

Radial displacement outlet VA-PV....

Radial displacement outlet

Preliminary remarks and construction design

Preliminary remarks

The function of displacement outlets is to remove pollutants from production and work areas with minimal mixing with indoor air. Depending on the kind of pollutants and the specific room heat load, these outlets are placed either above the occupied zone or on the floor.

Basically, in production facilities the supply air must be discharged as close to the occupied zone as possible to keep the load factors for pollution and heat low. This is not always feasible for constructional or production-related reasons. Yet, in order to achieve an optimal displacement flow in the occupied zone in such cases, KRANTZ KOMPONENTEN has developed the radial displacement outlet. It is ideal where supply air is to be discharged at low turbulence from a height of 4 – 8 m above the occupied zone.

The jet spread and hence the penetration depth as well can be adjusted to the temperature difference between supply air and indoor air. This ensures a constantly optimal indoor air flow despite varying internal heat loads.

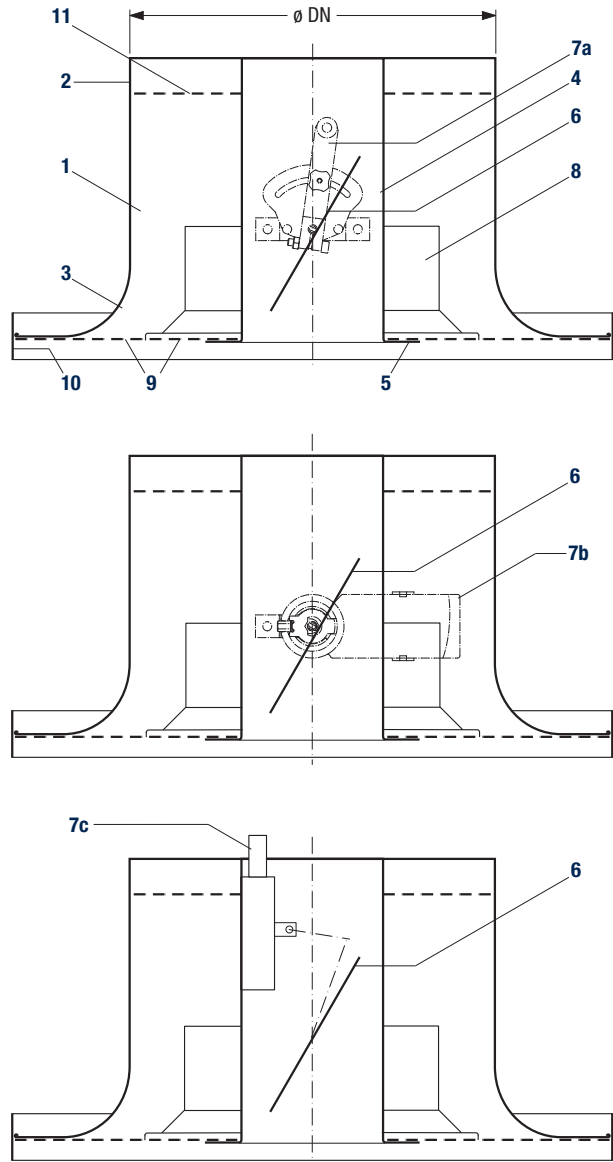
Construction design

The radial displacement outlet consists of the outer cylinder **1** with straight intake **2** and rounded exit **3**, and the core tube **4** with collar **5** in its lower section. The volume flow rate passing through the core tube **4** can be regulated by the oval adjustable damper **6**. This damper can be adjusted via a manual adjusting device **7a**, an electric actuator **7b**, or a self-acting thermostatic control unit **7c**. The air dispersion element **8** disperses the jet as required. The air discharge surface **9** is a perforated metal sheet through which the supply air flows at low turbulence. The spread, i.e. the diameter of the supply air jet, is codetermined by the outer ring **10**.

Sizes DN 630 and DN 710 are additionally fitted with a perforated baffle **11** which evens out the air volume flow rate in the intake cross section.

The radial displacement outlet can be connected directly to a circular duct to EN 1506 or via a connection box. Using a spigot, the radial displacement outlet can also be built onto the bottom of a rectangular duct (see Page 5 for details).

All cylindrical and circular outlet parts are made of aluminium; the perforated metal sheet and baffle and the connection box are made of galvanized sheet metal.



