk of low outside temperatures
- In the case of boiler installation rooms, where full insulation of the system components and valves only allows minimal heat emission, and where there is therefore no heating in the boiler house

2.3.2 Electrical integration

In the case of adjustable supply air valves, the firing system, or the unit which generates the waste heat, may only be started, if the supply air valve has been completely opened (potential-free feedback signal to the boiler control via safety-related limit switches). Control of the supply air valves must be provided. The pressure or temperature in the boiler may drop due to the actuation time of the flap control drives.

2.4 Requirements on the foundation

The following requirements on the foundation must be met:

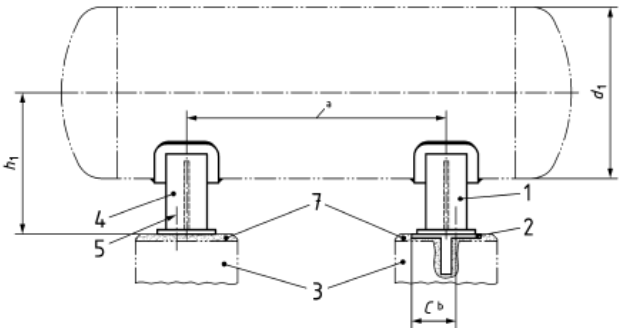
- Care should be taken to ensure that the floor in the installation room is completely level (evenness tolerance: in accordance with DIN 18202: 1.5 mm for each floor metre) and of a sufficient loadbearing capacity.
- Possibly existing ground ducts must be covered and equipped with drainage systems.
- In calculating the loadbearing capacity of the foundation, the maximum operating weight of the relevant components must be taken into account. In determining the operating weight, additional attachments (e.g. control cabinet, burners, sound attenuators, flue gas pipes, etc.) must also be taken into account and their weights included. The operating weight corresponds to the weight of the components when filled.

- The operating weight of boilers must be recorded in the area of the front and rear feet of the foundation. Bear in mind that with certain boiler types the rear boiler foot (when viewed from the burner side) is constructed as a fixed point on the longitudinal support (for more information, see the relevant operating instructions for the "Fire-tube boiler"). The front boiler stage is designed as a movable bearing, i.e. the boiler expands towards the front when heating up.
- Each component must be levelled when it is installed.
- If a separation between the installation surface and the system is required due to structure-borne sound, sound insulation strips must be positioned under the system before it is installed.
- If the boiler or system components are set up on a load-bearing structure, care must be taken to ensure that any vibration arising is absorbed by the load-bearing structure (e.g. by means of spring assemblies at the bearing points).

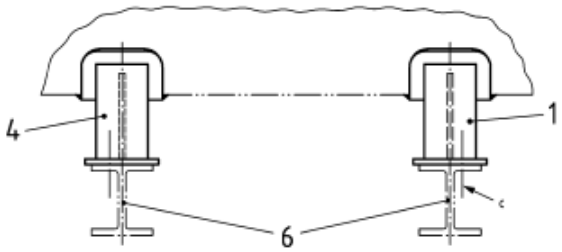
2.4.1 Installation for horizontal containers, boiler house components

The following additional requirements must be taken into account for the installation of horizontal containers (boiler house components):

- The technical design for the substructure / foundation and the dimensions of the bolts must be implemented on the basis of DIN 28080.
- When installing on foundations or a steel structure, the anchor bolts are fitted in the middle of the elongated holes.
- As a matter of principle, the feet are designed with elongated holes for fixing to a foundation or steel construction. A saddle is permanently screwed on as a fixed point saddle. The remaining loose point saddles are not screwed on permanently but rather secured with a locking nut. All the screw attachments must be fitted with washers.
- The materials for sleeve bearings and the associated steel structure for the installation must comply with the minimum standard S235JRG2 in accordance with DIN EN 10025.
- External dimensions for the foundation (length x width): We recommend installation of the saddle feet on foundations with a 50 mm protrusion all around (L + 100 mm and W + 100 mm).
- As regards the sliding plates, we recommend a protrusion of 25 mm all around (L + 50 mm and W + 50 mm) - see the following Fig. dimension C



Installation on foundations



Installation on a steel construction

1	Sliding saddle	5, c	Anchor bolt
2	Sliding plate	6	Steel construction
3	Foundations	7	Levelling compound
4	Fixed saddle		

Fig.: Examples of the installation of units with saddles (extract from DIN 28080:2015-06, Appendix A)

2.5 Combustion air from the installation room

Sufficient supply and exhaust air openings are required, when combustion air is extracted from the installation room.

