# Installation Manual

OF

HIGH-SPEED DIESEL ENGINES

AIR-COOLED
and
OIL-COOLED

Series

**D 909 / 910**
**B/FL 1011 / F / 2011**
**B/FM 1011 F / 2011**
**B/FL 912/913/914/C**
**B/FL 413 F / 513 /C / CP**

These guidelines are not meant to serve as operating instructions for the end user of machinery but refer to all equipment manufacturers using a DEUTZ diesel engine as prime mover in their products. The guidelines are therefore no user information according to DIN Standard 8418; they fulfill a similar purpose, however, because their compliance ensures operability of the engines and thus also protects the user of the end product against risks which may arise from operation of the engines.

A high degree of operational reliability and a long service life can only be expected from properly installed engines allowing also quick and easy servicing. The present guidelines supply you with the respective instructions for an appropriate installation and make reference to the limit values to be complied with.

In this connection, the guidelines exclusively refer to the engine functions involved and not to any laws and regulations applicable to the equipment in which the engines are installed. These will have to be observed by the original equipment manufacturers.

The great variety of installation conditions makes it impossible to lay down any rigid rules which would apply universally. Experience and specialized knowledge are required to achieve an optimized installation under the given conditions.

We therefore recommend early consultation with Application Engineering already in the planning stage. All relevant contacts should be arranged through the appropriate sales division.

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In the electronic pocket-book all necessary changes and supplements will be registered at short notice. A list showing the request of modification, date and modification index see next page.

## Modification List

| Modification-index | Date | Modification |
|---|---|---|
| 00 | | |
| 01 | 23.02.2005 | Chapter 10.2: Notes to use of 12V 3kW starter<br>Chapter 10.15: (new) Checklist for starter system check |
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| | | |
| | | |
| | | |

**Contents** **Page**

**Page**

Page

# 1. ENGINE COOLING

## 1.1 General

DEUTZ diesel engines of the air-cooled (B/FL 912/913/914/413F/513) and air/oil-cooled series (B/FL1011F) are directly cooled by the ambient air which is supplied by engine-integrated blowers (direct engine cooling).

DEUTZ diesel engines of the fully oil-cooled series (B/FM1011F/2011) are cooled by the circulating engine oil. In this case the lube oil dissipates the heat to the ambient air via a separate air/oil heat exchanger, which is supplied with cooling air from a fan (indirect engine cooling). Depending on the installation position of the oil/air heat exchanger the fan may be driven mechanically or by an electric motor.

In most cases the engines are installed in such a way that adequate weather protection is ensured. Usually an engine compartment is provided.

When the engines are installed in engine compartments or are encapsulated for noise silencing purposes the air in the engine compartment is heated up. To ensure adequate ventilation of the engine compartment cooling air intake and discharge systems are required in most cases. The following two most important rules are mandatory:

1. Only fresh air is suitable for cooling and combustion purposes, the engine should never take in hot exhaust air or exhaust gas.

2. Restrictions in the air intake and discharge ducting must be avoided as far as possible.

Any heat-sensitive components arranged in the engine compartment should be checked for their maximum compatibility with the prevailing ambient air temperature.

## 1.2 Configuration of air intake and discharge ducts

When a blower is operating, a vacuum pressure prevails at its inlet and at the impeller and, hence, air flows in from all sides. To prevent any hot engine air from proceeding to the cooling air blower, suitable measures will have to be taken to avoid this “hot air recirculation”. Costly ducting of intake and exhaust air may be ineffective if the duct outlets are configured unfavorably towards each other so that hot air can be drawn in again from the outside of the system.

Besides, the duct ends should be arranged so that no snow, rain or splash water can get in (particularly with marine installations). If necessary a water drain should be provided.

The duct openings should be covered by screens, with special attention to be paid to the cooling air inlet. The type of screen and the mesh size are dependent on the application of the respective equipment and the contamination to be expected (e.g. leaves, air-borne debris).

Applicable accident prevention regulations must be observed.

Air currents which may arise as a consequence of thermal lift, wind or motion of the vehicle involved have also to be considered in the layout of the duct openings.

With multi-engine installations the cooling air ducts of the individual engines should be routed separately from each other so that after shutdown of one engine no hot air will be recirculated into the other engine.

Basically, four different air intake and discharge configurations are possible:

**Table 1:**

| Configuration | Intake air duct | Discharge air duct |
|---|---|---|
| a | without | without |
| b | with | without |
| c | without | with |
| d | with | with |