Nominal diameter	Volume flow rate				Discharge height H m	Min. outlet spacing m
	\dot{V}_{min}		\dot{V}_{max}			
DN	l/s	m ³ /h	l/s	m ³ /h		
315	280	1 000	555	2 000	4 – 7	3.0
400	415	1 500	835	3 000	5 – 7	3.5
500	640	2 300	1 250	4 500	6 – 8	4.5
630	890	3 200	1 800	6 500	6 – 8	4.5
710	1 100	4 000	2 220	8 000	6 – 8	5.0
Max. temperature difference $\Delta\vartheta$ supply air to indoor air					-6 K in cooling mode +8 K in heating mode	

Fig. 1: Outlet construction, sizes and specifications

- 1 Outer cylinder
- 2 Straight intake
- 3 Rounded exit
- 4 Core tube
- 5 Collar
- 6 Adjustable damper
- 7a Manual adjusting device
- 7b Electric actuator
- 7c Thermostatic control unit
- 8 Air dispersion element
- 9 Air discharge surface
- 10 Outer ring
- 11 Perforated baffle (for DN 630 and DN 710)

Radial displacement outlet

Mode of operation

Mode of operation

The supply air always flows vertically downwards. The spread, i.e. the diameter of the air jet, alters in response to the temperature difference between supply air and indoor air. To ensure an adequate penetration depth in heating mode, the core tube is opened. A support jet forms and flows vertically downwards at a higher momentum, thus inducing the remaining supply air and increasing the penetration depth. The larger the temperature difference between supply and indoor air in heating mode, the higher the percentage of the support jet should be. The open position of the adjustable damper is especially suitable for the heating-up process. The jet patterns in cooling and heating modes are sketched in Figure 2; they correspond to those photographed in Figure 6.

The diameter of the supply air jet depends on air volume flow rate, temperature difference between supply air and indoor air, and position of adjustable damper. It is specified in Table 1 for each size in relation to the minimum and maximum outlet volume flow rates.

Nominal diameter DN	Air outlet volume flow rate \dot{V}_A		Jet diameter D in m for temperature difference $\Delta\vartheta$		
	l/s	m ³ /h	Cooling		Heating
			-6 K	-2 K	+4 K
315	280	1 000	1.5	2.5	1.0
	555	2 000	2.5	3.0	1.3
400	415	1 500	2.0	3.0	1.2
	835	3 000	3.0	3.5	1.3
500	640	2 300	2.5	3.5	1.3
	1 250	4 500	4.0	4.5	1.4
630	890	3 200	2.8	3.5	1.3
	1 800	6 500	4.5	4.5	1.3
710	1 100	4 000	3.2	4.0	1.3
	2 220	8 000	4.5	5.0	1.5