2.5.1 Layout of openings

The aeration openings should ideally be located at the back of the boiler. If this is not possible, for structural reasons, deflector plates or metal ducts must be installed within the boiler installation room to divert the intake air. When planning the aeration openings, the position of system components that are sensitive to frost (e.g. water treatment systems) must be taken into account to ensure that they are not installed directly in the flow of incoming air. In addition, the aeration openings must be installed in the boiler installation room in such a way that the flow of incoming air does not pass across boiler doors or reversing chambers (to avoid condensation).

Vent openings must also be provided. Aeration openings should be 500 mm above the boiler room floor and vent openings should be located at the highest point in the installation room. Cross ventilation must also be provided.

2.5.2 Determination of size

The supply and exhaust air openings must be designed in such a way, that there is a pressure of ± 0 mbar in the boiler installation room. The calculation formulae given below are a **non-binding recommendation**. It is essential that the system installer obtains the agreement of the responsible approval body or building authorities. When determining sizes, take into account additional consumers of supply air (e.g. compressors).

Classification according to heat output:

GR 1	≤ 2000 kW
GR 2	> 2000 ≤ 20000 kW
GR 3	> 20000 kW

Supply air cross-sections:

$A_{GR\,1}$	300 + [(Q – 50) x 2.50]
$A_{GR\,2}$	5175 + [(Q – 2000) x 1.75]
$A_{GR\,3}$	36675 + [(Q – 20000) x 0.88]

When using burners, which are operated at full load with a greater air surplus (e.g. gas pre-mix surface burners), the supply air cross-sections must be increased:

	Air surplus λ $1.25 < \lambda \leq 1.4$	Air surplus λ $1.4 < \lambda \leq 1.7$
	Residual oxygen content with natural gas as fuel $3.7 < O_2 \leq 5.4$	Residual oxygen content with natural gas as fuel $5.4 < O_2 \leq 8.0$
Boiler without flue gas heat exchanger	Increase by 30 %	Increase by 50 %
Boiler with flue gas heat exchanger (without condensing technology)	Increase by 10 %	Increase by 30 %
Boiler with flue gas heat exchanger (with condensing technology)	Increase by 5 %	Increase by 20 %

Key to symbols:

A_{GR} = Free cross-section in cm²

Q = Heat output in kW

Maximum side ratio 1 : 2

Exhaust air cross-sections correspond in each case to 60 % of the supply air cross-sections.

The cross-sections are net cross-sections.

2.6 Combustion air from outside the installation room

The following conditions must be observed, when combustion air is extracted from outside the installation room (examples: combustion air via air ducts from other rooms or from the air outside; installation of a fan in a different room (e.g. in the basement) in the case of duoblock burners):