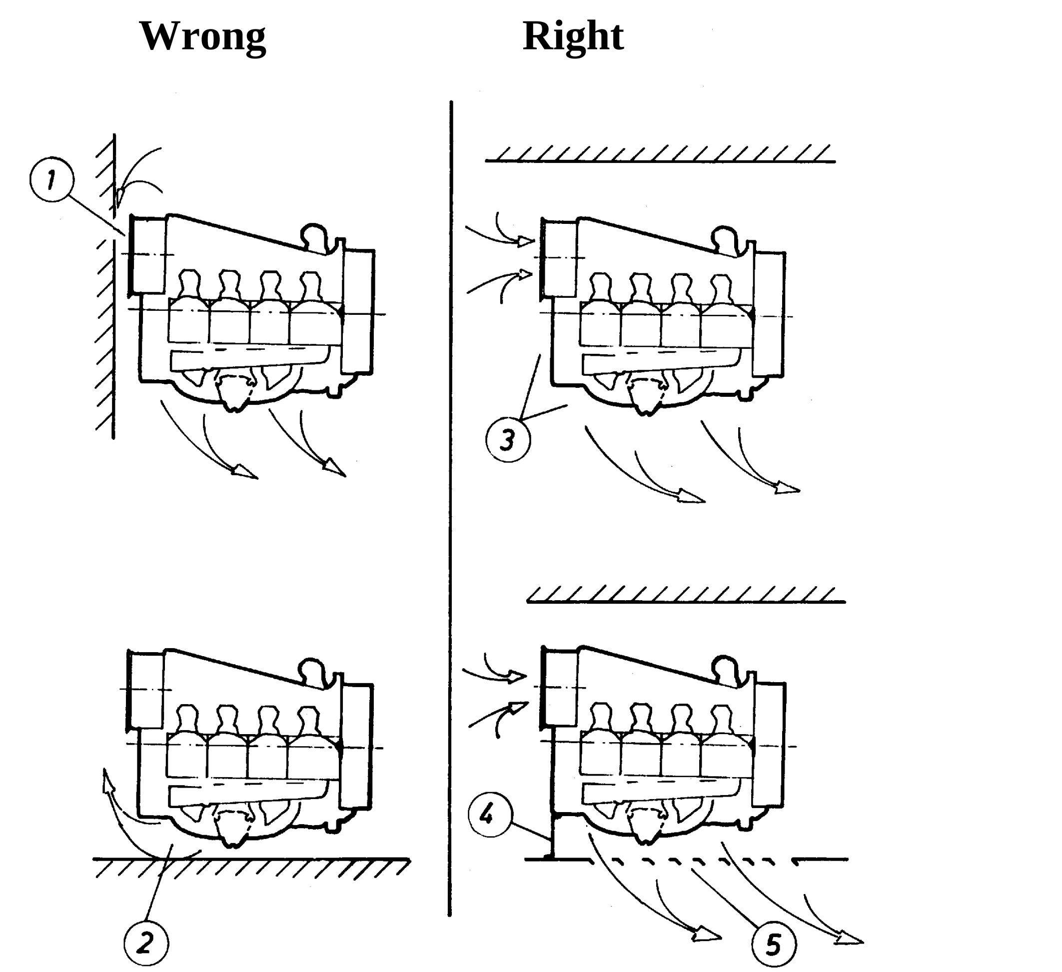
The configurations a to d are described below:

## Configuration a:

### Free intake and discharge of cooling air

This system is usually only possible if the engine can be installed in the open so that intake and discharge of cooling air is not restricted in any way.

**FIG. 1 -1**




1. Cooling air inflow obstructed by wall
2. Hot air discharge obstructed by wall so that hot exhaust air re-circulates to blower
3. Free intake and discharge of cooling air
4. Partition wall prevents admission of hot exhaust air to blower
5. Free discharge promoted by louvers in the wall

## Configuration b:

**Ducted cooling air intake and free discharge of the hot air**

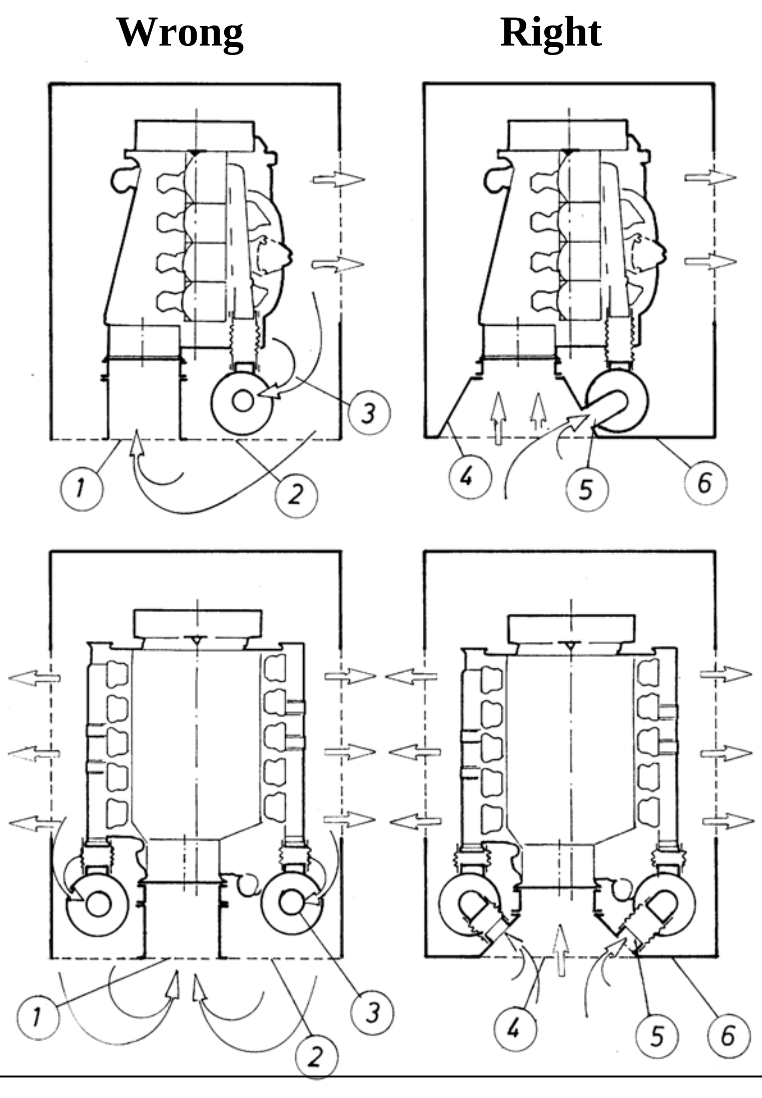
This system can be adopted when the engine hood has adequately dimensioned openings communicating with the outside air or when the engine compartment is relatively large and well ventilated so that the hot exhaust air can mix with the cool ambient air.