Table 1: Rough diameter D of supply air jets in m

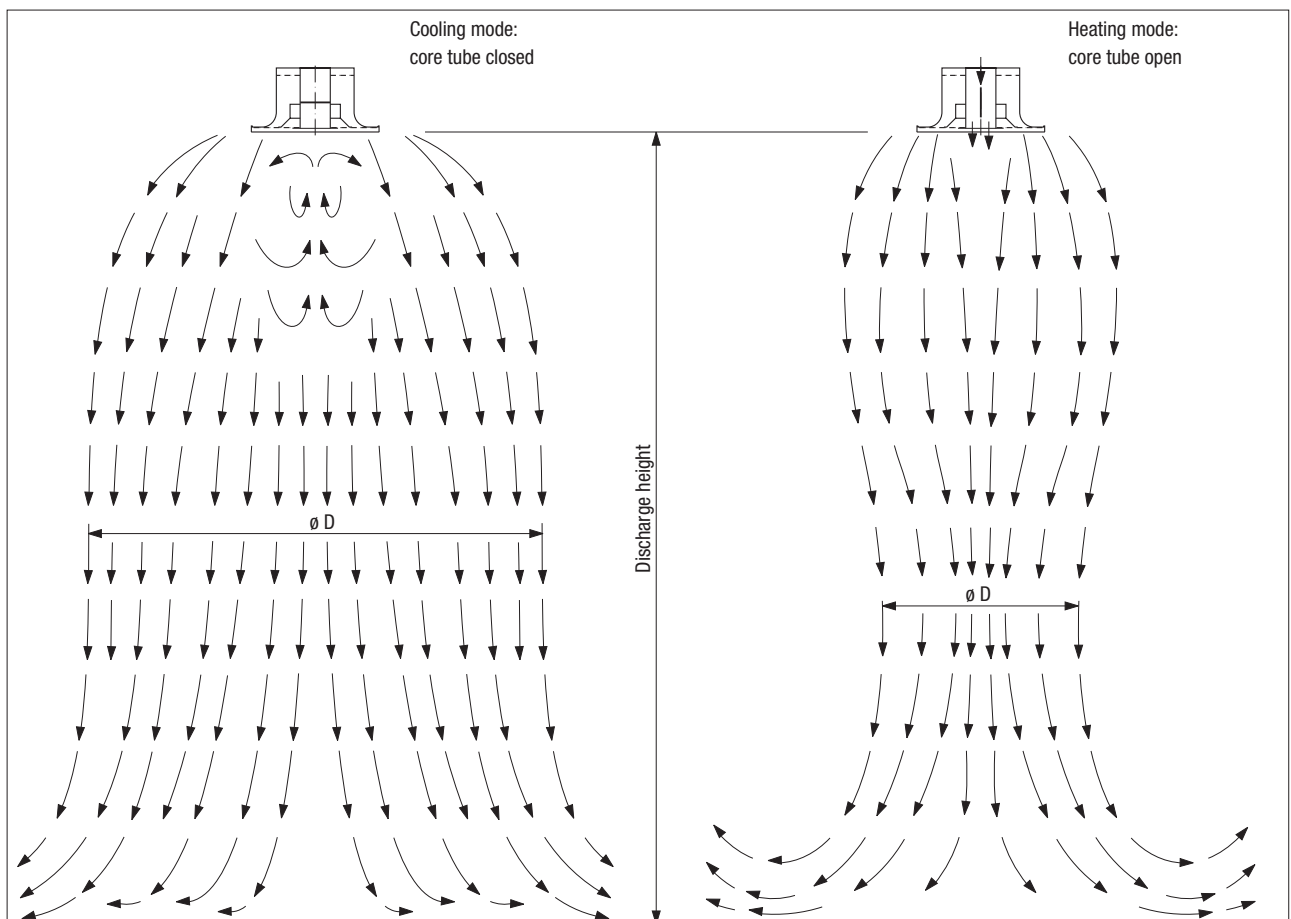


Fig. 2: Jet patterns – left: cooling mode, right: heating mode

Adjustment to thermal load

Adjustment to thermal load (i.e. heating, isothermal or cooling mode) can occur in three different ways.

With manual adjustment, the adjustable damper must be set to

the required position manually, directly at the air outlet. This option is preferred if the thermal loads are rather constant throughout the year or if thermal comfort requirements are of secondary importance.

Radial displacement outlet

Jet penetration depth

For electrical adjustment, the radial displacement outlets must be equipped with actuators. The penetration depth of the supply air will be set on the basis of the measured supply and indoor air temperatures, using the building management system (BMS) and an appropriate control graph.

Thermostatic control obviates the need for a central control system and outlet wiring. Each radial displacement outlet is fitted with a thermostatic control unit which gets energy for damper adjustment from the supply air temperature. The thermostatic control unit is filled with expandable material and works within a supply air temperature range of 20 to 28 °C (standard model). Another advantage of this unit is that the supply air temperature is measured inside the air outlet, not at a central point such as behind the HVAC system. In large halls, for instance, significant temperature differences are likely to occur and to impair both thermal comfort and heating-up periods. This is precluded by the thermostatic control unit.

Jet penetration depth

