1. The following specifications are essential for Booster design and must be provided by the Sales Representative or customer:

- Required free air delivery $\dot{V}_{eff}$
- Minimum initial pressure available (p_1)
- Working pressure required at the takeoff point (p_B)
- Quality standard of the available operation air: at least refrigeration dried and dust-free => FC filter grade
- Ambient temperature, max/min
- Compressed air temperature, max
- Required quality of the boosted air (to determine Δp and hence the booster switching pressure p_2)
- μ = duty cycle
- η = volumetric efficiency
- $P_{(abs)} = p(g)+1bar$
- swept volume = $\dot{V}_{swept}$

2. An air receiver is necessary between the existing air main and the booster and also downstream of the booster, before the treatment equipment.

3. Specifying the booster – swept volume

$$\dot{V}_{swept} = \frac{\dot{V}_{eff}}{P_{1\,(abs)} \times \eta \times \mu}$$

μ = max. duty cycle (see T 9739)

$\eta = 0.8$ at $\frac{P_{2(abs)}}{P_{1(abs)}} < 3$

$\eta = 0.75$ at $\frac{P_{2(abs)}}{P_{1(abs)}}$ between 3 and 4

max. permissible pressure ratio $= \frac{P_{2(abs)}}{P_{1(abs)}}$ = 4 for two cylinder unit
4,5 for three cylinder unit

Swept volume should be determined according to T 9693.1.

4. Decision if continuous running is possible (sheet 4). (at ambient >40°C + inlet temp. >45°C reference to VKI is essential) If not, then the next larger size of booster must be selected,
or;

5. Decision if the booster should operate in continuous mode (switching from load to idle as needed) or;
stop/start mode.
If a continuous control (load/idle) is needed, this must be offered at extra price.
If stop/start operating mode is needed, the air receiver size (sheet 5) must be calculated with reference to the maximum booster running time (sheet 5). The maximum switching frequency of the motor must also be taken into consideration (table, sheet 2).

6. Determination of components for treating the boosted air
(e.g. dryer, filter, etc.)

Table 1: Duty cycle related to motor size

Motor power in kW	Duty cycle in h
30 – 45	8
15 – 22	12
7.5 – 11	15
4 – 5.5	20
1.5 – 3	25
0.37 – 1.1	30

Table 2: Cooling air

Type	cooling aftercooler	Cooling air m³/h
N 60-G	air	750
N 251-G	air	2600 by 7,5 kW / 3600 by 11 kW
N 350-G	air	3600 by 11 kW / 4700 by 15 kW
N 501-G	air	3600 by 11 kW / 4700 by 15 kW / 5800 by 16,5 kW
N 753-G	air	10000
N 753-G	water	3600
N 1100-G	water	4300
N 1400-G	water	4700
N 2000-G	air	10000 by 30 kW / 12000 by 37 kW

Δ T = difference between ambient temperature and discharge temperature aftercooler

Δ T = 35 K for air cooled aftercoler

Δ T = 5 K for water cooled aircooler

1. The following specifications are essential for booster design and must be provided by the sales representative or customer:

- Required free air delivery $\dot{V}_{eff}$
- Minimum initial pressure available (p_1)
- Working pressure required at the takeoff point (p_B)
- Quality standard of the available operation air: at least refrigeration dried and dust-free => FC filter grade
- Ambient temperature
- Compressed air temperature
- Required quality of the boosted air (to determine Δp and hence the booster switching pressure p_2)

2. Example:

$\dot{V}_{eff}$ = 2900 l/min
p_1 = 9 bar $_{(g)}$ = P_1 10 bar $_{(a)}$
p_B = 35 bar $_{(g)}$ = P_B 36 bar $_{(a)}$
t_1 = Ambient temperature = 40°C
t_2 = Air inlet temperature = 45°C

3. Specifying the booster – swept volume

a) $$\dot{V}_{swept} = \frac{\dot{V}_{eff}}{P_{1\,(abs)} \times \eta \times \mu}$$

$$\eta = 0.8 \quad \text{at} \quad \frac{P_{2(abs)}}{P_{1(abs)}} < 3 \qquad \eta = 0.75 \quad \text{at} \quad \frac{P_{2(abs)}}{P_{1(abs)}} \text{ between 3 and 4}$$

max. permissible pressure ratio $= \frac{P_{2(abs)}}{P_{1(abs)}} =$ **4 (for two cylinder package)**

see Example: $\frac{P_{2(abs)}}{P_{1(abs)}} = \frac{36}{10} = 3,6 \longrightarrow \eta = 0.75$

$\longrightarrow \mu = 0.8$ (see T 9739)

$$\dot{V}_{swept} = \frac{\dot{V}_{eff}}{P_{1\,(abs)} \times \eta \times \mu} = \frac{2900}{10 \times 0,75 \times 0,8} = 483 \text{ l/min}$$

Swept volume should be determined according to T 9693.1.