Under these conditions the engine surroundings are heated up quite strongly. Therefore, when components being sensitive to heat are mounted on the engine or within the engine compartment, the maximum admissible ambient temperatures of these components will have to be taken into consideration.

In any case, it is important to prevent the combustion air and the fuel from being heated up by radiation from hot components, such as exhaust piping or by contact with hot air, otherwise a power loss must be expected.

For instructions about extending connections at the blower inlet see chapter 1.4 "Connection of cooling air duct to blower".

**FIG. 1 -2**




1. Cooling air inlet cross section reduced by screen
2. Openings at end allow discharge of hot air into blower
3. Hot combustion air is drawn in
4. Enlarged cooling inlet to allow for reduction in cross section by screen.
5. Combustion air taken from cooling air intake system
6. Front end closed, blower can only draw in fresh air

## Configuration c:

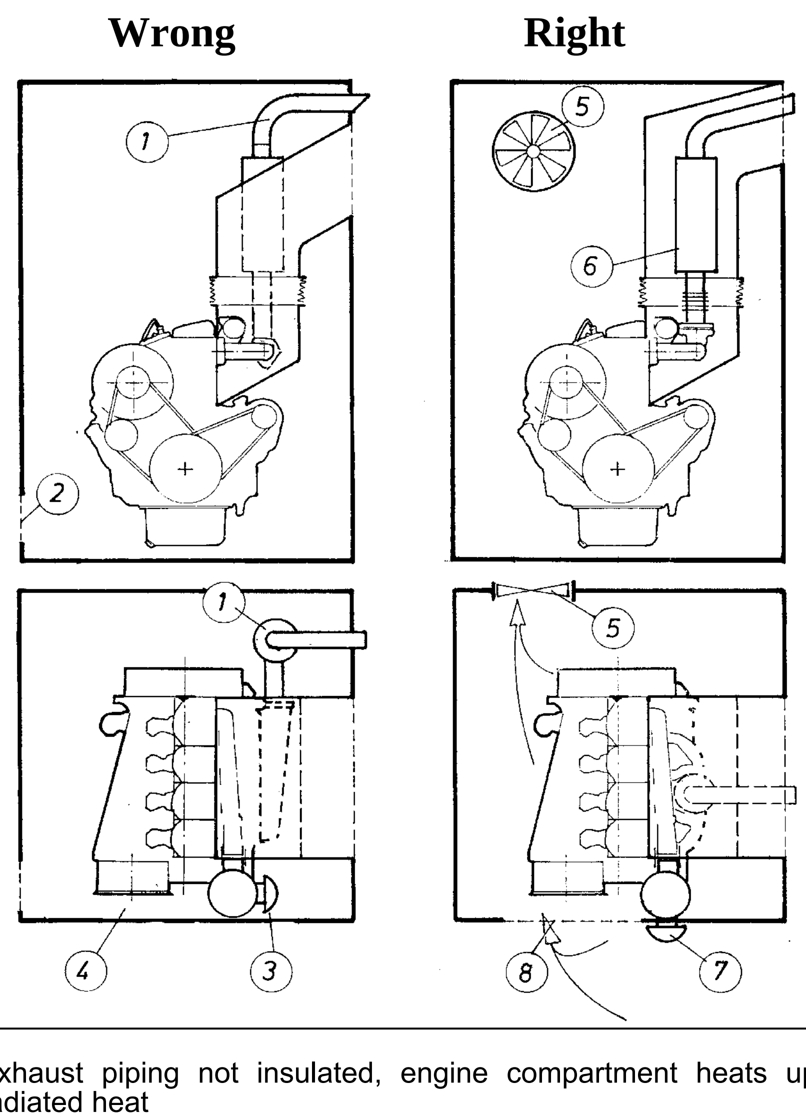
**Free cooling air supply to engine and ducted hot air discharge**

This system may be adopted for engine installations in compartments with adequately dimensioned inlet cross sections for fresh air intake. It may be necessary to provide for forced ventilation of the engine compartment.