- Air ducts and flue gas ducts must be laid separately from each other (no pipe-in-pipe systems).
- The back-pressure of the air ducts on the air side must be taken into consideration when designing the firing.
- The line for the combustion air infeed must be sufficiently airtight, for example with components for ventilation systems, which meet the requirements of airtight classes C and D in DIN EN 12237 or DIN EN 13180, in order that air is prevented from being sucked in from the boiler house (and creating for example the danger of negative pressure in the boiler house).
- In order to monitor the pressure conditions on the supply air side in the air ducts, caused for example by contamination, different flow conditions at the air inlet, or icing due to condensation in the air duct, a low-pressure monitoring system (designed with a pressure limiter of a special type) is required on the suction side of the combustion air fan (integrated into the burner safety chain). This pressure-monitoring system ensures, that sufficient air is provided for stable combustion.
- In the case of air suction from outside, the supply air ducts must be designed with protection against wind and rain, and they must be provided with a suitable grille (mesh size maximum 15 mm), if this is necessary due to the building conditions. The external air suction system must be arranged with an adequate distance to the chimney outlet, so that flue gases are prevented from being sucked into the system.
- Any condensate that forms in the air suction ducts must be safely removed upstream of the combustion air fan.
- To ensure that the permitted combustion air temperature (see sec. "Combustion air") is achieved, a heating register for controlling the temperature of the combustion air is necessary in the case of air suction from outside. The combustion air temperature must be monitored via safety temperature limiters for any temperatures that are too low or too high. The safety devices are to be integrated into the boiler safety chain. If the maximum permitted temperature fluctuation (see sec. "Combustion air") is exceeded, oxygen control for the burner system is required.
- In order not to exceed the maximum permitted temperature in the boiler installation room (see section "Basic requirements for the boiler installation room") due to inadequate air exchange, it may be necessary to provide ventilation for the boiler room due to radiated heat loss from the installed units and piping. When designing the ventilation, the arrangement of frost-sensitive system components must be taken into account (e.g. water treatment), which must not be installed in the direct path of the air flow. The air openings in the boiler installation room must also be installed in such a way, that the ventilation air does not flow over boiler doors or reversing chambers (to prevent condensation). Exhaust air openings must also be provided. Supply air openings for ventilation should be located 500 mm above the boiler room floor, while the exhaust air openings should be located at the highest point in the installation room. Ensure that there is cross ventilation.
- In order to prevent the build-up of poisonous gases in the boiler installation room, self-monitoring CO monitors must be provided and integrated into the boiler safety chain (depending on the boiler size, several monitors may be necessary: 1 in close proximity to the burner, 1 at the end of the boiler, plus other monitors depending on the design of the flue gas system (e.g. at joints)). The CO monitors must be checked at regular intervals by a competent person (at least every 6 months or in accordance with the manufacturer's instructions), and they must be replaced after the time period specified by the manufacturer.
- In the case of fuels. which tend to produce contamination in the flue gas path during combustion (e.g. heavy fuel oil, sulphur-containing fuel oils or special fuels), the burner system must be equipped with oxygen control and safety shutdown, if a critical oxygen limit is not met.
- Contrary to information in the operating instructions in Index B or L, the testing interval for assessing the flue gas system (boiler including flue gas ducts and as far as the chimney) must be reduced as follows. Here checks for leaks and escaping flue gas in particular must be performed. Any leaks must be eliminated immediately. In addition to this, the seals on the flue gas side must be inspected for wear and replaced if necessary:
    - Every 4 weeks a visual examination must be carried out by the operator. Changes in smell or discolouration of insulation caused by temperature can be an indication that flue gas is escaping.
    - Every 6 months a detailed examination must be carried out by a competent person or a specialist company. Leaks and prohibited amounts of escaping flue gas can for example be identified by means of an oxygen measuring device.

As part of a hazard assessment (or a systematic inspection specified in accordance with the regional statutory regulations), the operator must check whether other and/or alternative measures are required. The public monitoring authorities responsible must also be involved.

2.7 Special requirements for open air installation

If boilers are installed in the open air, the following additional requirements must be met:

- All the components and parts of the system must be suitable for external installation (i.e. suitable material, necessary protection category, paint / protective coating, etc.).
- Sensitive components (burner system, control cabinet, measurement and control equipment, motors, pumps, etc.) must be protected by a roof against rain and sunshine.
- Thermal insulation must be provided in accordance with the conditions in situ.
- Cable material and wiring must be suitable for external installation.
- If there is a risk of frost, the system components, pipes, pumps and fittings must be provided with background heating.
- An effective lightning conductor system must be provided.

3 Burner system

Technical Information TI030 – 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 – must be complied with. When attaching the burner system and burner components (e.g. silencer hood, oil circulation module, etc.), care should be taken to ensure that it is easy to open the front reversing chamber door and/or boiler door and to swivel the burner without any problems. Oil hoses, cables, etc. should be laid accordingly, and the burner fittings should project at the side. The compensator in the gas regulating line must be installed in the longitudinal direction of the boiler in order to absorb the axial expansion of the boiler.

3.1 Fuels

Facilities for the storage, preparation and supply of fuels must be design and made in such a way that they can be used without danger and meet the national and local regulations and relevant standards.

For commissioning the burner system it must be possible to measure fuel quantities for each burner and fuel type.

3.1.1 Fuel oil

The storage and distribution of fuel must be carried out in accordance with safety requirements. If the fuel supplied is EL fuel oil, the storage and transport temperature should not be less than 5°C; with medium and heavy oils, higher temperatures are necessary, depending on the viscosity, in order to guarantee that the oil can still be pumped. If necessary, background heating must be provided for the tank and pipe system.

3.1.2 Gas

A device for safe drainage under pressure must be installed upstream of the gas regulation module.

Liquid gas must be available in vapour form at the gas regulating module. The safeguard pressure at the transfer station may not be greater than the maximum permitted gauge pressure at the gas regulating module.