Selection: N501-G = $\dot{V}_{swept}$ = 500 l/min (N501= two cylinder package)

$$FAD = \dot{V}_{swept} \times p_{1\,(abs)} \times \eta = 500 \times 10 \times 0{,}75 = 3750 \text{ l/min}$$

Motor according T 9693.1 = 15 kW

b) Decision if continuous running is possible (see T 9739).
If not, then the next larger size of booster must be selected,

or;

Decision if the booster should operate in continuous mode (switching from load to idle as needed)

or;

Stop/start mode.

If stop/start operating mode is needed, the air receiver size must be calculated with reference to the maximum booster running time. The maximum switching frequency of the motor must also be taken into consideration.
Continuous running is possible because the limiting values will not be reached.

→ **Decision:** continuous running mode in idle

An air receiver is required between both the existing air main and the booster (see screw information for size) and downstream of the booster but upstream of the high pressure air treatment.

Formula for evaluation of optimum receiver size

$$V_R = \frac{\dot{V}_{eff} \text{ x } (DF - DF^2)}{Z \text{ x } \Delta p}$$

V_R = receiver volume

Δp = regulating differential of compressor in bar

Z = permissible cut-in frequency of the largest switched compressor in continuous running mode or the motor in stop/start mode

Z_1 = permissible cut-in frequency of the compressor in continuous running mode and idle

Z_1 = 40 for package up to 15 kW; Z_1 = 30 for package above to 15 kW

Z_2 = permissible cut-in frequency of the compressor in stop/start mode (see motor manufacturer's data)

$\dot{V}_{eff}$ = air delivery of the compressor in m³/h

$\dot{V}_2$ = air consumption of the factory in m³/h

DF = $\dot{V}_2 : \dot{V}_1$ = duty factor

Example:

$\dot{V}_{eff}$ = 3750 l/min ≙ 225 m³/h

$\dot{V}_2$ = 2900 l/min ≙ 174 m³/h

Δp = 3 bar

Z_1 = 40 cut-ins per hour (booster in load to idle mode)

Z_2 = 12 cut-ins per hour (booster in stop/start mode) see page 2/Tab.1

Receiver size for load to idle mode

$$V_{R1} = \frac{225 \text{ x } (0.77 - 0.59)}{40 \text{ x } 3}$$

$$DF = \dot{V}_2 : \dot{V}_{eff} = \frac{174}{225} = 0.77$$

$$V_{R1} = \frac{225 \text{ x } 0.18}{120} = 0.34 \text{ m}^3$$

$$DF^2 = (0.77)^2 = 0.59$$

Recommended air receiver size: 0,5 m³

Receiver size for stop/start mode

$$V_{R2} = \frac{225 \text{ x } (0.77 - 0.59)}{12 \text{ x } 3}$$

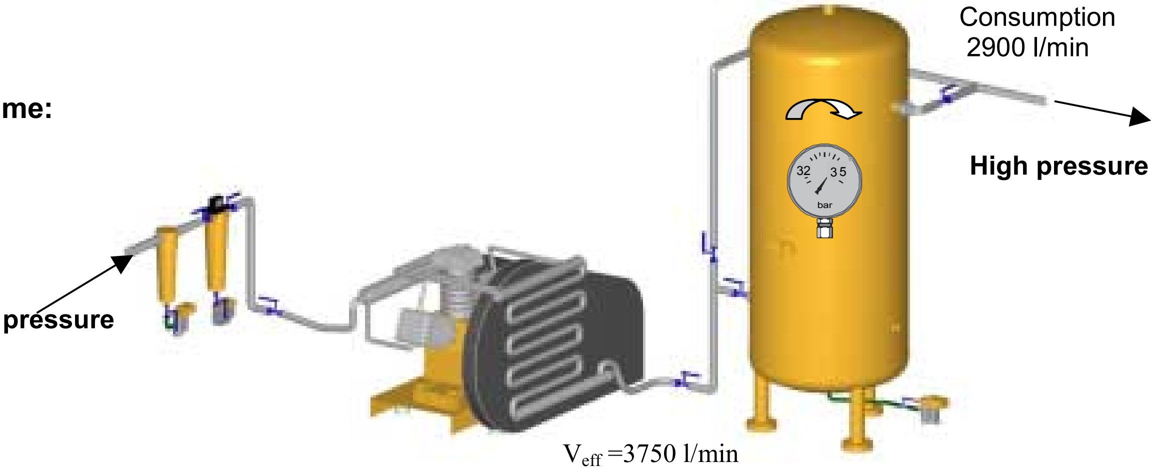
$$V_{R2} = \frac{225 \text{ x } 0.18}{36} = 1.13 \text{ m}^3$$

Recommended air receiver size: 1.5 m³

Example:

$\dot{V}_{eff}$	3750 l/min	Receiver tank V_{R2}	1500 l
Total air consumption	2900 l/min	Pressure differential	Δp = 3 bar
Excess air delivery	850 l/min		

