

Flue Systems, Installation Requirements, System Certification

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Summary

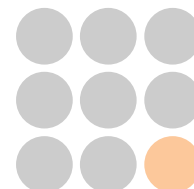
The updated DVGW-TRGI '86/96 include a number of significant concessions on the installation and approval of gas appliances, including flue gas discharge and combustion air supply. Both the simplified requirements of the new Specimen Firing Ordinance of February 1995 and the harmonisation objectives of European Directives and standards have been taken into account here. The latter provide for uniform classification and designation of the various types of appliance with respect to combustion air supply and flue gas discharge, which are also taken into consideration as part of the common system certification of appliances and flue systems under the EC Gas Appliances Directive. This system certification helps to achieve significant simplification and reduce costs and is therefore explicitly recommended by the DVGW Certification Body.

Essentially, the innovations in the updated DVGW-TRGI '86/96 can be described as follows:

- Simplified requirements for the installation room, particularly with respect to ventilation and exhaustion.
- The general requirement for a chimney has been dropped and is replaced by a requirement for a flue system in general as standard approach for flue gas discharge from gas appliances.
- Reduced distances between flue systems and inflammable building materials.
- Reduced height of flue system outlets above roof.
- Simplified requirements of shafts for flue ducts and connection ducts.
- Adoption of the European classification of types of appliance according to CEN.

Appliance installation requirements

A major change is the requirement for only one ventilation opening (instead of two) of 150 cm² clear section, which means simpler installation of gas appliances with a residual feed pressure at the flue outlet, such as condensing appliances. The flue duct of such appliances can now be directly routed in the installation room, independent of its material and without additional protective tubes or jackets, provided that there is at least one ventilation opening of 150 cm². In the case of increased tightness of the duct system, as expressed for type C appliances by the additional marking "x", no ventilation opening is now necessary and appliances with 50 kW maximum output can be installed in rooms for human occupation. Although the „increased tightness“ requirement has been left open in-





tentionally in the TRGI in order to arrive at a harmonised European definition, this requirement is likely to be guided today by the current tightness definition in DVGW VP 113 "System certification of appliances and flue systems", i.e. to result in $0.05 \text{ m}^3/\text{h} \cdot \text{m}^2$ internal surface at 1000 Pa test pressure.

Table 1 shows the various installation room requirements for type B and C gas appliances with respect to the ventilation situation. It can be seen that a combustion air compound system is still possible with type B appliances up to 35 kW as an alternative to the ventilation opening mentioned above, and that opening sections $> 150 \text{ cm}^2$ are only required for appliance output greater than 50 kW, i.e. another $2 \text{ cm}^2/\text{kW}$ for outputs $> 50 \text{ kW}$. If flue gases are discharged under pressure the version with increased tightness (as with type C_x appliances) is also possible with outputs $< 35 \text{ kW}$ as an alternative to a ventilation opening, irrespective of the room dimensions and ventilation measures. Adequate ventilation (or a combustion air compound system for $< 35 \text{ kW}$) is only required with respect to combustion air supply. Appliances $> 50 \text{ kW}$ must be installed in separate rooms which do not serve any other purposes, i.e. they must not be rooms for human

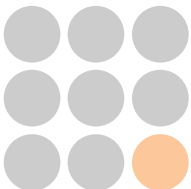
occupation. However, a boiler room is generally no longer required.

There is also far-reaching simplification for installation of type C appliances. In accordance with the state of appliance development in Europe, the simplified installation conditions without special ventilation measures are now permitted even for versions without air circulation in addition to the concentric design with combustion air circulation of all components carrying flue gas under pressure, provided that the above-mentioned increased tightness requirements of the flue gas carrying parts are met. In both cases (concentric combustion air circulated or increased tightness): this is expressed by the "x" in the appliance type marking scheme.

Another extension of current simplified requirements makes possible type C₃ gas appliances with integral air/flue ducts terminating above roof. In addition to the fan-assisted versions C_{3,2} and C_{3,3} (previously C_{3,2}), which may only be installed in the attic or in rooms directly beneath the attic, joint testing and approval of air/flue ducts and appliance is now possible even for duct lengths greater than 4 m according to the EC Gas Appliances Directive. This also applies to type C₅ appliances with

Table 1: installation room requirements (ventilation) for type B and C gas appliances

appliance type and size	pressure of flue gas carrying components relative to installation room	installation room requirements (ventilation)	section TRGI
type B $< 35 \text{ kW}$	negative pressure	combustion air compound system or opening to atmosphere ($1 \times 150 \text{ cm}^2$ or $2 \times 75 \text{ cm}^2$)	5.5.2
type B $> 35 \text{ kW}$ $< 50 \text{ kW}$	negative pressure positive pressure	opening to atmosphere ($1 \times 150 \text{ cm}^2$ or $2 \times 75 \text{ cm}^2$)	5.5.3
type B $> 50 \text{ kW}$	negative pressure positive pressure	separate room, opening to atmosphere ($150 \text{ cm}^2 + 2 \text{ cm}^2 / \text{kW}$ above 50 kW)	5.5.4
type B $< 35 \text{ kW}$	positive pressure	opening to atmosphere ($1 \times 150 \text{ cm}^2$ or $2 \times 75 \text{ cm}^2$) or special tightness	5.5.2.8
type C $< 50 \text{ kW}$	negative pressure	independent of room volume and ventilation	5.6.1
type C $< 50 \text{ kW}$	positive pressure	opening to atmosphere ($1 \times 150 \text{ cm}^2$ or $2 \times 75 \text{ cm}^2$)	5.6.1
type C _x $< 50 \text{ kW}$	positive pressure	independent of room volume and ventilation	5.6.1
type C/C _x $> 50 \text{ kW}$	negative pressure positive pressure	separate room, with ventilation facility	5.6.8



air/flue ducts terminating in areas of different pressures. While installation in the attic requires a protective tube made of non-flammable materials (which only has to prevent mechanical damage), and installation beneath the attic requires a protective tube with the same fire-resistance rating as that of the ceiling being penetrated, a ventilation shaft with a fire-resistance rating of F 90 (F 30 for lower buildings such as one or two-family houses) is required where several floors are passed. For type C₃ and C₅ appliances and the associated combustion air and flue ducts this results not only in a significantly simplified approval procedure and increased reliability of operation but also in installation and fitting requirements that can be more easily met. The fact that gas appliances and their connecting components/combustion air and flue ducts belong together and should be certified together is explicitly noted for type C₁, C₃, C₄, C₅ and C₈ appliances. For type C₆ appliances, involving the connection of air/flue ducts approved by the building inspectorate, reference is made to the manufacturer's installation instructions or the building inspectorate's approval of the air/flue systems to be connected.

Another major simplification is for flue system outlet levels above roof. The minimum distance of 40 cm between flue outlet and roof surface permitted in the past only for type C₃₂ and C₃₃ appliances up to 30 kW output is now explicitly extended to cover all room air independent type C appliances with fan up to 50 kW output. It therefore applies to types C₃₂, C₃₃, C₅₂, C₅₃, C₆₂ and C₆₃. This means a significant simplification and cost reduction for the installation and flue gas discharge of room air independent appliance types, which are increasingly becoming the standard appliance. As an alternative to the previously prescribed 40 cm exit level above ridge, a distance of 1 m between exit and roof surface is also required for all room air independent and room air dependent appliance types connected to chimneys or air/flue ducts (a practice already found in some Federal Laender).

There are also important simplifications in specifications for appliance type C₁₁ (balanced

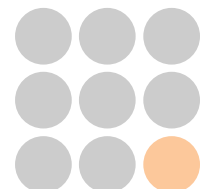
flue appliances without fan). A lateral and vertical distance of 2.5 m from one flue gas terminal to another and a lateral one to ventilation openings as well as a vertical distance of 5 m to ventilation openings is applicable to this appliance type, which is important for existing installations and modernisation of old buildings. The same applies to the distances to windows and opening facade doors. A special regulation expiring on 31 December 2004 was adopted specifically for balanced flue room heaters without fan. No lateral clearance is specified and a vertical distance of 0.3 m to opening windows is held sufficient if the NO_x concentration in the flue gas does not exceed 50 mg/kWh and the CO concentration does not exceed 100 mg/kWh. Reference is made to DIN 3364, Part 1 A2, Draft June 1994 (gas appliances, room heaters; terms, requirements, marking, testing; amendment 2) for further details. To prevent a concentration of flue gas terminals on one facade, the mean facade area per terminal must not be smaller than 16 m² and a maximum of four is specified for flue gas terminals arranged vertically.

Flue gas discharge requirements

In addition to the above-mentioned specific provisions for room air independent appliances of type C, the general requirements for the flue gas discharge of gas appliances have also been substantially revised.

This includes the following items:

- General demand for a flue system instead of a chimney as a standard approach.
- Use of an L 90 installation duct for flue systems, or L 30 in the case of lower buildings (one/two-family houses) for fire protection reasons.
- Option of combining multiple flue tubes in one duct if flue tubes made of non-flammable building materials are used and if appliances are installed in the same storey or otherwise permitted by the building inspectorate.