In heating mode, with fully open core tube, the vertical penetration depth of the supply air jet depends on the outlet volume flow rate and the temperature difference between supply air and indoor air. This correlation is shown in Figure 3. The parameters \dot{V}_{min} and \dot{V}_{max} depend on the outlet size and can be read off Figure 1. For size DN 630 for example, at a volume flow rate of 1 800 l/s [6 500 m³/h] and $\Delta\vartheta = +8$ K, a penetration depth of 6.75 m can be achieved.

If the volume flow rate is reduced for this size to 900 l/s [3 200 m³/h], the penetration depth is shortened to 3.6 m.

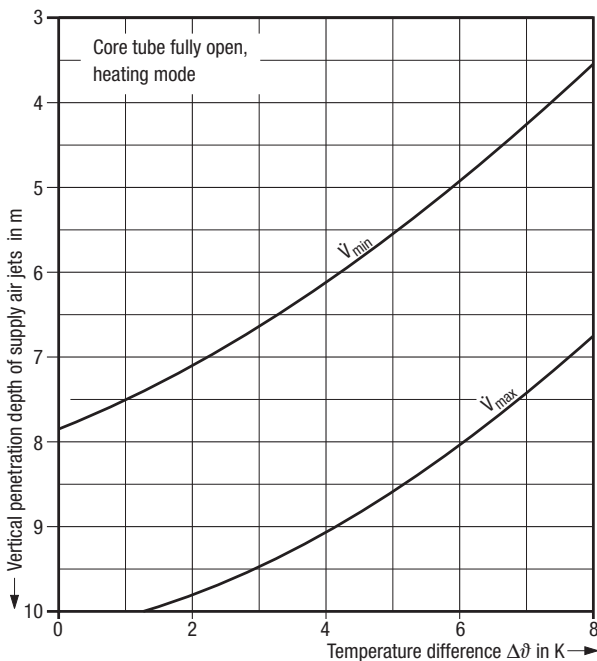


Fig. 3: Vertical penetration depth of supply air jets depending on temperature difference between supply and indoor air in heating mode

In cooling mode, the penetration depth is virtually unlimited because the cooler supply air tends to flow downwards. The criterion are the air velocities under the outlet, which depend on the outlet size and the temperature difference between supply and indoor air. It is assumed that the core tube remains closed in cooling mode. The ranges of maximum air velocities 5 m under the outlet are shown in Figure 4. For size DN 400 for example, with $\Delta\vartheta = -5$ K the maximum air velocity is 0.39 to 0.42 m/s, with $\Delta\vartheta = -3$ K it is 0.32 to 0.34 m/s. According to the German standard VDI 3802 (Air-conditioning systems for factories) these air velocities are allowable for activity levels II and III. Further, they occur only at points within the areas mentioned in Figure 1 and Table 1, under the displacement outlet, and are required in terms of physics to ensure a stable downflow of supply air into the work area.