4 Flue gas system

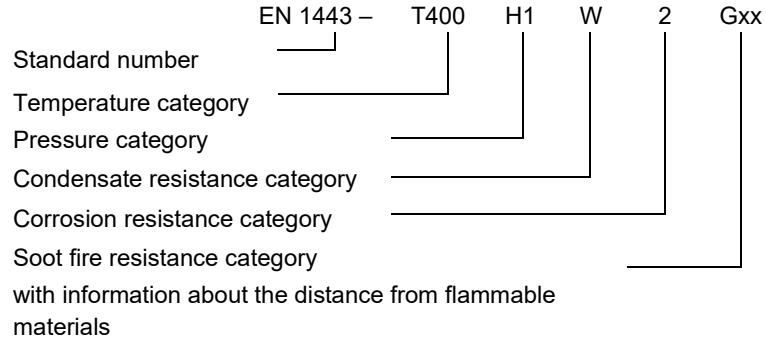
The following sections contain recommendations for the design of flue gas systems, which should ensure fault-free operation of a burner system (in the case of waste heat boilers in conjunction with a unit generating the waste heat, the notes from the manufacturer of the unit, which is generating the waste heat, about the flue gas system must also be observed). If these rules are not observed, substantial operating problems during combustion can arise, and this may even result in flash fires. These are frequently acoustic faults or impairment of the combustion stability, or also excessive vibrations on modules or their components. Low NOx firing systems are to be viewed as being more sensitive to these operating problems on account of their combustion control.

The flue gas system must therefore be planned and designed with particular care from an engineering perspective. In this regard see also the BdH (Bundesindustrieverband Deutschland Haus-, Energie- und Umwelttechnik e.V) Information Sheet, Number 32: http://www.bdh-koeln.de.

The flue gas system usually consists of a connection piece between the heat source and the vertical part of the flue gas system, and of the vertical flue gas system itself (chimney). In the case of a waste heat boiler, the flue gas system also consists of an additional connection piece between the heat source and the unit generating the waste heat.

The following requirements must be met when designing and constructing the flue gas system:

- Flue systems must be sized in accordance with the particular national and local regulations and applicable standards. General requirements for flue systems in and on buildings are specified in DIN EN 1443. The design of flue systems must comply with local building regulations and DIN V 18160. In addition to building regulations, DIN EN 13084-1 also applies to free-standing chimneys. For specifications regarding technical flow sizing, refer to the DIN EN 13384 standard for flue systems in and on buildings, or DIN EN 13084-1 for free-standing chimneys.
- Flue gas ducts must be made from non-flammable building materials and must be resistant to the effects of flue gas and heat. The material for the flue gas system must be suitable for temperatures up to 350°C. If the boiler is equipped with a fourth pass, or in the case of a waste heat boiler for using the waste heat from flue gases produced by a CHP system or gas turbine, the flue gas system must be suitable for the temperatures specified in the order confirmation.
- We recommend a flue gas line with the following classification in accordance with EN 1443 - a higher classification may be necessary depending on the outline conditions and local regulations (e.g. use of fuels with a sulphur content > 0.2 %: corrosion resistance class: 3):



- When selecting the material for the flue gas system, the composition of the combustion gases must be taken into account, in order to prevent damage and contamination of the parts of the system, which are in contact with the flue gas. If a flue gas condenser is installed, the downstream flue gas system must be suitable for operation with condensation (stainless steel construction). The maximum sulphur content in the fuel must also be taken into account.
- The flue gas system must be dimensioned in such a way, that full-load shutdowns of the firing or any pressure fluctuations, as well as vibrations from the combustion process (particularly with low-emission burners) and any resulting resonance, do not cause the destruction of the flue gas system and thereby allow flue gas to escape.
- Route the flue gases to the chimney as directly as possible and taking the most favourable flow characteristics into consideration (e.g. short route with a rising gradient and the fewest possible diversions), see figure below.

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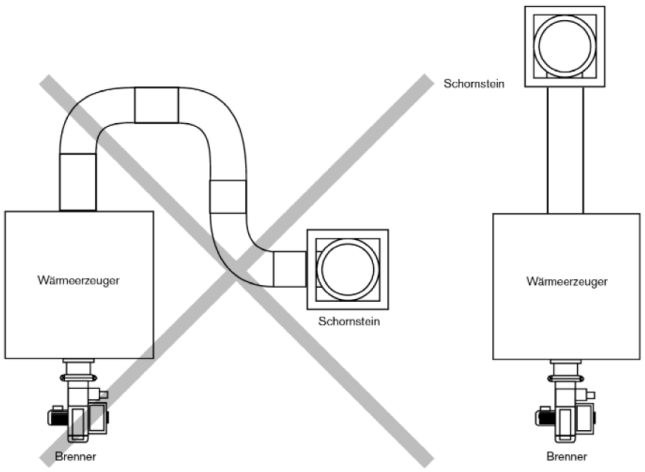

Source: BdH Information Sheet, Number 32
(Http://www.bdh-koeln.de)