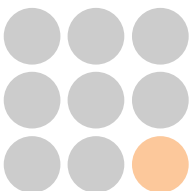
- Reduction of the previous requirements of tubes jacketing and ventilation of the installation room for flue tubes under pressure to one ventilation opening of at least 150 cm² or, alternatively, exceptional tightness of the flue duct.
- General reference to Land Ordinances on firing installations or DIN 4705 for design and construction.
- Specific reference to system certification, i.e. joint testing and certification of air and flue tubes if these form an integral part of the gas appliance according to the manufacturer's definition.

Under this general regulation flue sharing is now also possible for all appliances of type B (and even different types of appliances under certain conditions) provided that the shared flue system calculation allows this and fire propagation can be excluded. This also applies to flue gas discharge under pressure where return flow through appliances not in use is prevented by suitable measures. This means that sharing of flue systems not tested and approved jointly with the appliance (e.g. chimneys), which in general are firmly anchored in the building, is becoming much more flexible and is contingent solely on the mathematical verification of sound flue gas discharge. This will in future increase the importance of individual inspection or expert assessment of relevant designs by the district master chimney sweeper.

Typical and specific flue systems in Germany such as appliance types C₄ (for the connection to air/flue ducts) and C₈ (former type D_{3.2} for connection to shared flue systems) with their special features were also taken into consideration. For the former D appliances (D_{3.1} and D_{3.2}: room air dependent and room air independent fan-assisted gas appliances for connection to shared flue systems) reference is made to DVGW Work Sheet G 637/I in respect of shared flue calculation. Dimensioning of flue systems shared by different types of appliances will be regulated in Part II of DVGW Work Sheet G 637.

Editorial adaptations were also made regarding the regulation of flue system distance to components made of inflammable materials and windows. The following distance requirements now apply (Table 2):

- Connectors without a jacket for flue systems shared by gas appliances and solid fuel burning furnaces must be 40 cm from inflammable materials.
- The distance of matching pieces in flue systems shared by gas appliances and solid fuel burning furnaces to inflammable materials may be reduced to 10 cm if such matching pieces are covered by a non-inflammable 2 cm thick heat-insulating jacket.
- Flue ducts and matching pieces without jacket having surface temperatures > 160 °C must be 20 cm from inflammable materials.
- Flue ducts and matching pieces having surface temperatures > 160 °C and a non-inflammable 2 cm thick heat-insulating jacket, or having surface temperatures < 160 °C and no jacket, must have a distance of at least 5 cm.
- Flue systems of gas appliances without downdraught diverter having surface temperatures > 160 °C and leading through ceilings or walls made of inflammable materials must have a non-inflammable protective tube with a distance of 20 cm or a non-inflammable 2 cm thick heat-insulating jacket.
- Flue systems of gas appliances with downdraught diverter or with surface temperatures < 160 °C leading through ceilings or walls made of inflammable materials must have a non-inflammable protective tube with a distance of 5 cm or a non-inflammable 5 cm thick jacket.
- Combustion air circulated flue ducts from type C appliances with surface temperatures > 85 °C must have a non-inflammable protective tube with a distance of 5 cm

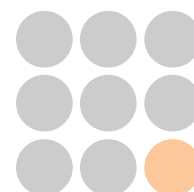


or a non-inflammable 5 cm thick jacket when passing ceilings or other components made of inflammable materials. These distances also apply to components made of or containing inflammable materials.

- Flue ducts, matching pieces or duct passages with surface temperatures shown to be < 85°C at nominal conditions are not subject to any special distance requirements.

Table 2: requirements of distance to inflammable building materials

type of flue system	distance requirement	section TRGI
matching piece for flue systems shared by solid fuel burning furnaces, without jacket	40 cm	6.5 para 2
matching piece for flue systems shared by solid fuel burning furnaces, with non-inflammable 2 cm thick jacket	10 cm	6.5 para 2
matching piece or flue duct with $T > 160^{\circ}\text{C}$ without jacket	20 cm	6.5 para 1
matching piece or flue duct with $T > 160^{\circ}\text{C}$, with non-inflammable 2 cm thick jacket or with $T < 160^{\circ}\text{C}$	5 cm	6.5 para 1
duct passage for appliance without draught diverter and $T < 160^{\circ}\text{C}$	20 cm in non-inflammable protective tube or with non-inflammable 20 cm thick jacket	6.5 para 3
duct passage for appliance with draught diverter (B1) or with $T < 160^{\circ}\text{C}$	5 cm in non-inflammable protective tube or with non-inflammable 5 cm thick jacket	6.5 para 3
flue duct on buildings, distance to windows	20 cm	6.5 para 4
flue duct distance or passage, circulated by combustion air with $T > 85^{\circ}\text{C}$	5 cm in non-inflammable protective tube or with non-inflammable 5 cm thick jacket	5.6.3
flue duct, matching piece or passage with T shown to be < 85°C	no distances required	5.6.3 and 6.5 para 5



- Flue ducts on buildings must be at least 20 cm from windows.

Clearance requirements significantly lower than those usually applicable in the past now exist for most modern gas appliances with flue gas temperatures $< 160\text{ °C}$ or $< 85\text{ °C}$. This enables flue ducts to be installed in attics or on facades under simplified conditions. Since most of the condensing appliances do not exceed flue gas temperatures of 80 °C , the fact that any distance requirements have been omitted for this temperature range is particularly helpful in practice.

European gas appliance type classification scheme

Abbreviations used to designate appliances which have already appeared in the preceding text and have not been usual for us in the past, such as designs designated C_5 or C_8 . These abbreviations represent a new denomination system based on a European harmonisation document. Within the European standardisation organisation, CEN a classification scheme has been developed for gas appliance types with respect to their air/flue ducting which serves as a basis for the individual standardisation committees that are required to use these designations in drawing up the various appliance-specific standards. This scheme continues to follow the coarse classification usual in our country in the past in type A appliances (appliances without flue gas discharge), type B (room air dependent appliances with flue gas discharge) and type C (room air independent appliances with flue gas

discharge). A suffixed two-digit code indicates how the flue gas is discharged and the combustion air is supplied or how specific air/flue systems are connected. The first digit stands for the design of the air/flue system while the second digit indicates the existence and the location of a fan. Number 1 means an appliance design without fan, number 2 the location of a fan in the flue, and number 3 the location of a fan on the combustion air side. Within type B_1 appliances there is a special variant, i.e. type B_{14} , where a fan is located downstream of the downdraught diverter. In Germany a special feature with type C appliances is to suffix the lower case "x" to the appliance code if the components of the appliance and the flue system under pressure are completely circulated by combustion air or increased tightness of the flue system is ensured. This results in a logically designed structured denomination scheme which classifies the various types of appliance with respect to combustion air supply and flue gas discharge and thus serves as a reference to the various nationally different installation requirements. The most important basic types of appliance are explained in the following by means of typical applications which reflect the optional variants permitted in Germany. It should be noted that the schematic diagrams shown do not always reproduce all optional and permissible features. They should be understood as examples reflecting the flexibility and versatility of the European classification scheme. A synoptic table (3) classifies and explains the various types of appliance according to their importance. The former national names and the German installation requirements of the individual types have also been included where possible.

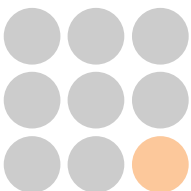
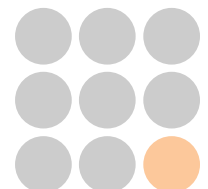


Table 3: European gas appliance type classification scheme including air supply and flue gas discharge according to CEN CR-17.4.9

gas appliance type		flue system	combustion air supply	down-draught diverter	type of air supply and flue gas discharge	fan location		combustion air circulation or increased tightness ¹⁾ yes = x	CO ₂ -stop = AS FGS ²⁾ = BS	former national designation	national installation requirements according to DVGW Codes of Practice								
a ₁	a ₂	b	c	d	e	f		g	h	i	j								
A	A ₁	no			flue gas discharge and combustion air supply via installation room	1	without		AS	A	cf. TRGI '86/96, para 5.4: gas appliances with "AS" additional marking (CO ₂ stop device) do not meet the installation requirements for Germany								
	2					downstream of bum./h.e.		AS											
	3					upstream of burner													
B	B ₁₁	dependent	room air	1	yes	connection to flue system, shared flue system (negative pressure), combustion air supply via installation room	1	without		BS	B with burner without fan	cf. TRGI '86 / 96							
	B ₁₂						2	downstream of h. e.					BS	at present not covered by German installation rules					
	B ₁₃						3	upstream of burner					BS		possible with "fan-assisted burner" like B ₁₁				
	B ₁₄						4	downstream of ddr. div.							not specifically covered by German installation rules (ggf. G 626, G 660)				
	B ₂₁						1	without	connection to flue system, shared flue system (negative / positive pressure), combustion air supply via installation room				1				at present not covered by German installation rules		
	B ₂₂												2	downstream of h. e.		B	cf. TRGI '86 / 96,		
	B ₂₃												3	upstream of burner		B with burner with fan	special ventilation conditions with flue outlet under pressure		
	B ₃₂						3	2	downstream of h. e.				connection to flue system, shared flue system (negative pressure), combustion air supply in external tube via installation room	2	circulated		D _{3,1}	cf. G 637 / 1 and TRGI '86 / 96	
	B ₃₃													3	upstream of burner		D _{3,1}		
	C						C ₁₁	yes	room air independent					no	air supply and flue gas discharge through external wall in an area of equal pressure	1	without		
C ₁₂		2	downstream of h. e.	X	C _{3,3}	cf. TRGI '86 / 96													
C ₁₃		3	upstream of burner	X	C _{3,3}														
C ₂₁		2	1	without	connection to AFS ³⁾ , (single flue), shared flue system	1					C ₂	only existing appliances according to G 627							
C ₂₂						2	downstream of h. e.			X		not permitted under building regulations							
C ₂₃						3	upstream of burner			X									
C ₃₁		3	1	without	air supply and flue gas discharge above roof in an area of equal pressure	1						at present not covered by German installation rules							
C ₃₂						2	downstream of h. e.			X	C _{3,2}	cf. TRGI '86 / 96							
C ₃₃						3	upstream of burner			X	C _{3,2}								
C ₄₁		4	1	without	connection to AFS, (twin flue), shared flue system	1						at present not covered by German installation rules							
C ₄₂						2	downstream of h. e.			X	C _{3,1}	cf. TRGI '86 / 96							
C ₄₃						3	upstream of burner			X	C _{3,1}								
C ₅₁		5	1	without	air supply and flue gas discharge from / to atmosphere in areas of different pressure	1						at present not covered by German installation rules							
C ₅₂						2	downstream of h. e.			X		only in combination with a jointly approved flue system							
C ₅₃						3	upstream of burner			X									
C ₆₁		6	1	without	air / flue connection to separately tested and supplied air / flue tubes	1						at present not covered by German installation rules							
C ₆₂						2	downstream of h. e.			X		only possible with clearly defined interface and e.g. flue system approved by the building inspectorate							
C ₆₃						3	upstream of burner			X									
C ₇₁		7	yes (in the attic)	1	without	flue gas discharge above roof, combustion air supply via attic	1									at present not covered by German installation rules			
C ₇₂							2			downstream of h. e.	X								
C ₇₃	3						upstream of burner	X											
C ₈₂		no			connection to flue system, shared flue system, combustion air supply through separate air duct	2	downstream of h. e.	X	D _{3,2}	cf. G 637 / 1 and TRGI '86 / 96									
						3	upstream of burner	X	D _{3,2}										