The cooling air intake opening must be in the immediate vicinity of the blower. The hot exhaust air must be discharged by the shortest route.

The exhaust air from mounted oil coolers can usually be discharged through the same exhaust air duct provided the latter has been enlarged. Otherwise, a separate discharge duct will be required.

**FIG. 1 - 3**




1. Exhaust piping not insulated, engine compartment heats up through radiated heat
2. Air intake opening in engine compartment too small
3. Combustion air is drawn in from the heated engine compartment
4. Distance between wall and blower too short
5. Forced ventilation of engine compartment by fan (only in exceptional cases with heat-sensitive engine-mounted or driven auxiliaries)
6. Exhaust system integrated in discharge air duct, no heating up of engine compartment
7. Combustion air drawn in from outside
8. Cooling air inlet near blower and amply dimensioned cross section

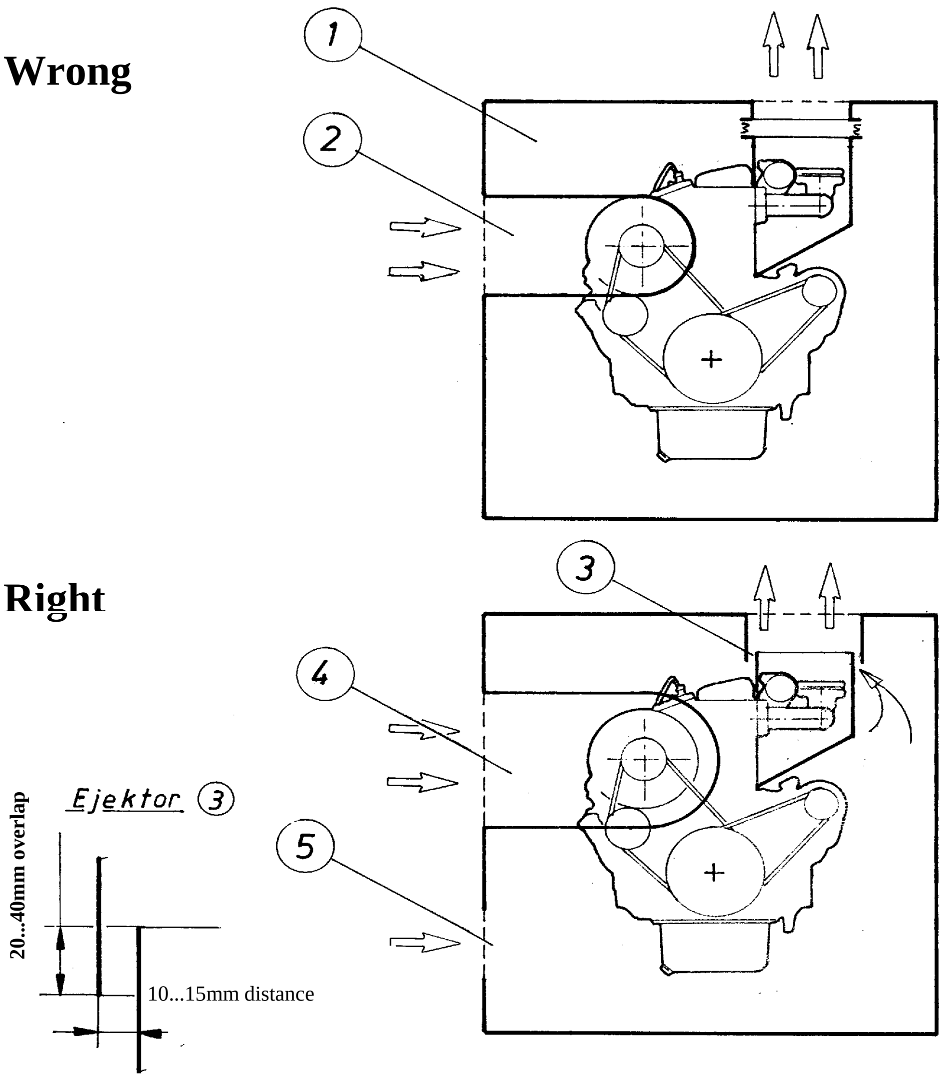
## Configuration d:

### Ducted air intake and discharge systems

This system is mainly required for special-purpose installations in enclosed rooms or for stationary engine installations where the air cannot be drawn from or dissipated into the immediate environment of the engine compartment or for engines which are totally enclosed for soundproofing reasons.

With this configuration an enclosed engine compartment is heated up by radiation from the engine, the exhaust system and the discharge duct to such an extent that forced ventilation of the engine compartment must be provided. However, the exchange of air in the engine compartment can also be achieved by profiting from the flow energy caused by the ejector effect of the engine blower.