1. Running time:

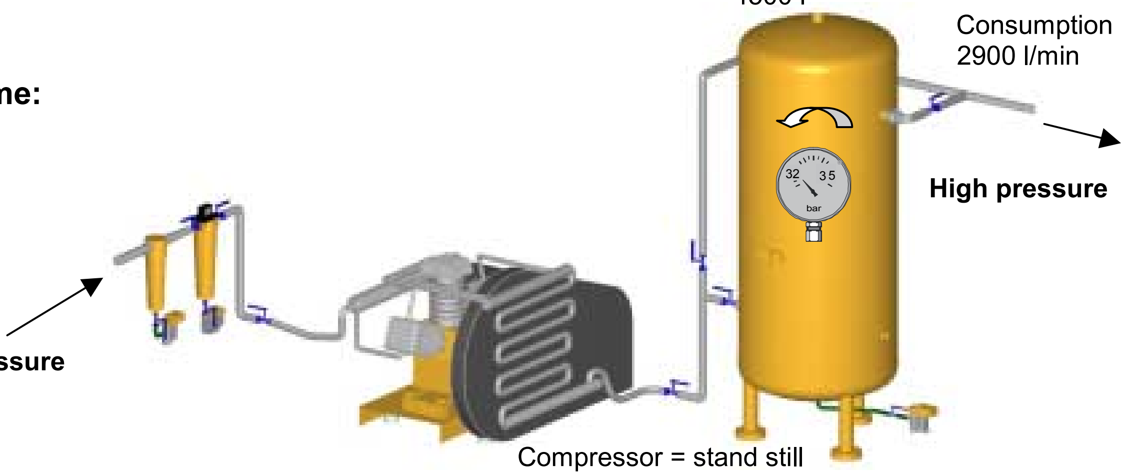


Storage volume = receiver tank x pressure differential = 1500 l x 3 = 4500 l

$$\text{Running time} = \frac{\text{storage volume}}{\text{excess air delivery}} = \frac{4500\ \text{l}}{850\ \text{l/min}} = 5.3\ \text{min}$$

Duration of pressure rise ≈ 5.5 minutes

Standstill time:



$$\text{Standstill time} = \frac{\text{Storage volume}}{\text{air consumption}} = \frac{4500\ \text{l}}{2900\ \text{l/min}} = 1.6\ \text{min}$$

Standstill time during pressure fall ≈ 1.6 minutes

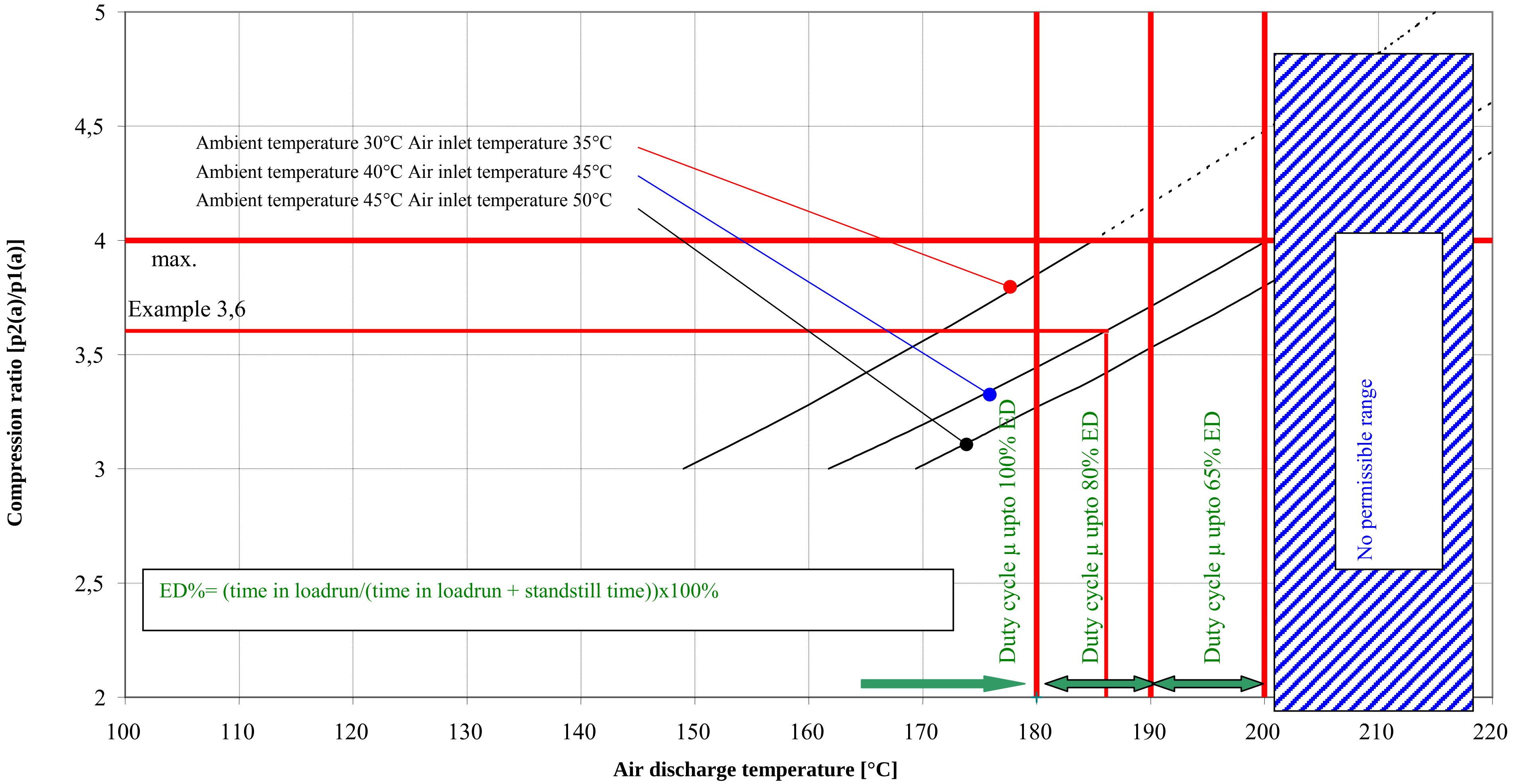
The storage volume of 4500 litres can supply the consumers with compressed air for 1 minute without the compressor cutting in.