1) appliances without "x" require special installation room ventilation
 2) FGS = flue gas sensor
 3) AFS = combined air flue system



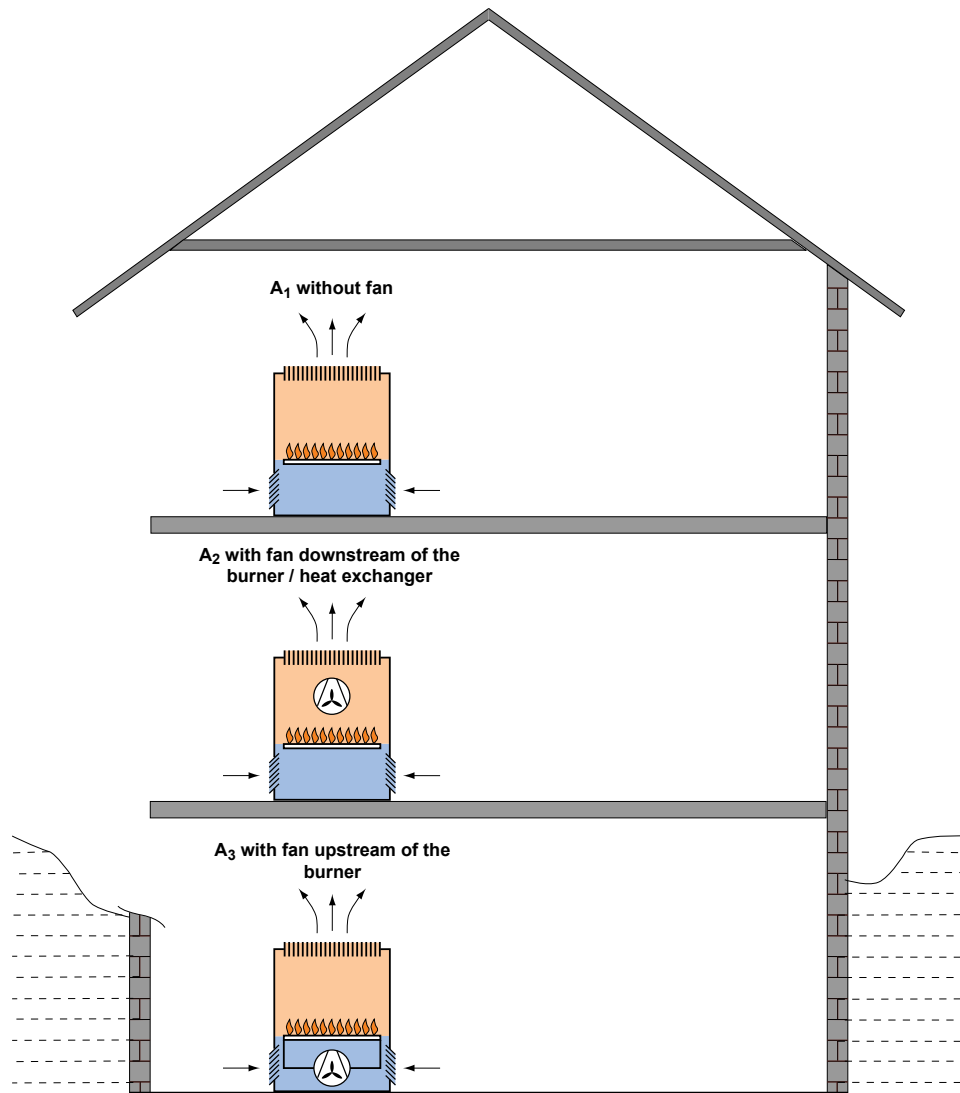
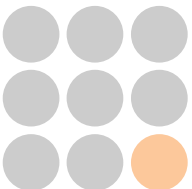


Figure 1: Type A: gas appliance without flue system. The combustion air is withdrawn from the installation room (e.g. gas cooker, stool cooker, laboratory burner, built-in baking oven)

Type A appliances are only classified into the three fan-specific variants A₁, A₂ and A₃ (Figure 1). These gas appliances have no flue gas discharge and include gas cookers, stool cookers, laboratory burners, baking ovens etc.

The installation of this appliance type is subject to very different regulations in the individual European countries and requires that mainly the various ventilation conditions with respect to flue gas dilution and combustion air supply are observed.



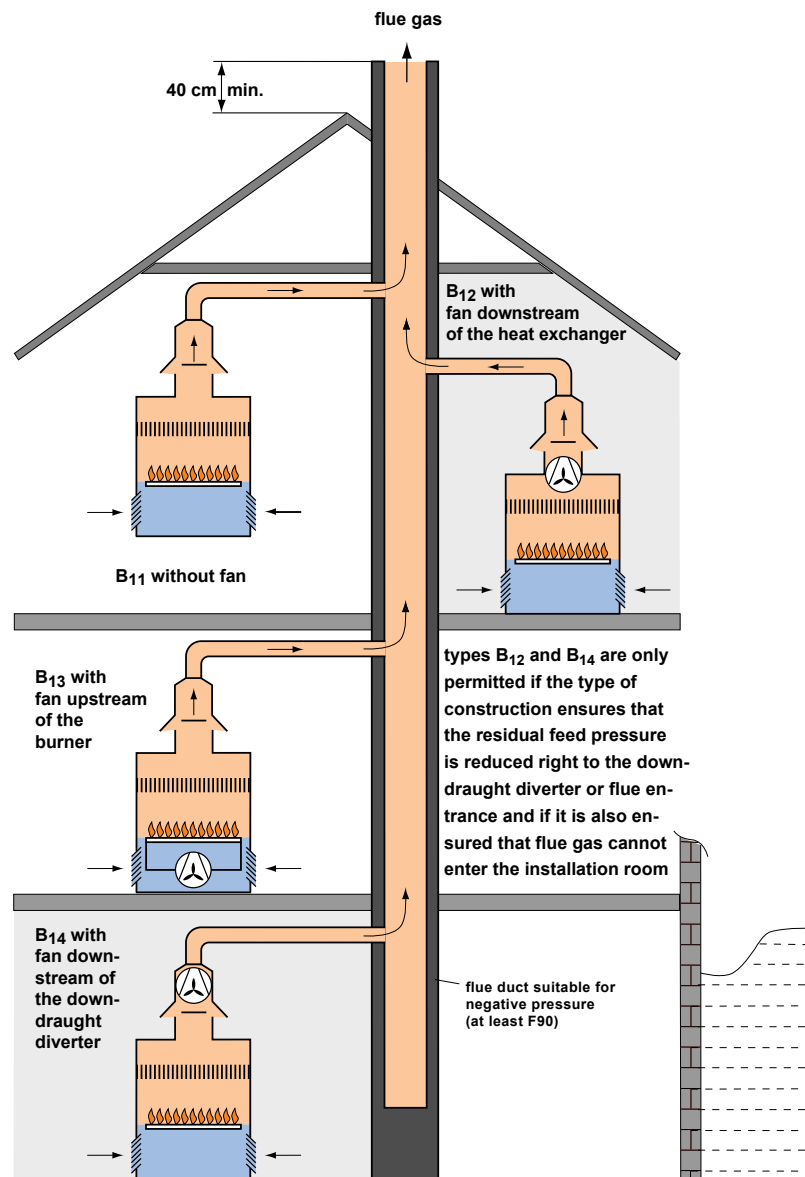
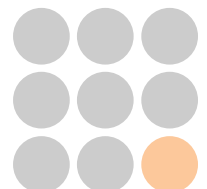


Figure 2: Type B: gas appliance with flue system withdrawing the combustion air from the installation room (room air dependent gas appliance)

Type B₁: Gas appliance with down-draught diverter
– Additional marking "BS" for flue gas sensor –

The type B₁ is defined as an open appliance with a draft diverter to be connected to a multi-connection natural draft chimney (Figure 2). In addition to appliances B₁₁, B₁₂ and B₁₃ there is the special variant B₁₄ with fan downstream of the down-draught diverter. For installation in Germany it must be observed that B₁₂ and B₁₄

designs on a shared chimney are only permitted if the type of construction ensures that the residual feed pressure is reduced right to the down-draught diverter (B₁₂) or flue entrance and if it is also ensured that flue gas cannot enter the installation room.