Wärmeerzeuger	Heat source
Brenner	Burner
Schornstein	Chimney

- A separate chimney flue must be provided for each boiler. The design of the flue gas line and chimney is made by specialised companies based on detailed information, and the design is based on a pressure of + 0/-1 mbar (in the case of boilers with a heat output ≤ 2 MW: + 0/-0.5 mbar) at the flue gas connection of the boiler or flue gas heat exchanger, or for every load point at the boiler manufacturer's supply interface. The flue system must ensure, that there are constant and reproducible combustion chamber pressure ratios under all operating states and at all load points.
- The thermal expansion of the system must be taken into account. Additional back-pressures in the flue gas line provided by the builder (flue gas silencers etc.) must be taken into account in the design of the flue gas and firing systems.
- If the residual manometric pressure remaining at the burner needs to be taken into consideration in the design of the chimney system, then a detailed agreement about this has to be reached between the manufacturers of the boiler, the burner and the flue gas system (including the chimney).
- Diversions in the connection pieces should be constructed as favourably as possible as regards the flow characteristics by using bends or deflector plates. Connection pieces with several diversions should be avoided, as they can have a detrimental effect on air-borne and structure-borne noise as well as the start-up pressure surge. Sharp-edged joints between right-angled connection flanges and the connection pipe should be avoided. As in the case of any reducers / expansions which may be required, the joint angle should not exceed 30°.
- The flue gas line after the boiler must be equipped with the facility for measuring the flue gas. As a matter of principle, the closable measurement port must be fitted after the last heat exchanger in the connection piece between the heat source and the chimney. The measurement port should be fitted after the flue outlet of the boiler / heat exchanger at a distance, which corresponds approximately to twice the diameter of the connection piece. The diameter of the measurement port must be at least 15 mm.
- Multiple firing stations (but not permitted for waste heat boilers or flue gas systems for boilers with a fourth pass) may only be connected to a common flue gas system (chimney, flue gas line), if their type of design ensures that they are suitable for this method of operation, and if the following requirements are met:
  - Dimensioning of the system for the faultless discharge of flue gases in every operating state.
  - Prevention of the inflow of flue gases into firing stations, which are out of operation, during overpressure operation (e.g. by means of tightly sealing flue gas valves in conjunction with an opening in the flow direction to the flue gas valve, so that backed-up heat can be discharged).
  - Constant combustion chamber pressure ratios in each of the connected heat sources under all operating states and at all load points.
  - Minimum flue gas speed of W_{min} in accordance with DIN EN 13084-1 Appendix A is taken into account, or simplified W_{min} = 0.5 m/s
  - There must be negative pressure at the junctions of the firing stations under all operating states.

Wherever possible, the merging of flue gas flows should be prevented, since a lower negative pressure arises in the chimney, if there is weak loading of the chimney (e.g. in the case of operation with a single heat source). The flue gases do not then fill the chimney completely, and cold air can come into the chimney. The cooling of the flue gas that occurs can cause an accumulation of soot and the danger of fire in the chimney. If the merging of flue gas flows can not however be prevented, the flue gases must be routed parallel to each other in a short partial section of the flue gas system, and isolated from each other by means of a partition, so that the flue gas flows are prevented from influencing each other.

The following must not be connected to flue gas systems, which have multiple allocations:

- Firing systems, which are operated by liquid gas.
- Firing stations with fans, unless all the firing stations are installed in the same room.