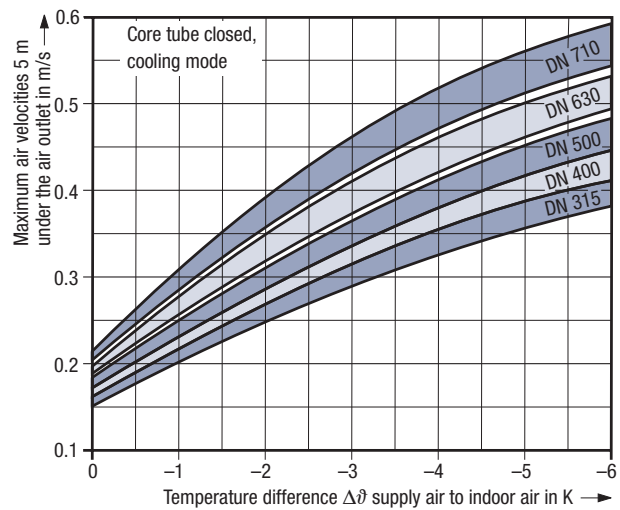


Fig. 4: Ranges of maximum air velocities 5 m under the air outlet in cooling mode

The air velocities under the outlet have no effect on thermal comfort when the outlet is installed above the gangway and the supply air is discharged vertically from a height of 4 to 8 m between the workplaces. The pollutants released during the process are best extracted directly from the workplaces (e.g. welding stations, grinding machines, etc.). Figure 5 shows a typical outlet arrangement.