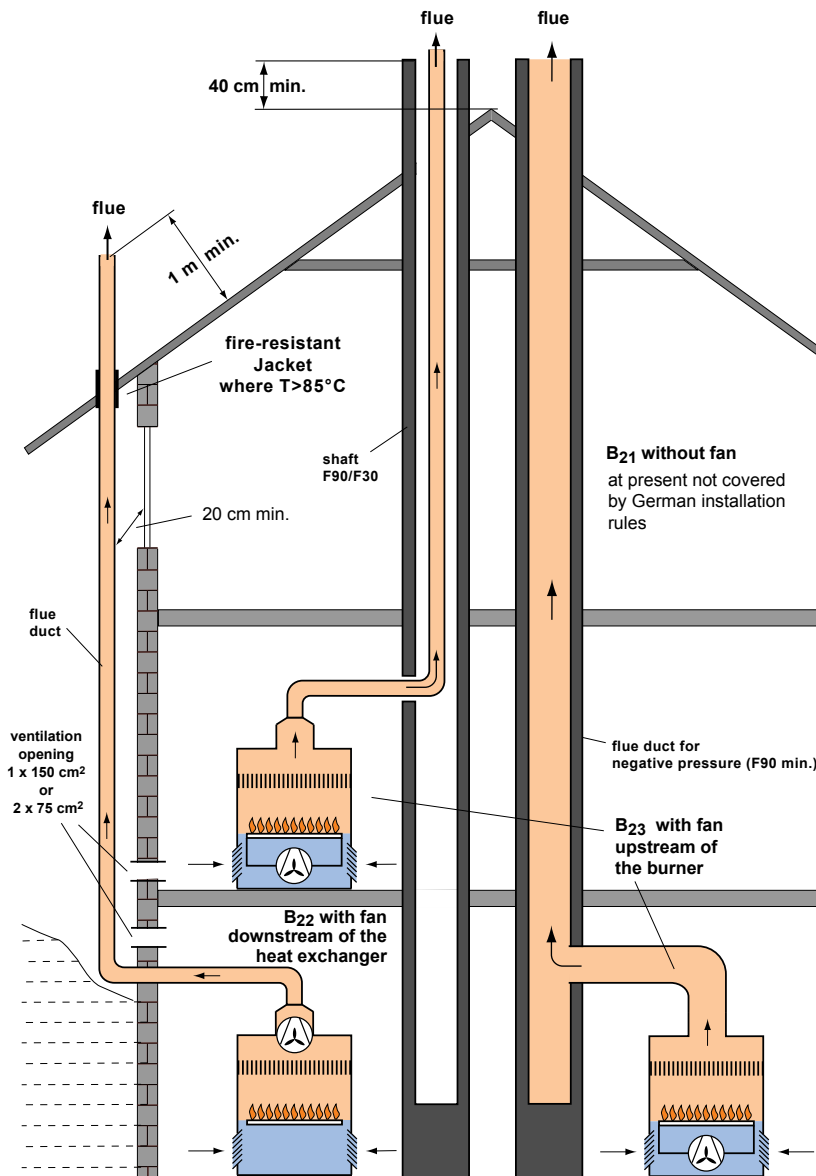
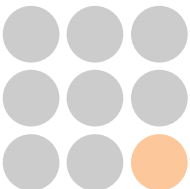


Figure 3: Type B₂: gas appliance with flue system withdrawing the combustion air from the installation room (room air dependent gas appliance)
Type B₂: gas appliance without downdraught diverter

Type B₂ gas appliances will be a very important group in the future since they represent a major part of the condensing appliances (Figure 3). This type comprises room air dependent gas appliances without downdraught diverter designed for connection to chimney, but mainly for operation with their own flue ducts. Type B₂₁ appliances are ruled out for practical considerations since operation without fan and without downdraught diverter on a flue system would result in problems of combustion stability. This approach is also in-

teresting as the flue gas can be discharged both at negative and positive pressure (see left and right parts of figure). This is not, however, reflected by the designation key. In this example, the above-mentioned distance requirements of 40 cm above ridge or 1 m from the roof area apply for ducts ending above roof. The relevant provisions for combustion air supply or installation room ventilation must also be observed (also applicable to type B₁ appliances).



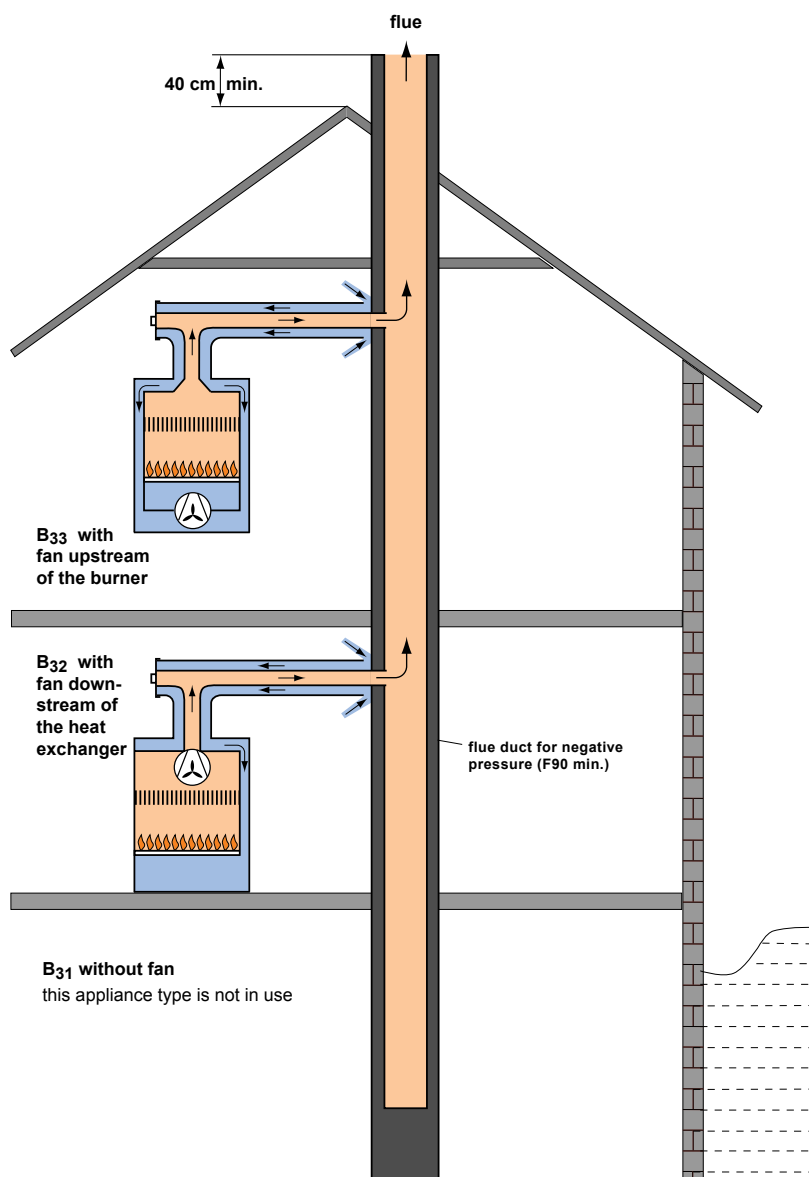
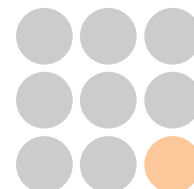


Figure 4: Type B: gas appliance with flue system withdrawing the combustion air from the installation room (room air dependent gas appliance)

Type B₃: gas appliance without downdraught diverter, where all components of the flue system under pressure are circulated by combustion air

Appliance type B₃, formally called D_{3,1} so far, is a design brought into the European classification scheme by Germany alone (Figure 4). There are only the two fan-assisted types B₃₂ and B₃₃ (type B₃₁ without fan is not in use). With this type of appliance the flue gas is discharged mechanically before entering a shared chimney, all components of the appliance and its matching piece carrying flue gas under pressure being circulated by com-

bustion air (analogously to version "x" of type C appliances). This allows installation of the appliance in rooms for human occupation without ventilation. Combustion air supply using a compound system is possible even under difficult conditions thanks to fan assistance. The installation requirements for combustion air supply are specified in TRGI Section 5.5 and for chimney sharing and design in DVGW Work Sheet G 637/I.