- Connection pieces should be introduced into the chimney to give the most favourable flow characteristics, and if possible with a rising gradient (at an angle less than 45°). If the chimney has multiple allocations, connections must be avoided, which lie opposite each other or at the same height. Any capping pieces on the chimney outlets must ensure that there is a free discharge of the flue gases into the open air.
- Any condensate which arises must be able to drain away freely over the total length, and it must be treated in accordance with local regulations (e.g. ATV Code of Practice 251 (Germany) and disposed of in accordance with local regulations.
- Cleaning openings must be provided in accordance with local regulations (e.g. DIN 18160-1, DIN 18160-5, IVS Directive 105), if necessary after discussion with a local flue gas inspector or chimney sweep.
- The chimney may be positioned directly on the flue gas heat exchanger if the load and the horizontal forces (e.g. wind forces) do not have any effect on the heat exchanger. A separate support for the chimney must be provided. In order to stop rain from entering and thus to prevent corrosion in the flue gas heat exchanger, the chimney must be provided in this case with a cover.
- The chimney must be separated from the boiler/flue gas heat exchanger system (e.g. using an expansion fitting) in order to not only prevent any structure-borne sound, but also absorb vibrations and linear thermal expansion. The separation must be made directly after the boiler or integrated flue gas heat exchanger.
- It is necessary to decouple the waste heat boiler or fourth pass inlet (e.g. with expansion fitting) from the system of the unit, which is generating the waste heat.
- The risk of frost damage during down times and sub-zero outside temperatures is to be prevented.
- If a flue gas valve is incorporated into the flue gas system, it is essential that a safety limit switch "OPEN" is incorporated into the boiler control. It must only be possible for firing to start if the limit switch reports that the flue gas valve is completely open. Due to the setting time of the flap drives, pressure or temperature drop in the boiler is possible. The "SHUT" position at the flue gas valve must be set in such a way that the flue gas valve never completely closes. This will prevent any damage from accumulated heat at the attached burner. To ensure that any accumulated heat can be safely removed, it is essential that there should be a sufficient vacuum behind the flue gas valve (on the chimney side) as soon as the assigned burner switches off. Alternatively, if the flue gas valve closes tightly, an opening to remove the accumulated heat should be provided in the direction of flow to the flue gas valve.
- In the case of twin fire tube boilers with single fire tube operation and downstream Economizer or flue gas condenser, attention must be paid to ensuring that the heat exchanger bundle is separated on the flue gas side, so that the flue gases are fed to the flue gas system in a targeted manner. If the two flue gas lines from the twin fire tube boiler are merged before the chimney, there must be a negative pressure at this point (at full load in single fire tube operation). If this is not the case, a sealing air blower is required for each burner.

4.1 Systems with external flue gas recirculation

Please note the following points for firing systems with external flue gas recirculation:

- In the event of the flue gas recirculation being shut down (e.g. for inspection), a suitable airtight shut-off device (e.g. shut-off valve, blanking plate) must be provided at the flue gas extraction point.
- It must also be ensured, that the condensate can be discharged properly, and that this is closed by means of a suitable siphon.
- The line for the external flue gas recirculation must be kept as short as possible and made of corrosion-resistant material.
- Any tension, which could arise from the heating of the line, must be prevented. It may be necessary to install an expansion fitting in the flue gas recirculation line. This depends on the expansion of the boiler (which in turn is dependent on the temperature of the medium in the boiler) compared to the expansion of the flue gas recirculation line (again dependent on the temperature of the recirculating flue gas and the piping material used).
- The piping must be insulated properly.
- Recirculation lines must be adequately supported on the building.

5 Piping

5.1 Piping design

- Pipes must be laid in accordance with the national and local regulations and relevant standards, taking into account the pressure losses and flow speeds.
- Use of suitable materials for the accessory parts (i.e. piping mountings).
- The relevant national and local regulations and applicable standards must be observed when using hoses on the oil side. The maximum hose length (to DIN 4755) is 1.5 m. Fixed piping must be used for longer lengths.
- In a boiler with a fourth pass for the waste heat recovery of flue gases from a CHP unit or a gas turbine, the connecting piping for the fourth pass must be designed so that no oscillations or vibrations whatsoever are transferred to the boiler or heat exchanger from the gas turbine or CHP unit (use of expansion fittings, silencers upstream of the boiler is required).

5.2 Material selection for piping

Generally suitable materials are to be used, which comply with the technical data (safety pressure, safety temperature) in the order confirmation, or with the Technical Data Sheets for the boiler and plant components. In the case of piping which is carrying water, the permitted water quality should also be taken into account. In addition to this, the operating instructions for the boiler, the boiler components and the plant components should also be observed.

5.2.1 General notes on material selection for piping

- See chapter on "Flue gas system" with regard to materials for flue gas lines.
- Compressed air lines (e.g. control line for quick shut-off blow-down valve) must be laid as galvanised piping as a minimum.

5.2.2 Material selection for piping at the steam boiler

All piping, which leads to and from the boiler, must be made from steel. Deviations from this are:

- Steam pipe (09.001 or 42.001 / 42.101): "culinary" steam, food industry, line to the consumer unit made of stainless steel.
- Blow-down line (12.001 or 12.101): due to the abrasive effect of the blown down boiler water, the piping should be constructed of stainless steel. Piping bends in the blow-down line should be constructed with thick walls.