Motor cut in-frequency:

ON time	= 5.3 min
OFF time	= 1.6 min
time per switching interval	= 6.9 min

$$\text{Cut-in frequency} = \frac{\text{Reference-time}}{\text{Interval}} = \frac{60\ \text{min}}{6.9\ \text{min}} = 8.7$$

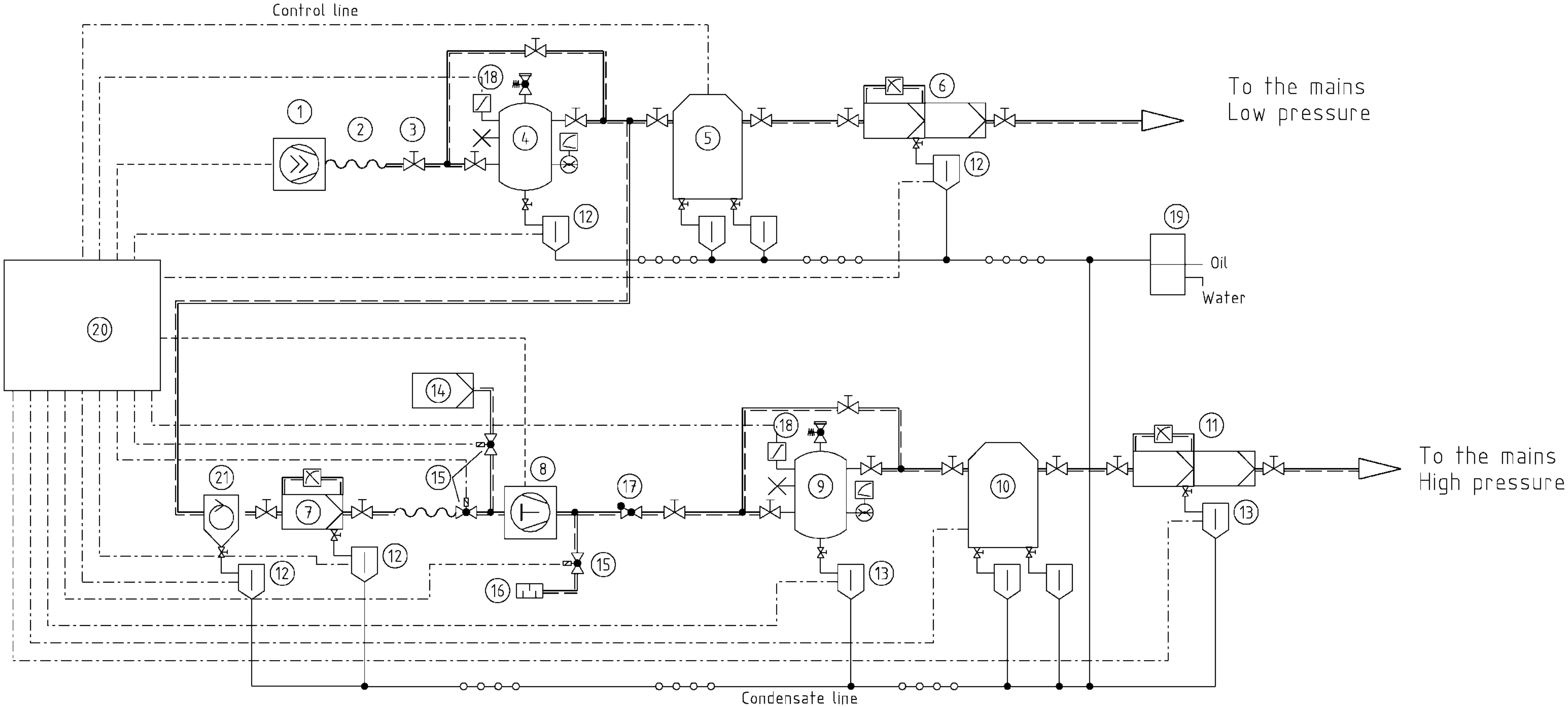
Thus, the motor cuts in 9 x per hour. Duty cycle for 15 kW = 12 (table 1, sheet 2).