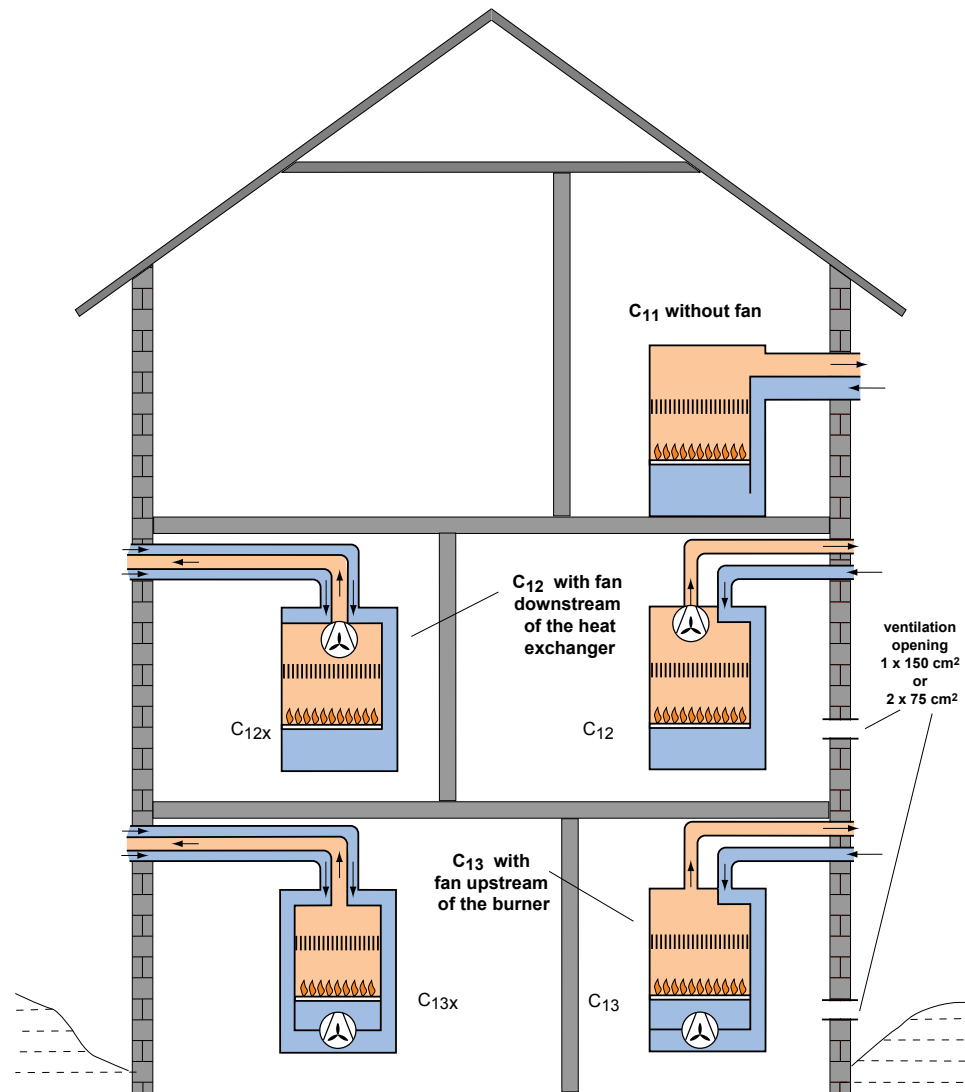
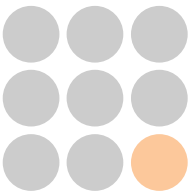


Figure 5: Type C: gas appliance with flue system withdrawing the combustion air from the atmosphere through a closed system (room sealed gas appliance)

Type C_i: gas appliance with horizontal combustion air supply and flue gas discharge through the exterior wall. They terminate close to each other in an area of equal pressure.

Type C appliances show the greatest variety within the individual types of appliance and also the most flexible installation and configuration options. The so-called exterior wall approach (Figure 5) is the first and oldest variant of this type, which is still widespread throughout the other European countries. Combustion air and flue connections are fitted with short tube lengths running either in parallel or concentrically through the exterior wall to the atmosphere. Appropriate ventilation (150 cm² opening) must be provided unless the components

of the flue system under pressure are circulated by combustion air or meet higher tightness requirements ("x" design). Appliance type C₁₁ now is only of practical importance for gas-fired room heaters in Germany. In our country, the exterior wall approach is subject to strong restrictions by the building inspectorate for environmental protection reasons. Nevertheless, in exceptional cases this type of appliance is permissible under the marginal provisions of TRGI Section 5.6.4.



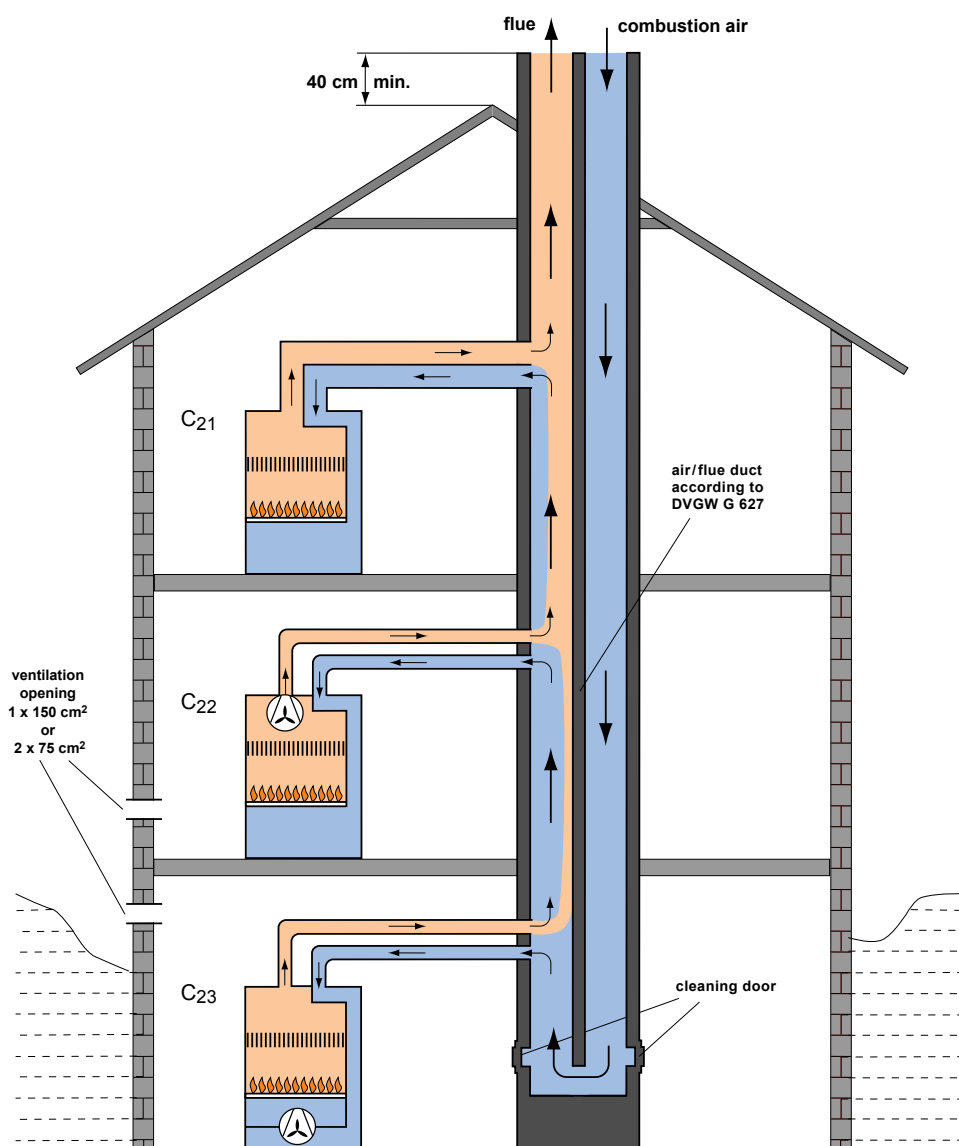
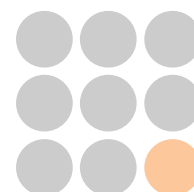


Figure 6: Type C₁: gas appliance with flue system withdrawing the combustion air from the atmosphere through a closed system (room sealed gas appliance)
 Type C₂: gas appliance with combustion air supply and flue gas discharge for connection to a common air and flue duct; this gas appliance is not permissible under building regulations in Germany.
 Only type C₂₁ gas appliances already installed are permissible in Germany under DVGW Work Sheet G 627 (protection of existing installations).

Type C₂ gas appliances, which can still be found in other countries and in the new Federal Laender, represent an installation approach (Figure 6) where the appliances are connected to a so-called "two-legged air/flue duct" or "U-duct". Fresh combustion air is led via the first duct to the base of the second duct from which the appliance both withdraws its combustion air and discharges its flue gas. The

combustion air available to the appliances at higher levels is in this way enriched with flue gas. However, modern gas burners fail to operate stably when the CO₂ content in the combustion air varies widely, so that this approach has long since lost its importance. It is only permissible in Germany to protect existing installations under DVGW Work Sheet G 627.