**FIG. 1 - 4**



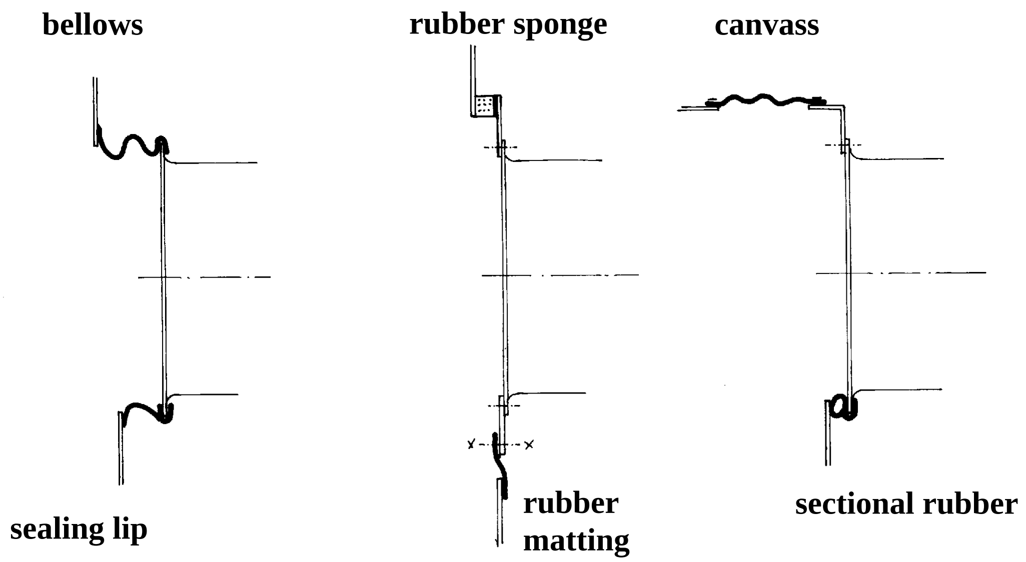

1. Engine compartment is heated up because there is no forced ventilation
2. Air intake duct too small, cowling pressure loss due to lack of cooling air
3. The transition from the engine exhaust air duct to the extending duct is designed as an ejector
4. Adequately dimensioned intake air duct without impeding blower inlet
5. Additional air intake because of ejector ventilation of engine compartment

## 1.3 Flexible connections for air intake and discharge ducts

On flexibly mounted engines the cooling air intake and exhaust air discharge ducts are exposed to vibrations if they are rigidly fastened to the engine. Therefore a flexible element has to be provided where the intake and discharge ducts are connected to the engine.