5.2.3 Material selection for piping at boiler components or plant components

The following notes must be observed in the area of the boiler components and plant components:

Line	Notes on material selection
Make-up water lines (e.g. line from the water treatment plant to the degassing system (41.001, 62.011))	depending on the water quality of the flowing water: • Salt-containing mode of operation: construction to be of steel • Low-salt / salt-free mode of operation: use of corrosion-resistant materials (stainless steel)
Lines for a secondary water circuit (e.g. at the flue gas condenser (33.009))	
Make-up water lines down-line from a heat exchanger (e.g. vapour heat exchanger (61.002, 41.002), expansion module and heat recovery module (60.012), flue gas condenser (33.010), feed water cooler)	Aggressive gases (oxygen, carbon dioxide), which are contained in the water, are driven out by the heating of the make-up water: lines to be made of stainless steel
Condensate lines (30.006, 30.007, 62.007, 64.004, 64.005)	depending on the water quality of the condensate: as an example, stainless steel is to be selected as the line material with pH values < 9
Vapour line at the degassing system (30.005, 61.004)	Construction to be of stainless steel due to the aggressive gases (oxygen, carbon dioxide) contained in the steam
Flue gas condensate line (line 33.012, 32.012)	if there is utilisation of the flue gas condensation: construction of the condensate network to be of stainless steel

5.3 Piping installation

- All supply and discharge lines must be laid in accordance with the regional applicable regulations as well as the recognised engineering rules.
- The thermal expansion of pipes and system components (boiler, flue gas heat exchanger) must be taken into account for piping installation.
- Lines must be laid in a stress-free way and they must not apply any forces or moments on the system components.
- Hot pipes must be marked and surrounded by an effective touch guard so that injuries by touching the hot pipes are excluded.
- Discharge into pump sumps, drain channels etc. must be designed in such a way that the discharged water can be controlled.
- Notes on the sizing (nominal diameters, maximum line lengths and maximum number of bends) are included in the operating instructions for the individual components.

5.4 Vent and drainage pipes

- Pipes must be installed over the shortest route and with drainage facilities at the lowest point and vent facilities at the highest point.
- Drainage and desalting, emptying and blow-down pipes must be laid separately and sloping to the blow-down, expansion and cooling device. The waste water must be cooled before passing into the sewage network in accordance with local regulations.
- If the blow-down pipe is taken more than 1 m upwards, the blow-down pipe must be drained at the lowest point before every blow-down procedure.
- Observe that blow-down lines of low-pressure boilers are pulled upwards max. 2 m from the boiler connection (drain).
- Pressure safeguard blow-down pipes or vent pipes at the blow-down, expansion and cooling device must be taken so that they open safely into the open air, must be protected against the penetration of rainwater and dirt and drained at their lowest point. In the case of warm and hot water boiler systems, an expansion vessel at the pressure safeguard blow-down pipe is necessary in order to separate the water-steam mixture.

- Vent pipes (e.g. to a partial deaeration system or condensate system) must terminate into the open air without any hazards. When laying the pipes, it should be noted that it is not permitted to route them horizontally or downwards. This prevents condensate being formed in the line and so-called "water spew" coming out from the line discharge. In cases where longer line lengths are required, a separator pot with venting and drainage must be installed in the vent pipe in accordance with the operating instructions for the particular component.
- Pressure safeguard blow-off lines may only be brought together with other lines in exceptional cases and with the corresponding calculated evidence.
- Drainage connections on the flue gas side of boilers (e.g. flue gas chamber) and system components must be provided with a water bag of at least 10 cm, in order to prevent the escape of flue gas. The drainage lines (made of stainless steel) must be routed via a neutralisation unit. A junction with lines, which convey other media, is not permitted in order to prevent undesired back flows.
- The starting line for the boiler must be incorporated into the pipeline network in such a way that each boiler can safely emit steam into the open air via the steam shutoff valve during the start-up procedure.

5.5 (Steam) condensate lines and condensate network

- It is crucial that the condensate lines are sized correctly to ensure operating safety and the service life of the condensate network.
- Condensate supercooling and the pressure conditions upstream and downstream of the trap determine the extent to which the condensate evaporates. As this flash steam has a considerably lower density than liquid condensate, condensate lines must not be sized exclusively for conveying water.
- We recommend routing condensate lines continuously with a drop of at least 1% in the flow direction to enable liquid condensate to flow out easily and heat exchangers and piping to be drained. This simplifies the start-up process for the heat exchangers and reduces the risk of corrosion.
- Water pockets in condensate lines in particular are to be avoided.
- Vertical sections in condensate lines are possible; in addition to the hydrostatic pressure drop, increased flow pressure losses must also be taken into account here. Horizontal sections must continue to be provided with a drop and suitable cold drains and/or start-up drains must be available at the lowest points.
- As the condensate does not usually accumulate at a sufficient height above the feed water tank, it should be collected in condensate tanks and returned via condensate pumps.
- When selecting the size of the condensate traps at the heat exchangers, the minimum pressure difference must be taken into account. This is obtained from the minimum steam network pressure minus the fitting pressure losses and the maximum back-pressure in the condensate line downstream of the trap in question.
- Steam and condensate lines should be routed separately from one another so that no heat from the steam is transferred to the condensate.
- A combination of suitable measures such as insulation, cold draining, sealing off the line sections in question or trace heating are to be taken to mitigate the risk of frost for condensate lines installed outdoors.