5
4,5
4
3,5
3
2,5
2
Compression ratio [p2(a)/p1(a)]
Ambient temperature 30°C Air inlet temperature 35°C
Ambient temperature 40°C Air inlet temperature 45°C
Ambient temperature 45°C Air inlet temperature 50°C
max.
Example 3,6
ED%= (time in loadrun/(time in loadrun + standstill time))x100%
Duty cycle µ upto 100% ED
Duty cycle µ upto 80% ED
Duty cycle µ upto 65% ED
No permissible range
100
110
120
130
140
150
160
170
180
190
200
210
220
Air discharge temperature [°C]

W-241.tif

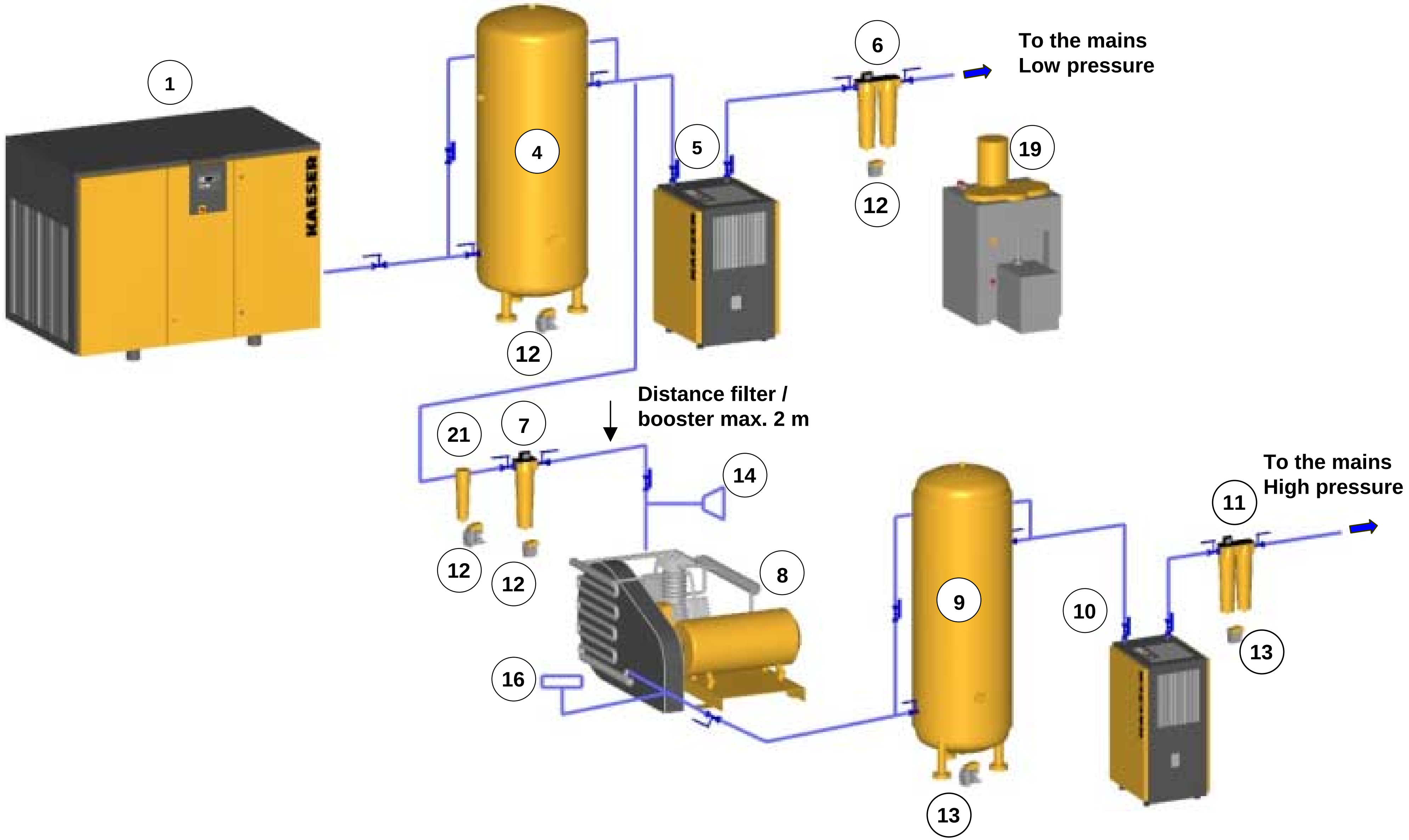
P + I Diagramm



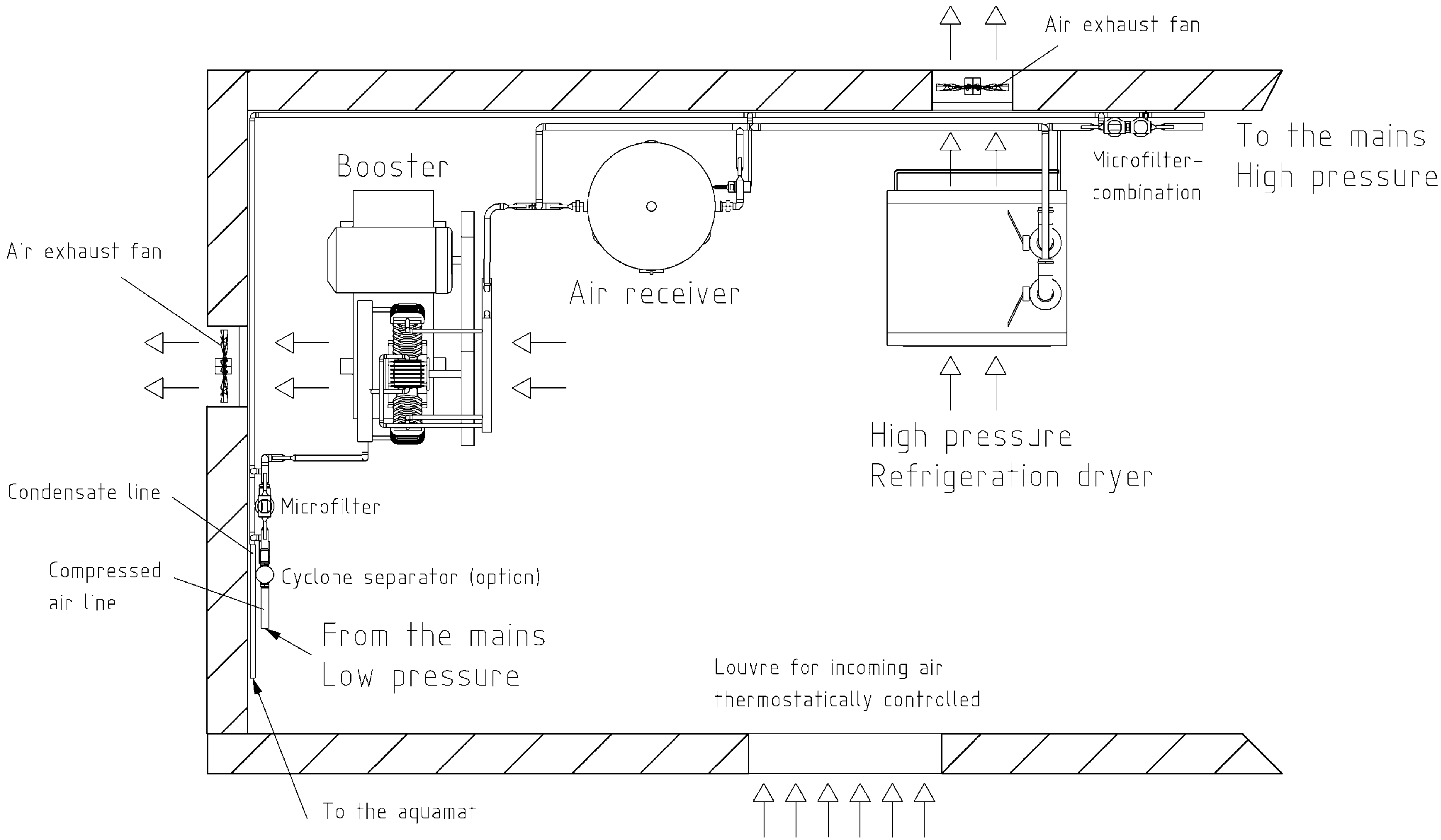
Legend

1 Screw compressor
2 Hose line
3 Ball valve
4 Air receiver low pressure
5 Refrigeration dryer low pressure
6 Microfiltercombination low pressure
7 Microfilter FE low pressure
8 Booster
9 Air receiver high pressure
10 Refrigeratoin dryer high pressure
11 Microfiltercombination high pressure
12 Autom. condensate drain
13 Autom. condensate drain PN 63
14 Inlet filter
15 Solenoid valve
16 Silencer
17 Nonreturn valve
18 Pressue switch
19 Oil- water separator Aquamat
20 Contro cubicle / control cabinet
21 Option : Cyclone separator