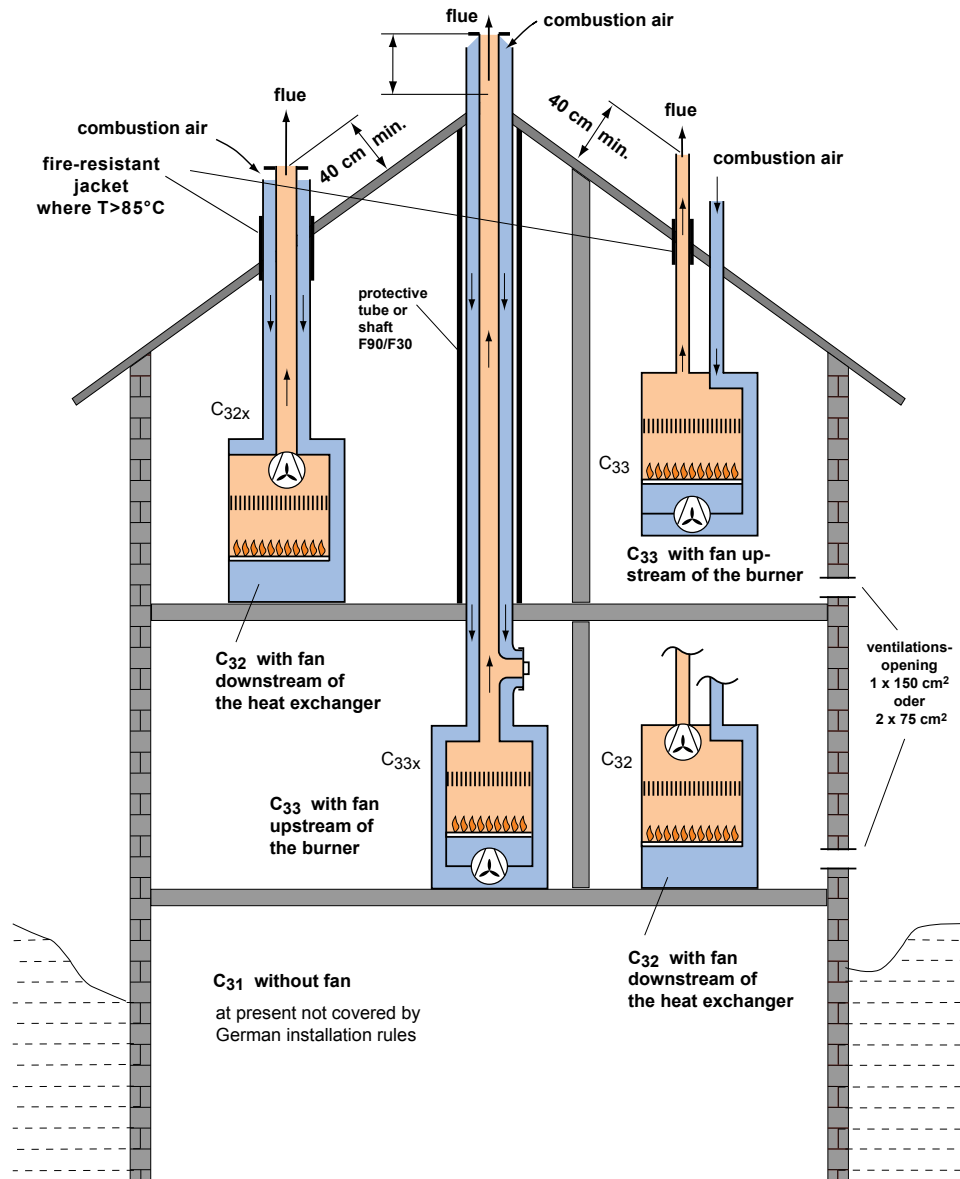
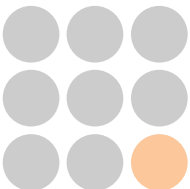


Figure 7: Type C₃: gas appliance with flue system withdrawing the combustion air from the atmosphere through a closed system (room sealed gas appliance)

Type C₃: gas appliance with combustion air supply and flue gas discharge system extending vertically above roof. They terminate close to each other in an area of equal pressure.

Type C₃ appliances (Figure 7) represent an installation variant which is now becoming almost a standard solution, mainly in low-cost new one or two-family houses and in many modernization projects. The special feature of this type is that combustion air supply and flue gas discharge are above roof by means of air/flue tubes which are tested and approved together with the appliance. In contrast to the previous C₃ ap-

proach which also involved flue gas discharge above roof, duct lengths of more than 4 m are also permitted. This however requires the use of a duct or protective tube depending on the type of floor passed. The above details on the ventilation of rooms where appliances without an additional "x" mark are installed and the minimum distance of 40 cm between duct end and roof surface or ridge apply accordingly.



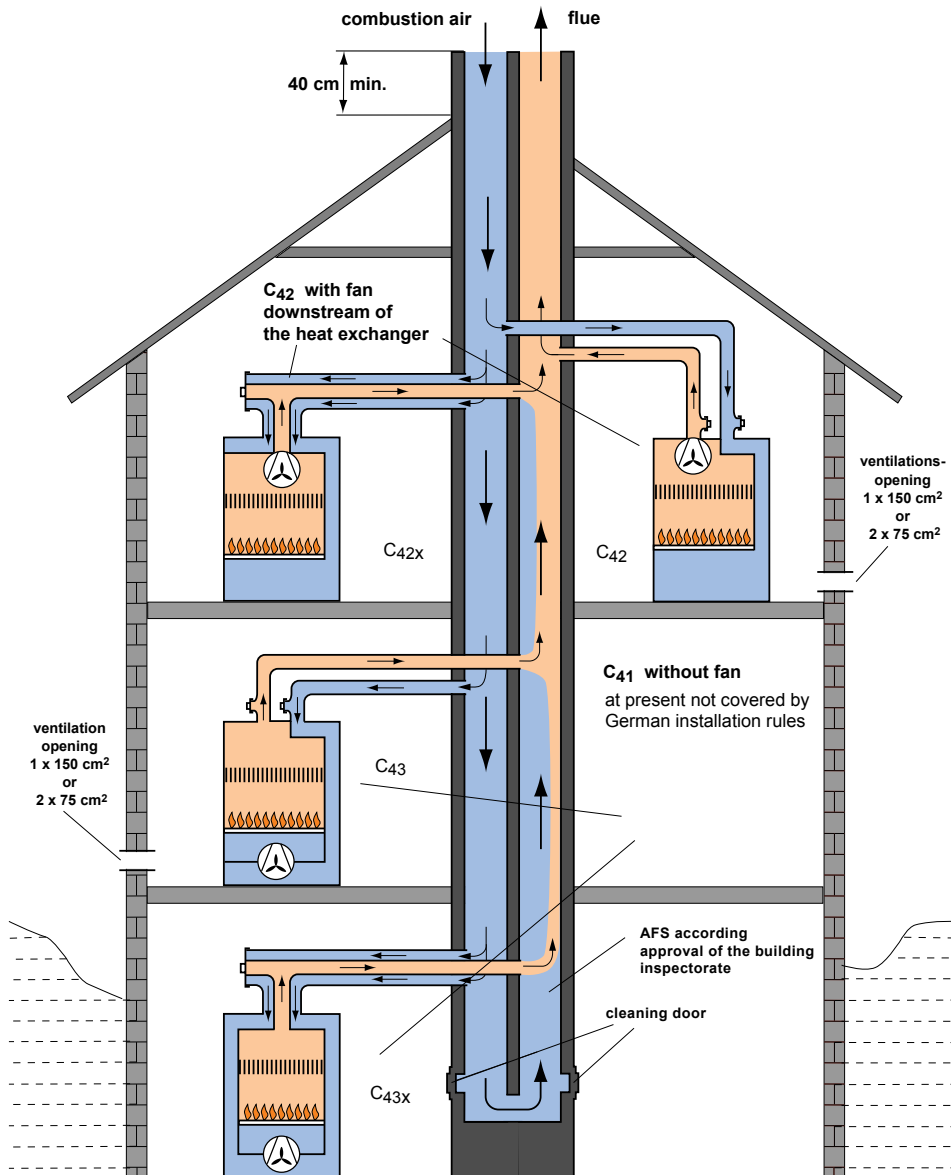
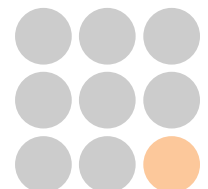


Figure 8: Type C: gas appliance with flue system withdrawing the combustion air from the atmosphere through a closed system (room sealed gas appliance)
 Type C₄: gas appliance with combustion air supply and flue gas discharge designed for connection to an air/flue system (AFS)

Another installation configuration increasingly found in our country uses type C₄ appliances for connection to air/flue ducts (Figure 8). Special air/flue tubes for connection to air/flue systems (AFS) are supplied with the appliance. In contrast to the two-legged air/flue duct in the case of type C₂ appliances, separate ducts are used here for combustion air supply and flue gas discharge, ensuring that every appliance is supplied with fresh combustion air. Air/flue systems of this type are on the market with both parallel and concentric duct configura-

tions. Appliances with either concentric or parallel air/flue system can be connected to both configurations. Some of the air/flue systems permit connection of more than 10 appliances over several floors, thus offering an outstanding option of installing room sealed appliances in multiple dwelling units. Appliances with the suffix "x" are used for preference in our country because of the less severe installation requirements in rooms for human occupation. Details on installation requirements are given in TRGI Sections 5.6 and 6.