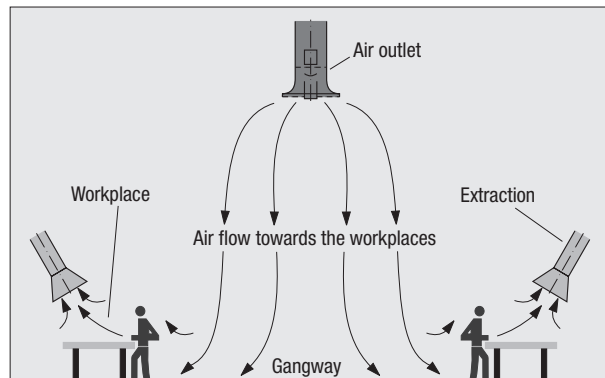
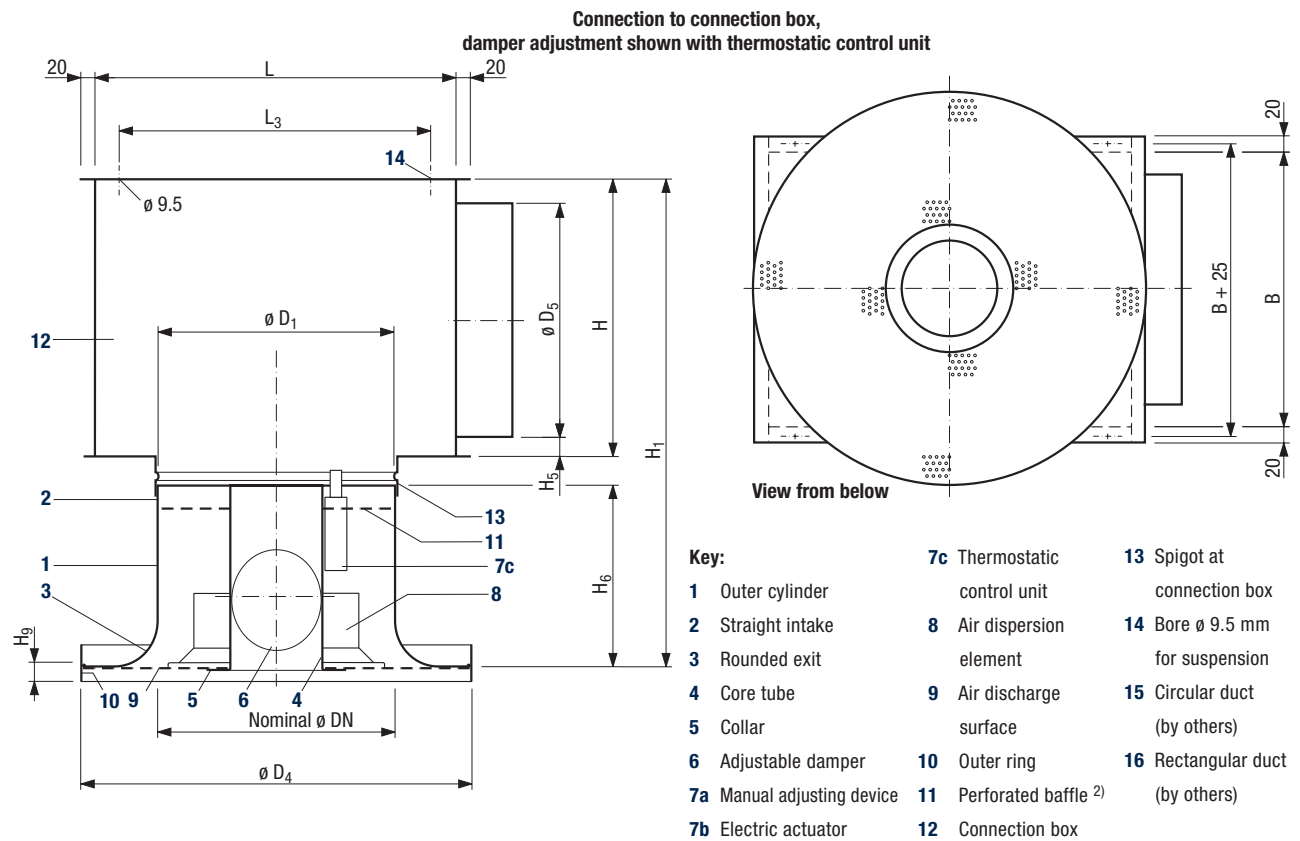
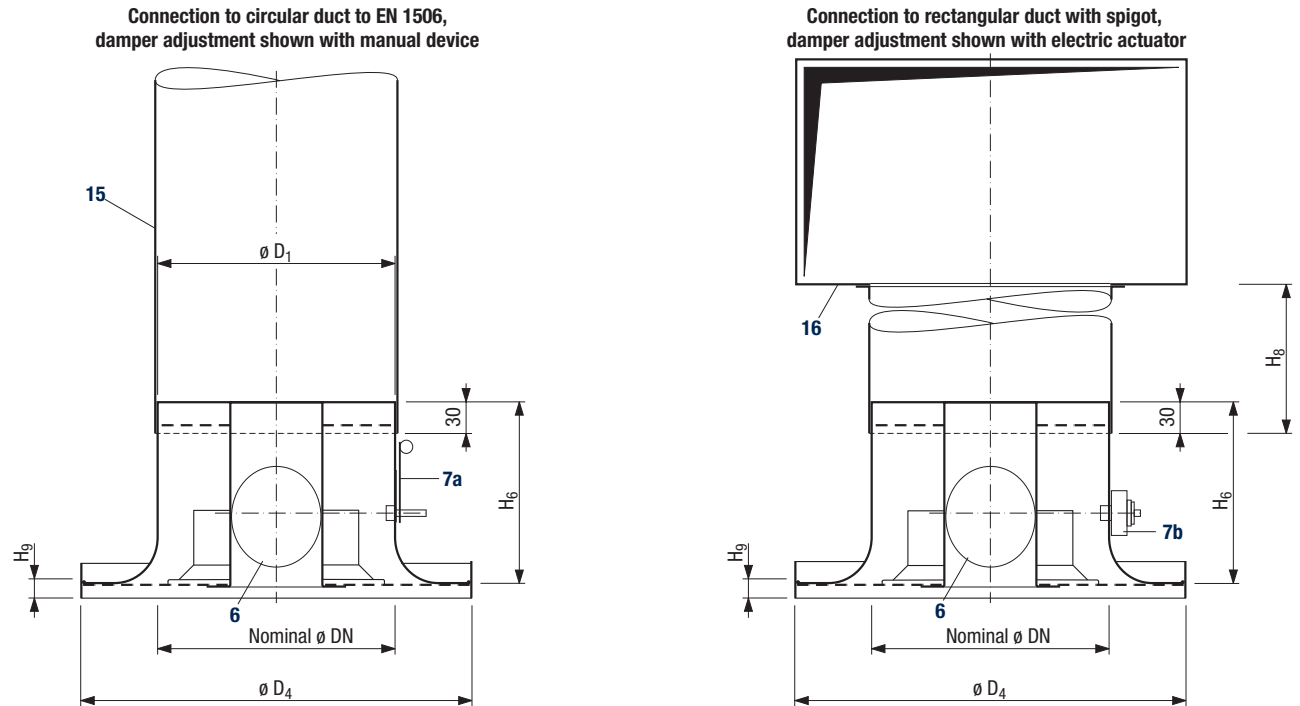