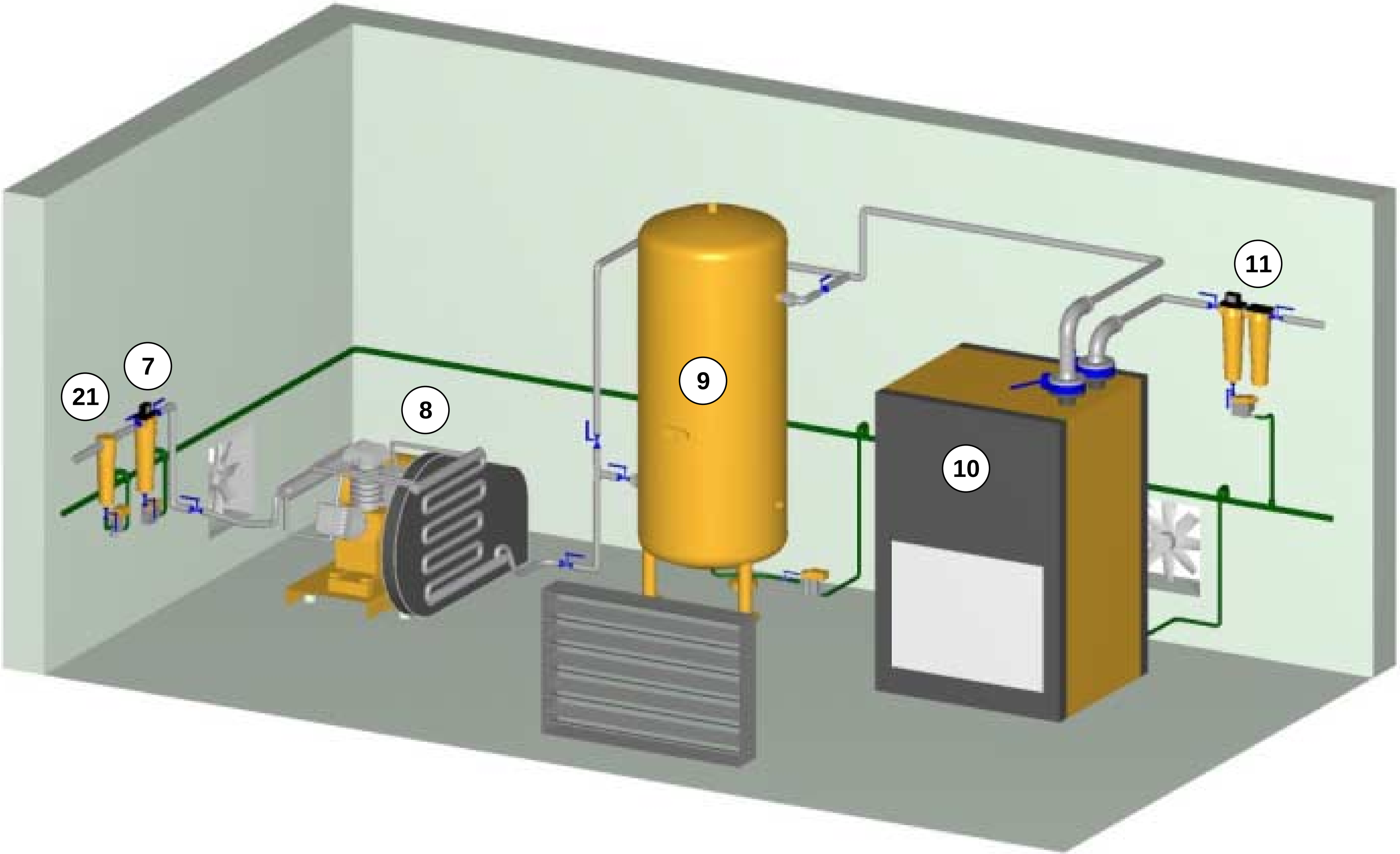
W-242.tif


1
4
12
5
6
To the mains
Low pressure
19
12
Distance filter /
booster max. 2 m
21
7
14
12
12
8
16
9
10
11
To the mains
High pressure
13
13