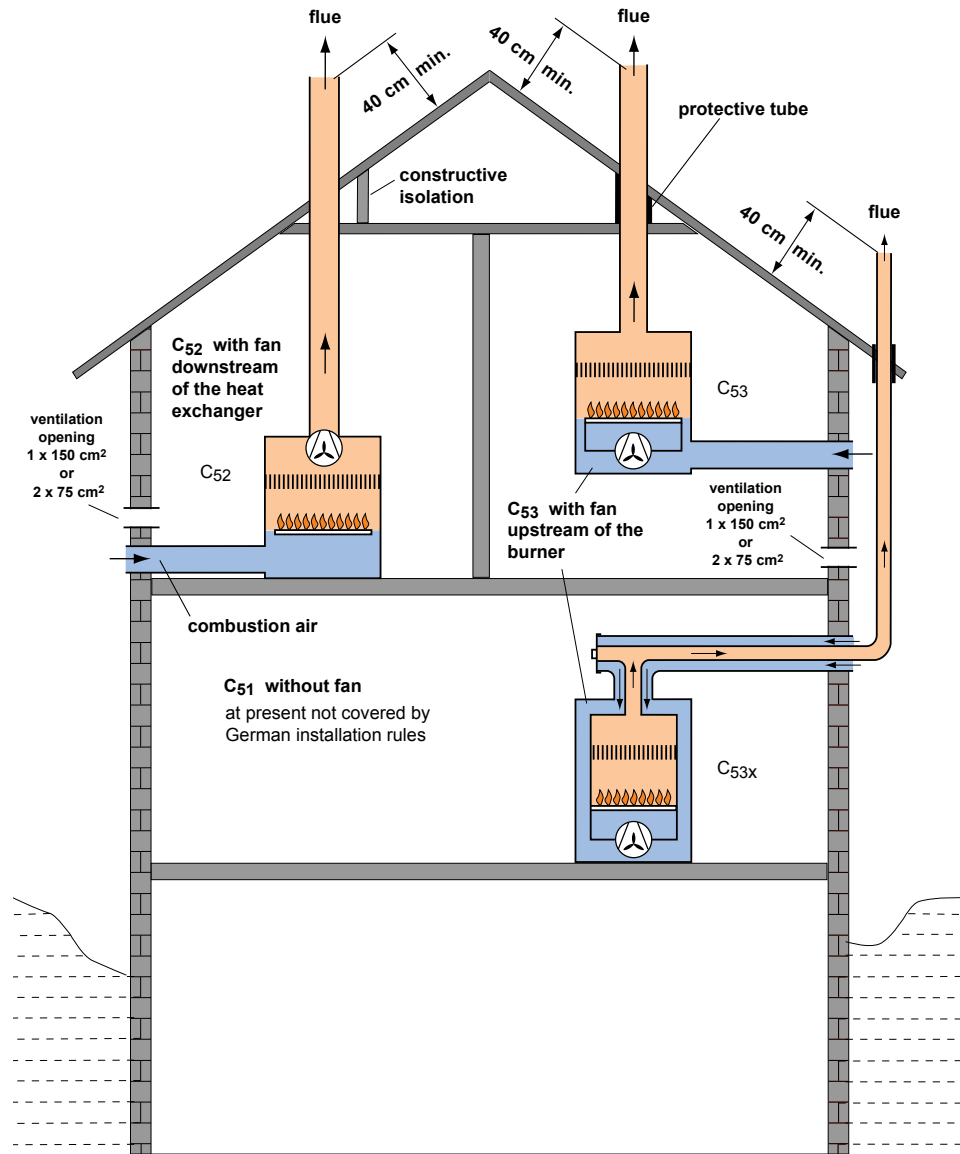
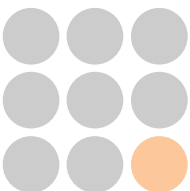


Figure 9: Type C₅: gas appliance with flue system withdrawing the combustion air from the atmosphere through a closed system (room sealed gas appliance)

Type C₅: gas appliance with separate combustion air supply and flue gas discharge systems; these terminate in areas of different pressure.

In contrast to type C₃ appliances, the combustion air of C₅, which also features a flue duct terminating above roof as an integral part of the appliance, is supplied from an area of different pressure, e.g. through a combustion air duct terminating at the exterior wall (Figure 9). Because of the greater effect of pressure differences due to wind between air duct and flue ends, such appliances must

have high combustion system stability against external pressure effects on the combustion air or flue gas side. This can be achieved for instance by a fan with steep characteristic or pneumatic gas/air compound control. Of the type C₅ appliances the C₅₁ design without fan is not practicable and is therefore not covered by German installation rules.



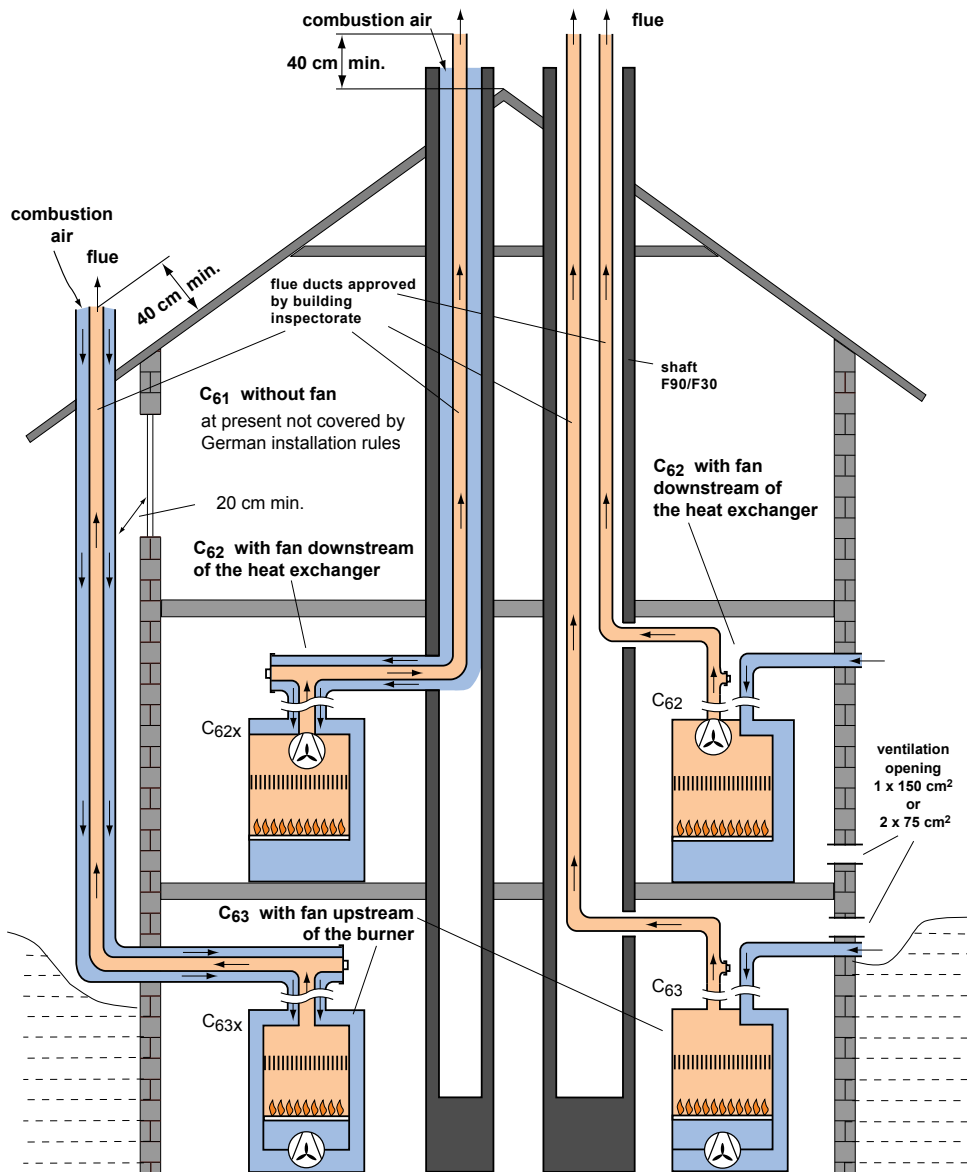
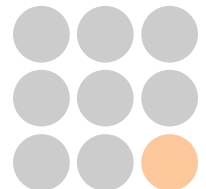


Figure 10: Type C: gas appliance with flue system withdrawing the combustion air from the atmosphere through a closed system (room sealed gas appliance).

Type C_6 : gas appliance designed for connection to a combustion air supply and flue gas discharge not tested together with the appliance

In contrast to all other variants of type C appliances, type C_6 appliances are tested, approved and delivered without combustion air and flue ducts (Figure 10). However, the installation options for separately approved flue systems are virtually unlimited. Virtually all condensing appliances fall in this category which have not been approved with their own air/flue ducts and are operated with separate

flue systems (usually approved by the German building inspectorate). Such flue systems can be installed both along exterior walls and inside ducts. Versions with air-cooled flue duct or higher tightness as well as with separate air and flue ducts also exist within this appliance type. A design without fan (C_{61}) is not practicable and is therefore not covered by German installation rules.