Fig. 5: Radial displacement outlet above the gangway between workplaces

Radial displacement outlet

Connection types and dimensions



Nominal diameter DN	Dimensions in mm												Weight in kg ¹⁾	
	L	L ₃	B	H	H ₁	H ₅	H ₆	H ₈ min.	H ₉ ³⁾	D ₁	D ₄	D ₅	Air outlet	With connection box
315	475	415	365	365	630	25	260	240	0 – 30	314	525	314	4	14
400	560	500	450	450	755	25	300	300	0 – 45	399	650	399	6	21
500	660	600	550	550	835	25	280	375	0 – 50	499	800	499	10	31
630	790	730	680	680	1 035	26	350	475	0 – 50	628	1 000	628	17	46
710	870	810	760	760	1 115	26	350	525	0 – 50	708	1 100	708	21	56

¹⁾ Weight without actuator; weight of actuator 0.5 kg

²⁾ for DN 630 and DN 710

³⁾ Basic setting H₉ = 20 mm

Radial displacement outlet

Minimum outlet spacing, sound power level and pressure drop

Minimum outlet spacing

The minimum spacing between outlets must ensure that the vertical supply air jet can disperse unobstructed. Figure 1 shows the minimum outlet spacing for the individual sizes.

Sound power level and pressure drop

Sound power level and pressure drop are influenced by the air outlet volume flow rate, the position of the adjustable damper and the connection type; they can be read off the following charts.

Key to charts:

\dot{V}_A = air outlet volume flow rate in l/s

Δp_t = total pressure drop in Pa

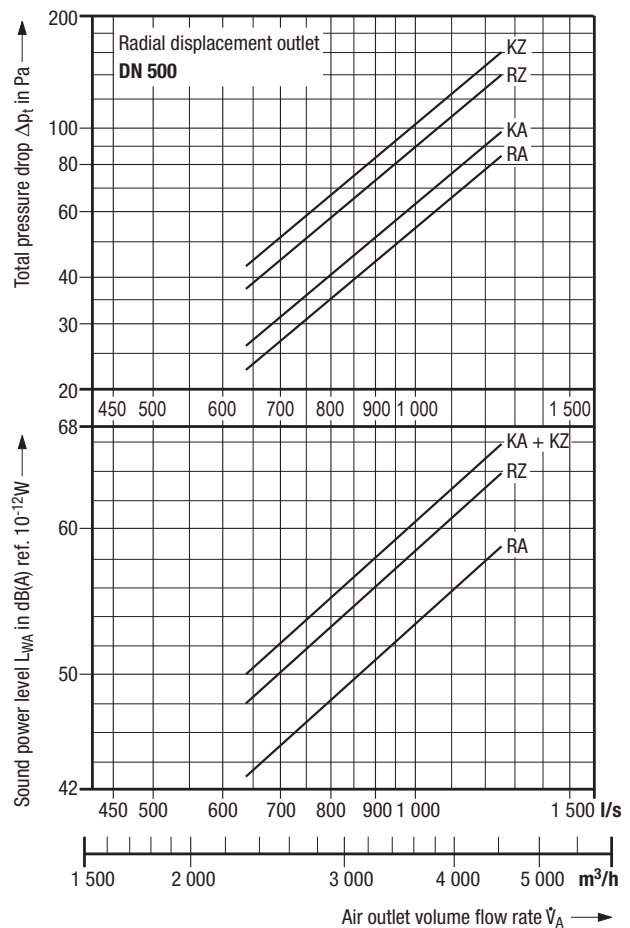
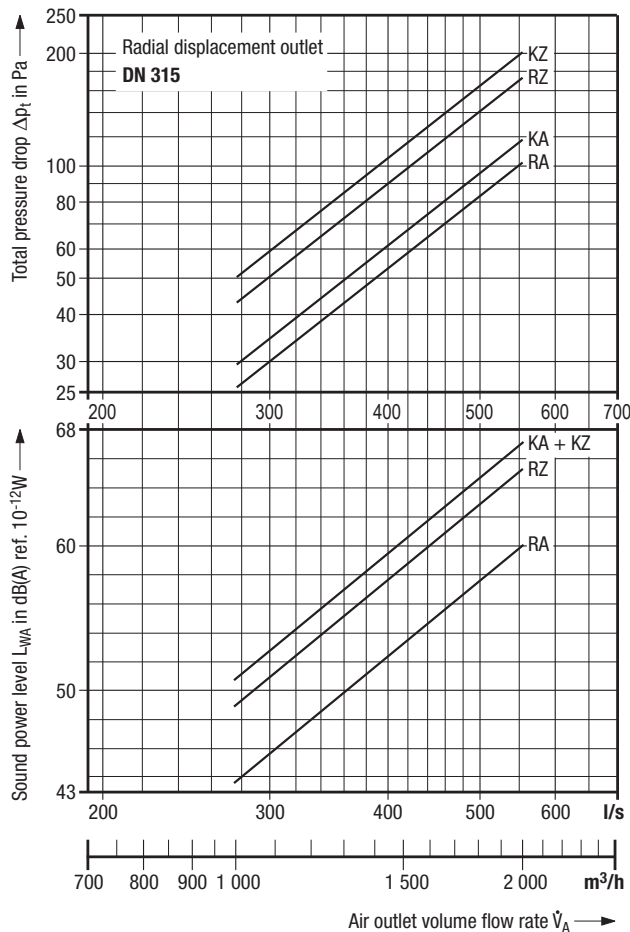
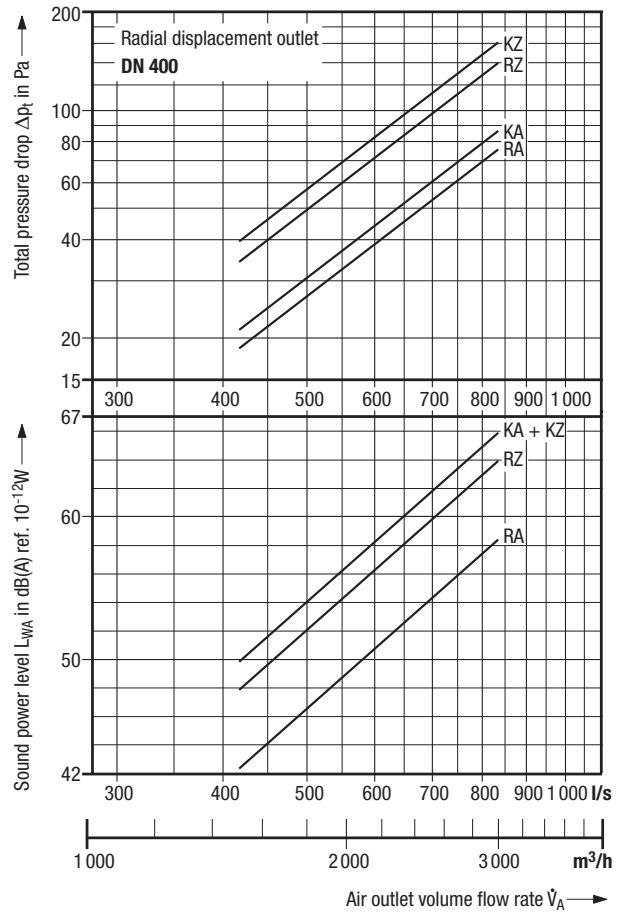
L_{WA} = A-weighted sound power level in dB(A) ref. 10^{-12} W