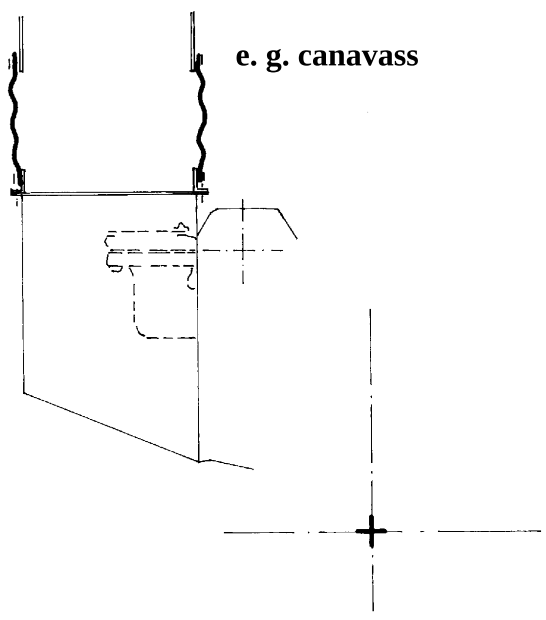
**FIG. 1 - 5**

<u>For air intake ducts</u>




**Also possible for air discharge ducts**
**- Temperature – resistance mandatory -**

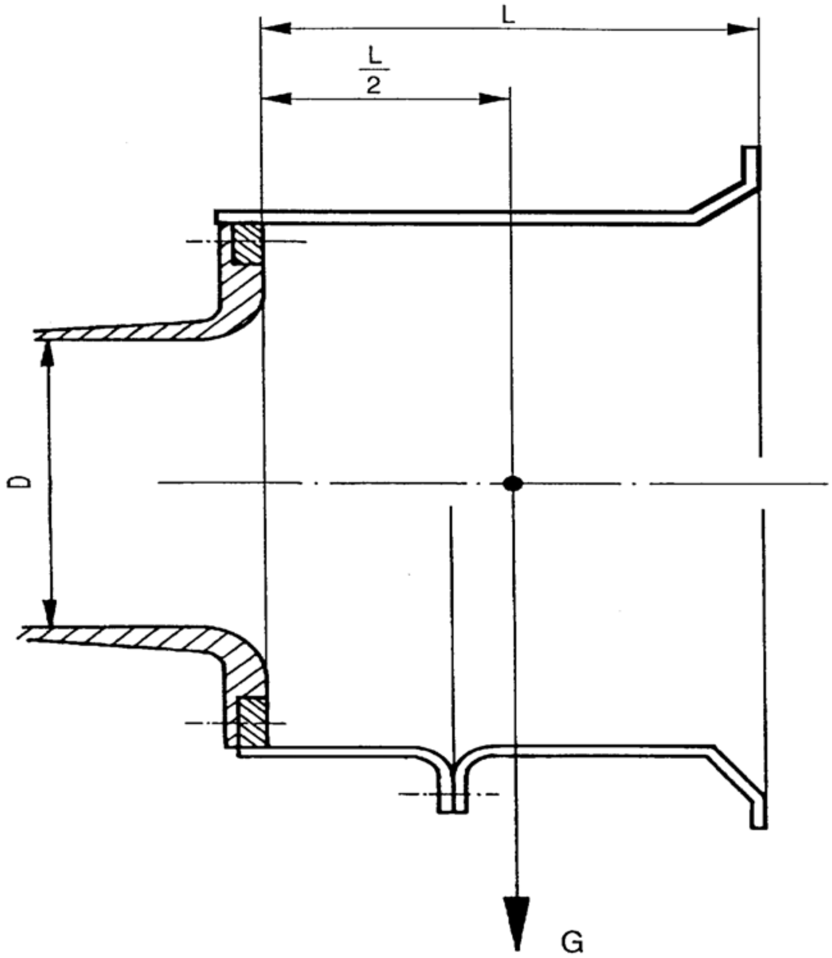
**<u>For air discharge ducts</u>**



A short **cooling air intake duct** (sheet thickness ≤1.5 mm) may be rigidly flanged onto the blower if a length of 300 mm or the following bending moments $M_B$ are not exceeded on the intake side from the connection on the cooling blower.

| | | |
|---|---|---|
| Blower diameter D up to | 335 mm: | $M_B \leq 5$ Nm |
| Blower diameter D above | 335 mm: | $M_B \leq 7$ Nm |

**FIG. 1 - 6**




$$M_B (Nm) = G (kg) \times 9{,}81 (m/s^2) \times \frac{L}{2} (m)$$

For the **discharge of cooling air** the engine scope of supply also includes adapter frames or in some cases also short cooling air discharge ducts.

A rigid cooling air discharge duct with a maximum length of 150 mm can be connected thereto (sheet metal thickness ≤1.5 mm).

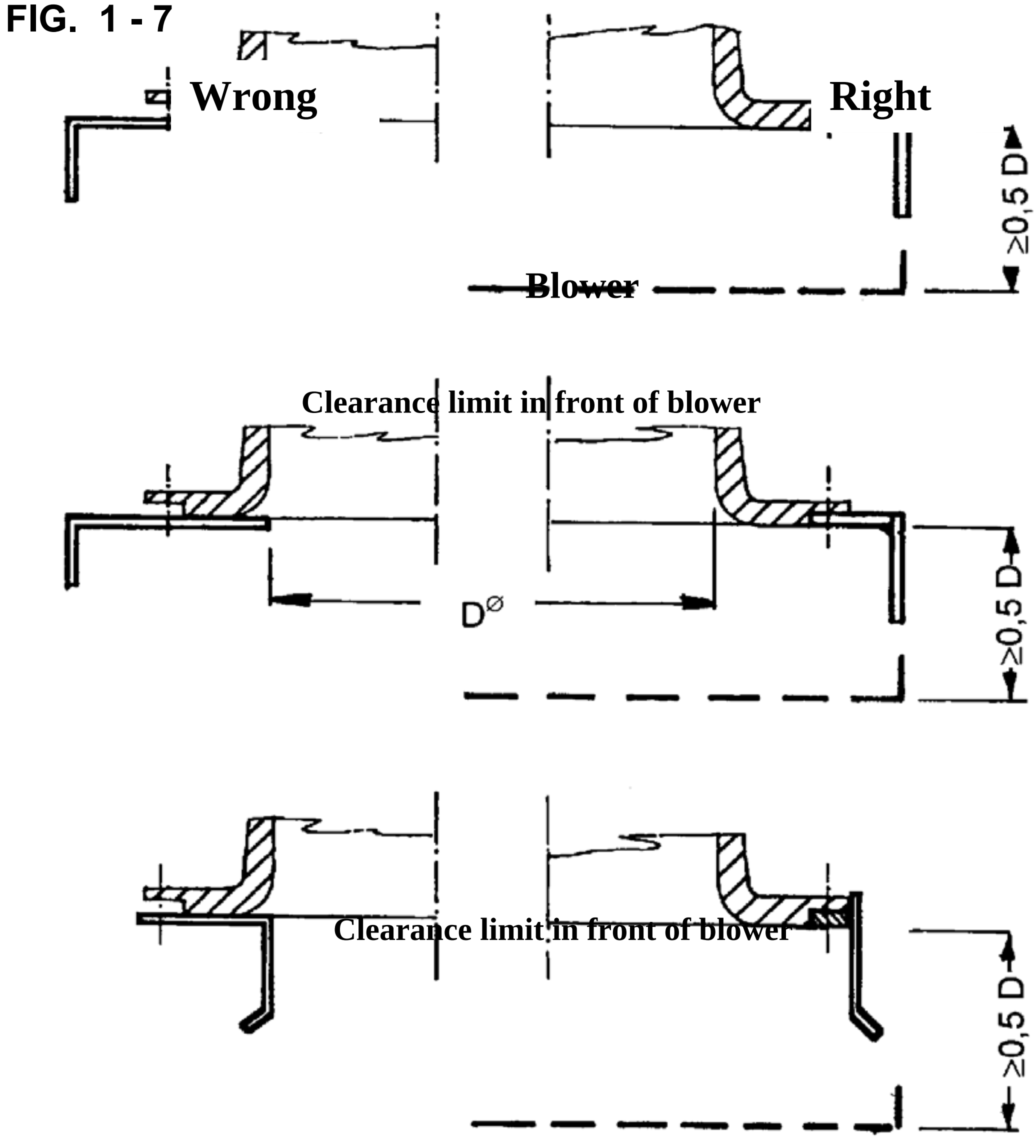
The ongoing cooling air duct must then be flexibly connected.