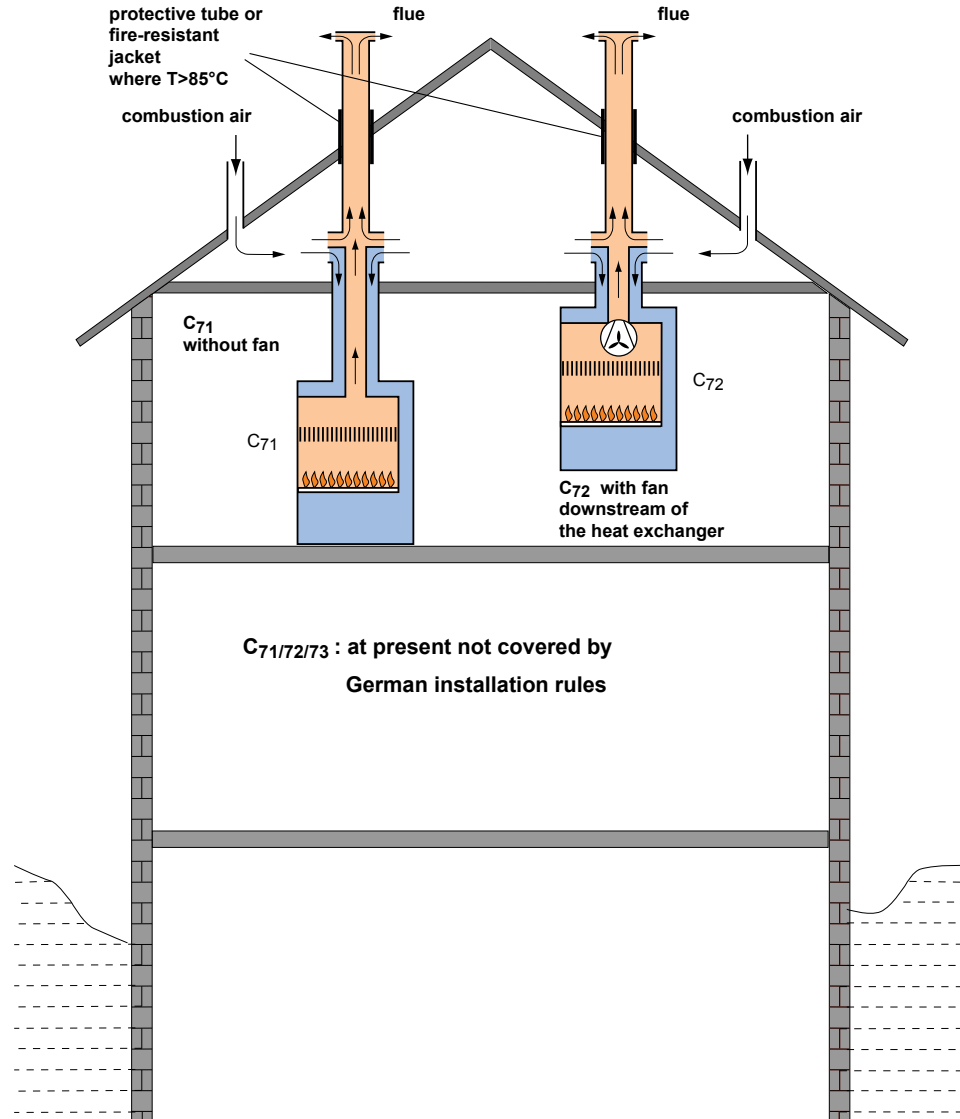
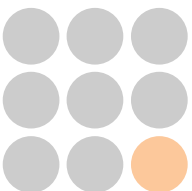


Figure 11: Type C: gas appliance with flue system withdrawing the combustion air from the atmosphere through a closed system (room sealed gas appliance)

Type C₇: gas appliance with vertical combustion air supply and flue gas discharge system; the combustion air is drawn from the loft and the flue gases discharged above the roof; a downdraught diverter is located in the loft.

Type C₇ appliances are a special solution only common in England, where the flue gases are discharged above the roof and the combustion air is supplied through a special downdraught diverter located in the loft (Figure 11). Although operation of the appliance in the installation room is independent of the room air, the combustion air is not directly supplied from

the atmosphere but through ventilation of the loft. Such appliances are at present not covered by German installation rules since they are not yet on the German market. Installation of such appliances in our country would currently require special approval by the building inspectorate.



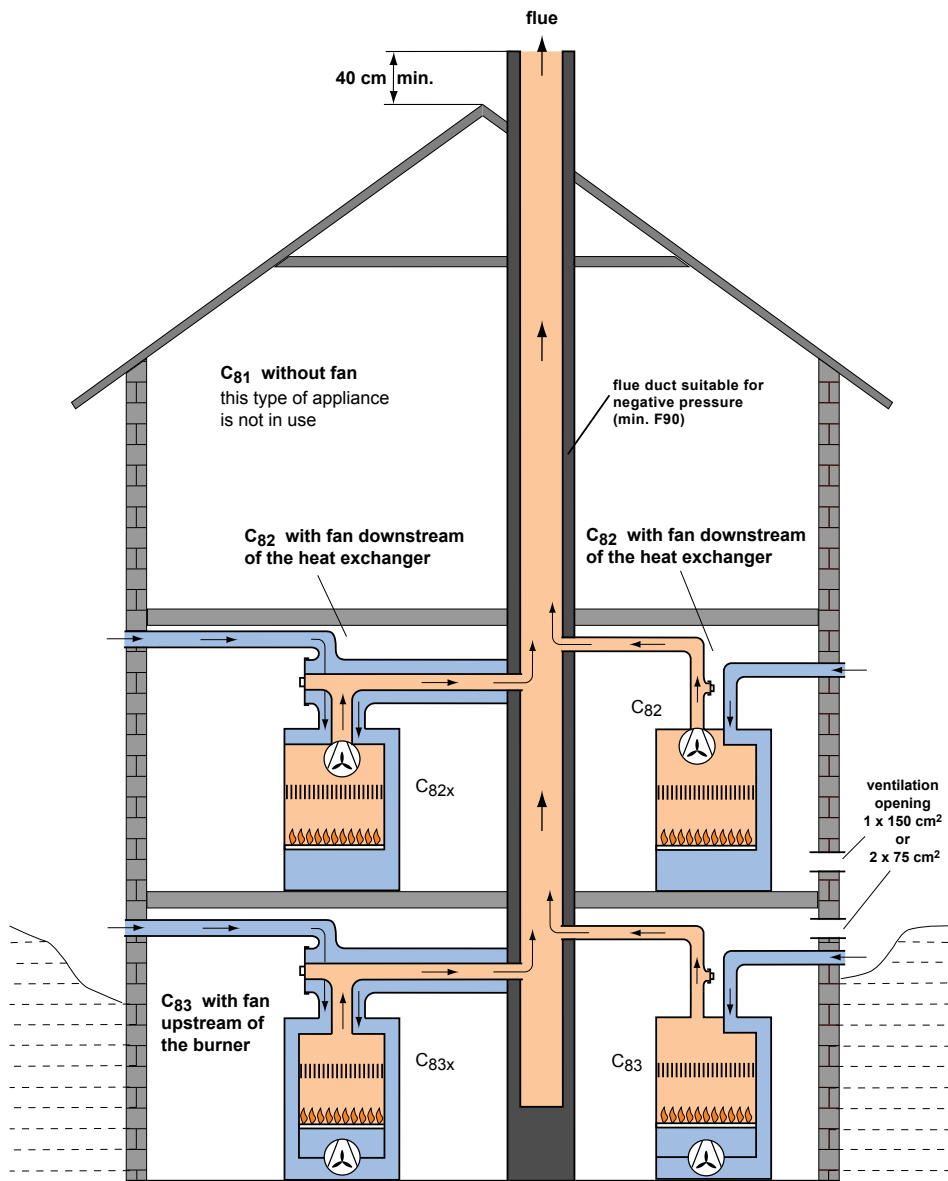
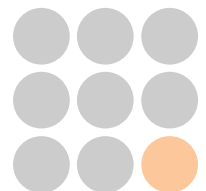


Figure 12: Type C: gas appliance with flue system withdrawing the combustion air from the atmosphere through a closed system (room sealed gas appliance)
 Type C₈: gas appliance with connection to a shared flue system (negative pressure operation) and separate combustion air supply from the atmosphere

Another German speciality is appliance type C₈ which is identical with the former D_{3,2} design (Figure 12). Like with type B₃ appliances, its special feature is the mechanical combustion air supply and flue gas discharge using a fan and the flue gas discharge through a shared chimney. The mechanical discharge pressure is completely released before entering the flue so that the flue gas is exclusively discharged using negative pressure. In con-

trast to type B₃ appliances, the combustion air is supplied from the atmosphere (independent of room air), usually through a combustion air duct from the exterior wall. This solution also represents an interesting approach in the modernization of old buildings since appliance design "x" allows installation in dwellings. A design without fan is impracticable with this type of appliance and has therefore been omitted from the classification scheme.





This completes the description of the most important installation variants of the individual types of appliance. A multitude of different solutions meeting virtually all conceivable installation requirements are possible by combining the various types of appliance, installation options and combustion air and flue duct configurations. Thanks to the great variety of appliances offered on an European level and to the ever growing practice of system certifi-

on comprising appliances and their air/flue components supplied by the same manufacturer, new appliance solutions are now available to designers and tradesmen, many of which were not previously possible. The ever increasing range of appliances on sale in the European Single Market will also result in price reductions making such solutions increasingly attractive.