5.6 Discharge of flue gas condensate

- Design of the condensate network in stainless steel.
- If the flue gas condensate is discharged through gravity, the internal diameter of the discharge line must be at least 13 mm.
- The discharge line must have a waste trap with hydraulic seal, so that no flue gases can get into the installation room.
- Condensate accumulating from the boiler / heat exchanger and flue gas line must be treated in accordance with regulations (neutralisation system). Discharge the condensate into public waste water systems in accordance with the country-specific regulations.

6 Installation of fittings and system components

When installing fittings and system components, the following requirements must be met:

- Fittings must be installed without tension. Installation mistakes may not be rectified by violently tightening the flange screws.
- Flange seals must be checked for cleanliness and proper fit.
- Fittings must be drained if necessary to prevent water impact.
- When fitting the individual system components and fittings, make sure that they can be operated and that the direction of flow is as indicated.
- The feed water pipework must be direct and suitable for the water flow. The feed pumps must be located right by the feed water container. When erecting the feed pumps, the minimum positive suction head of the pump must be maintained.
- In the case of condensing boilers, sufficiently dimensioned neutralisation systems must be used in accordance with the valid local regulations.
- The screws and nuts to be used for flange connections must be designed for the maximum overpressures and temperatures that arise, and suitable materials must be used in accordance with international, national or local regulations (e.g. material 5.6. for screws or material 5 (or previous designation 5-2) for nuts). In the case of superheaters with a maximum permitted temperature (safety temperature limiter) from 300 °C upwards, expansion screws (e.g. material 1.1181 C35E / Ck 35) and nuts (e.g. material 1.0501 C35E / C 35) must be used. If materials are used that deviate from this, proof of suitability must be obtained.
- In multi-boiler plants (steam or hot water systems) hydraulic decoupling of the individual boilers via non-return valves (at steam boiler plants e.g. at the steam distributor) is mandatory to avoid interaction of the boilers (pressure charging or backflow).
- If, in hot water systems, the pumps (boiler circuit pump, lifting pump, etc.) are installed geodetically below the boiler, the geodetic difference between the pump installation site and the boiler safety valve connection must be taken into account when designing the pressure of the pumps and the associated fittings.

7 Assembly of Measurement and Control Technology

The following requirements must be observed when installing measurement and control technology components:

- Observe the mounting position and conditions (e.g. max. ambient temperature) and the necessary inlet and outlet paths of the sensors (observe the operating instructions of the respective devices for this).
- When installing sensors in flue gas lines observe that they must be mounted in pipes that are constantly ascending or running vertically up (mandatory with limiter devices). Possibly occurring condensate must be discharged without any obstructions.
- If any water seals are installed upstream of sensors they must be filled with distilled water.
- Observe during installation that sensors must accessible for commissioning and maintenance.

8 Earthing and potential equalisation

Earthing and potential equalisation must be carried out in accordance with the "Requirements for protection against electric shock" in IEC 60364-4-41:2005 (or in Germany DIN VDE 0100-410:2007-06).

The technical design of the potential equalisation and the dimensions of the cross-sections must be in accordance with IEC 60364-5-54-2011 (or in Germany DIN VDE 0100-540:2012-06).

The implementation involves for example piping, flanges, valves, measuring equipment, motors, pumps, boiler pressure vessels, boiler and system components and control panels etc. In the case of boilers or boiler and system components, earthing can generally be carried out at the base frame (e.g. via earthing terminals). The connection between the base frame and the foot of the boiler or tank must be made via a conductive connection.

The design of this must be in accordance with the regulations that apply locally, and where applicable the manufacturer's instructions for the individual components must be observed.

The minimum requirements are:

- It must be ensured that the earthing measures are mechanically secure and corrosion-resistant.
- Provision must be made for the highest fault current (as calculated) from the thermal point of view.
- Damage to units, components and other operating equipment must be prevented.
- The safety of persons must be ensured as regards voltage on earthing systems arising from the highest possible fault current.
- The positions, which are used for potential equalisation, must be ground bare (removal of anti-corrosion paint) and provided with a suitable marking.