## 1.4 Connection of air intake duct to the blower

Blowers essentially draw in air within the area of the peripheral blower diameter. The outside blower casing diameter features an inlet radius on the air intake side for the purpose of noise reduction and avoidance of cooling air volume loss.

For this reason, no protruding edges on the blower inlet side are allowed to obstruct the free air inflow when mounting cooling air intake ducts. Such edges or corners increase the flow resistance resulting in a reduced cooling capacity and considerably increase the blower noise.

FIG. 1 - 7



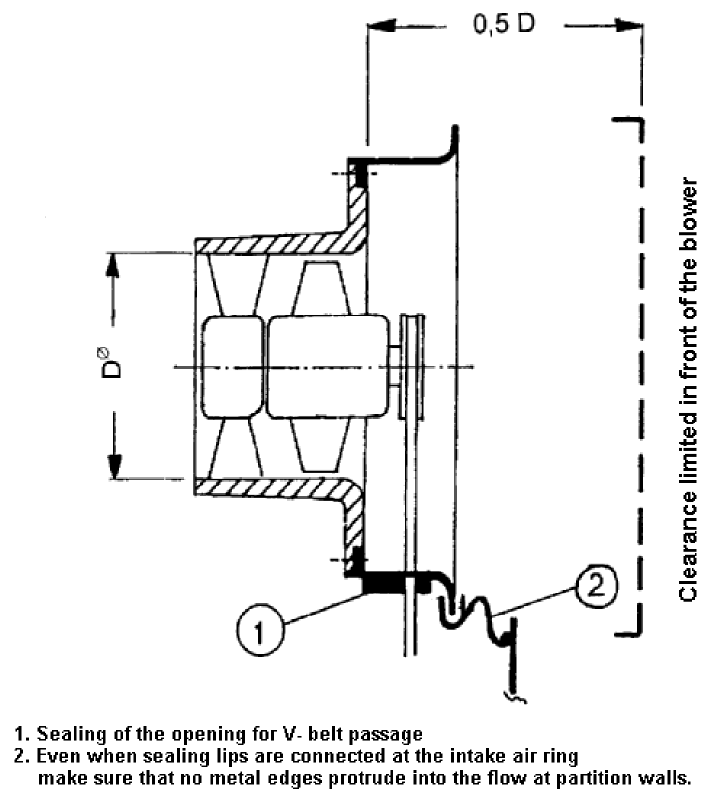

**Clearance limit in front of blower**

**Edges and restriction in front of the blower generate air turbulences exciting vibrations of the baffle plates and can, hence, jeopardize the strength of the baffle plates**

Customer-supplied extending air intake ducts must be matched to the inside blower casing diameter and to the inlet radius of the blower casing and are required to be connected permanently tight.

Below the schematics of the short, rigid cooling air intake ducts included in the scope of supply are shown to which any extending pipes can be connected in a flexibly and permanently tight manner.

FIG. 1 - 8

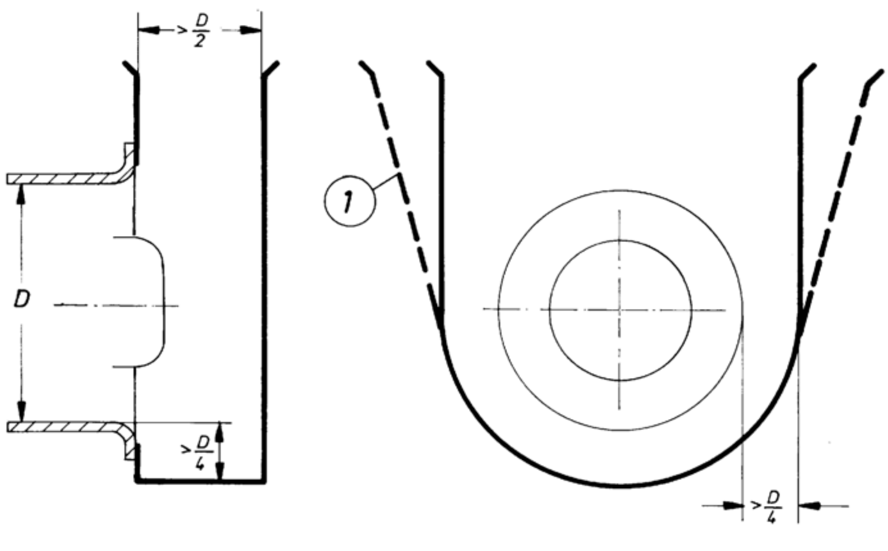



## 1.5 Dimensioning of short air intake ducts to the blower

In many cases the cooling air is supplied directly to the blower via a short air intake duct.