RA = duct connection, core tube "open"

RZ = duct connection, core tube "closed"

KA = box connection, core tube "open"

KZ = box connection, core tube "closed"



Radial displacement outlet

Sound power level and pressure drop

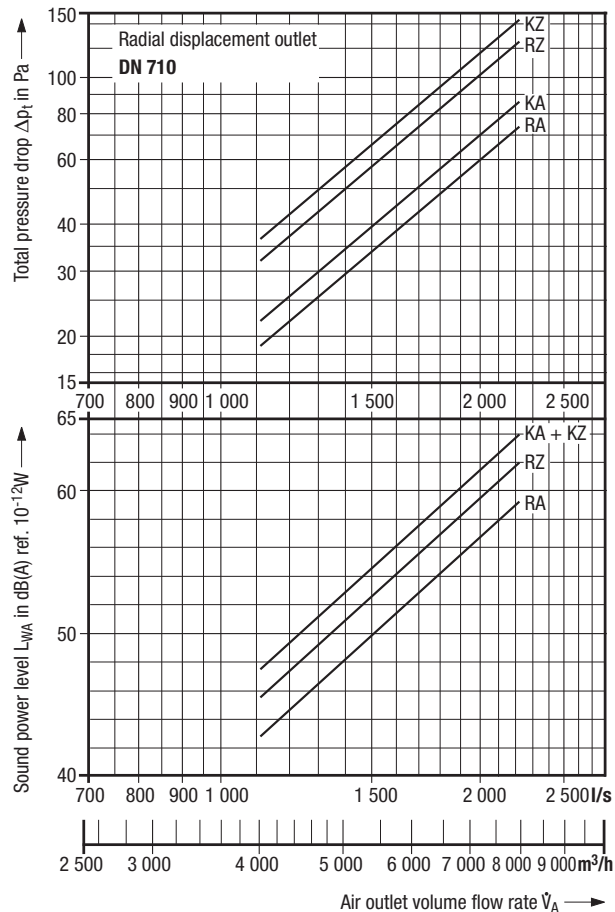
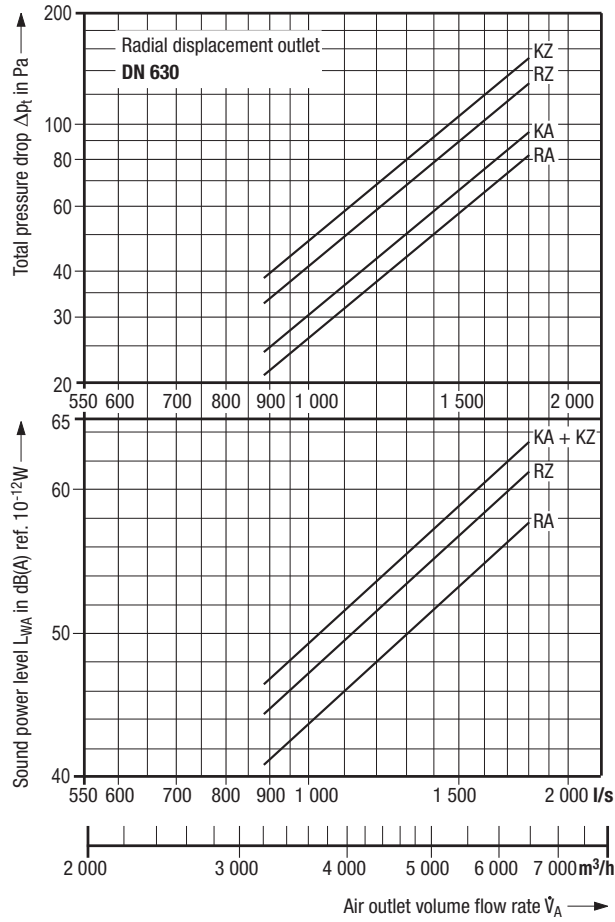


Fig. 6: Vertical discharge from a great height, jet pattern made visible by smoke tracer

Top: cooling mode, core tube closed

Middle: isothermal mode, core tube partly open

Bottom: heating mode, core tube open

Radial displacement outlet

Features, type code and tender text



Fig. 7: Radial displacement outlet in a printing shop

Features

- Low-turbulence displacement flow
- Vertical downflow of air ensuring effective fresh air supply
- Discharge height 4 to 8 m
- 5 sizes from DN 315 to DN 710
- Air volume flow rate range from 280 to 2 220 l/s [1 000 to 8 000 m³/h]
- Jet penetration depth adjustable to discharge height and heat load
- Adjustment
 - via thermostatic control unit; advantages: no wiring, no auxiliary energy necessary
 - with electric actuator
 - with manual adjusting device
- Maximum temperature difference between supply and indoor air: –6 K in cooling mode and +10 K in heating mode
- Connection to ductwork via circular duct or connection box

Tender text

..... units

Radial displacement outlet for vertical low-turbulence supply air distribution above the occupied zone into the gangways of production facilities, especially suited for workplaces with extract points; discharge direction continuously adjustable from inclined to steeply downwards, preferably in response to temperature difference between supply air and indoor air, consisting of:

- an outer cylinder, an air dispersion element, a core tube for a support jet, and a perforated metal sheet for low-turbulence air discharge,
- an oval adjustable damper for support jet regulation and alteration of jet spread and penetration depth; damper adjustment via manual device, electric actuator, or self-acting thermostatic control unit.

Outlet connection to circular duct or connection box with lateral spigot.

Material:

- Cylindrical and circular outlet parts made of aluminium; visible parts painted to RAL ...
- Perforated metal sheet and baffle made of galvanized sheet metal
- Connection box made of galvanized sheet metal.

Make: KRANTZ KOMPONENTEN

Type: VA-PV – DN _____

Subject to technical alterations.

Type code

VA-PV – DN _____					
Displacement outlet	Size	Connection type	Adjustment	Surface finish	Size
					315 = DN 315
					400 = DN 400
					500 = DN 500
					630 = DN 630
					710 = DN 710

Connection type

R = duct connection with rivet or screw connection

K = connection box

Adjustment

MA = manual

E1 = „Siemens actuator, 0 – 10 V modulation“, rotation drive type GDB161.1E

E2 = „Siemens actuator, 3-point type, 24 V“, rotation drive type GDB131.1E

E3 = „Siemens actuator, 3-point type, 230 V“, rotation drive type GDB331.1E

E38 = „Belimo actuator, 0 – 10 V modulation“, rotation drive type CM24-SR-R

E39 = „Belimo actuator, 3-point drive, 24 V“, rotation drive type CM24-R

E40 = „Belimo actuator, 3-point drive, 230 V“, rotation drive type CM230-R

T1 = thermostatic control unit, 20 – 28 °C

Surface finish

.... = face painted to RAL