W-247.tif

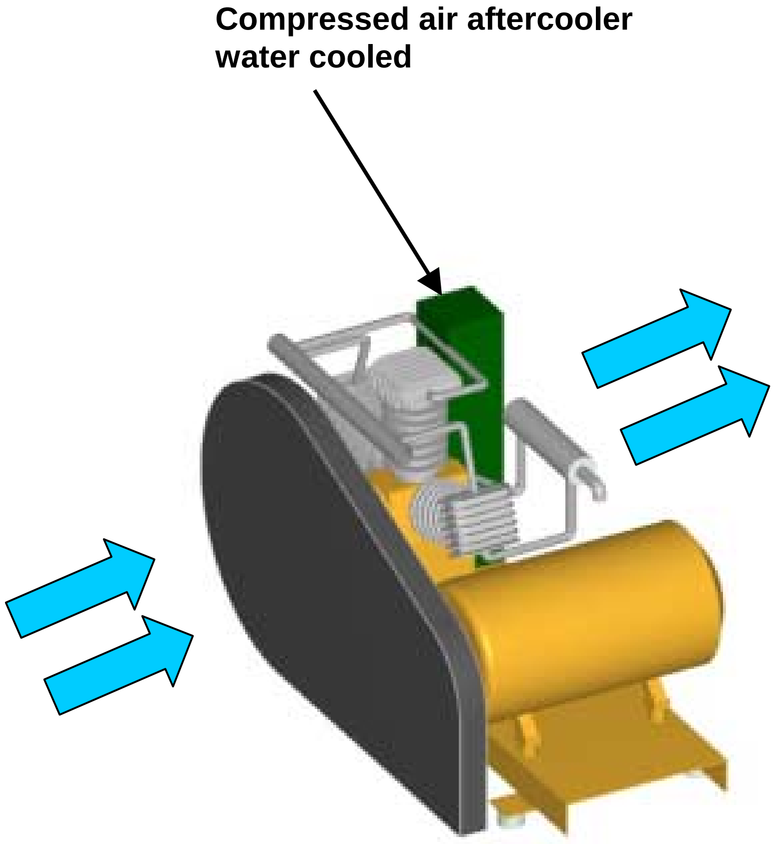

Air exhaust fan
To the mains
High pressure
Microfilter-
combination
Booster
Air receiver
Air exhaust fan
High pressure
Refrigeration dryer
Condensate line
Microfilter
Compressed
air line
Cyclone separator (option)
From the mains
Low pressure
Louvre for incoming air
thermostatically controlled
To the aquamat

W-245.tif

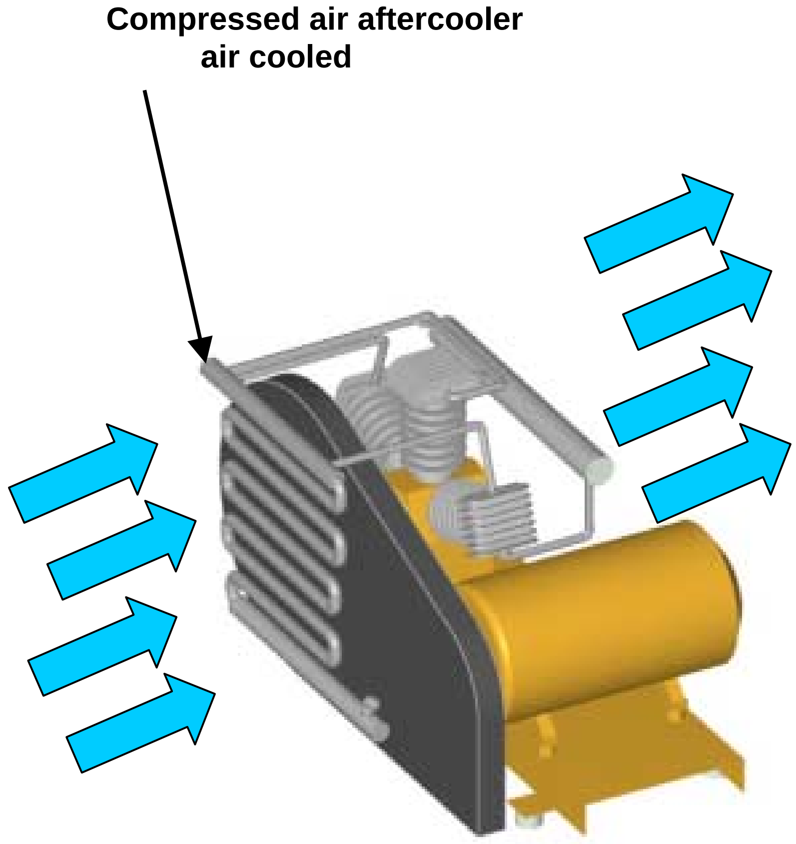


W-249.tif

Regardless of the medium by which the compressed air aftercooler is cooled (air or water) the compressor always requires a flow of cooling air.



Compressor unit – air cooled



Compressor unit – air cooled

Model	Standard	Soundproof enclosure	Position	
	dB(A)	dB(A)	Standard	With soundproof enclosure
N 60-G	74	58	Compressor block exhaust side	Cooling air outlet
N 251-G	76	60	Compressor block exhaust side	Cooling air outlet
N 350-G	77	61	Compressor block exhaust side	Cooling air outlet
N 501-G	78	62	Compressor block exhaust side	Cooling air outlet
N 753-G lgk	82		Compressor block exhaust side	
N 753-G wgk	82		Compressor block exhaust side	
N 1100-G	83		Compressor block exhaust side	
N 1400-G	84		Compressor block exhaust side	
N 2000-G	84		Compressor block exhaust side	

* Operating condition of the package:	Full load, compressor running at nominal speed, nominal pressure, nominal delivery.
Installation information:	Free field measurement
Measurement information:	Measurement according to DIN 45635 (noise measurement on machines, compressors) at 1 m distance, 1.6 m high, highest sound pressure value and corresponding measuring point.