The following schematic shows the minimum dimensions to be observed:

FIG. 1 - 9

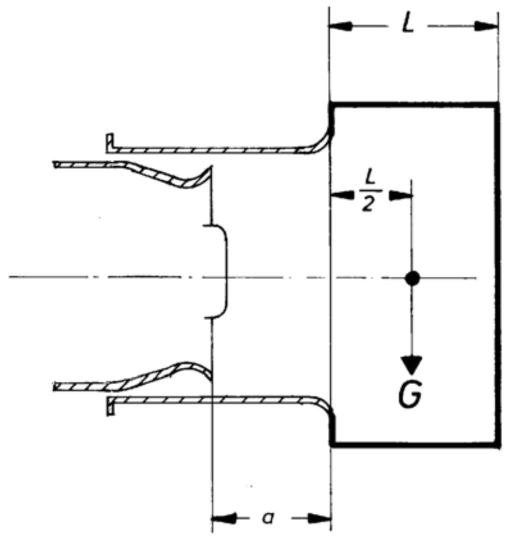


## 1.6 Connection of air intake and discharge ducts on B/FL 1011/2011

**Intake air:**
A short hood is available for the blower of the FL 1011/2011 engine series to which extending and flexibly sealing intake ducts (hood with profile rubber) may be connected.

If such intake ducts are rigidly connected to said hood, the admissible bending moments will apply, as mentioned before, with the center of gravity of the hood referring to the actual blower contour,

**FIG. 1 - 10**




$$M_B [Nm] = G[kg] \cdot 9{,}81 \cdot \left(a\,[m] + \frac{L}{2}\,[m]\right)$$

$a = 0{,}045\ m$

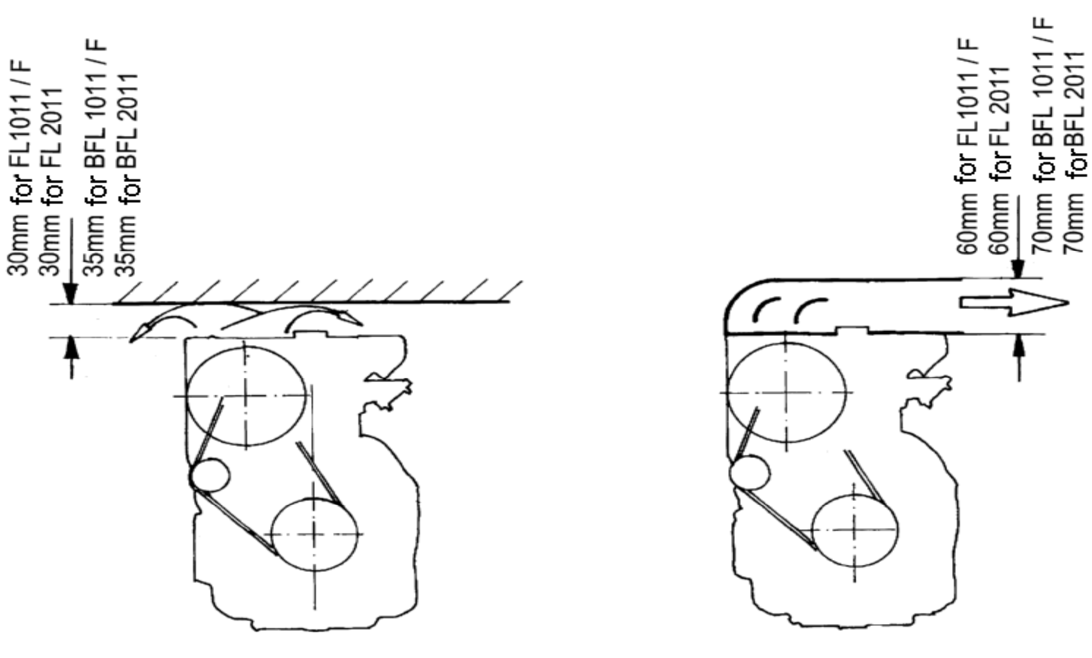
The data given before apply to the dimensioning of short air intake ducts directly mounted to the blower. As the FL 1011/2011 engines operate with so-called low pressure blowers it should be ensured that mounted air intake ducts are designed with favorable flow characteristics.

**Exhaust air:**
The air discharge frames included in the scope of supply for engine oil cooler and cylinder head exhaust air are suitable for rigid and flexible connection of duct extensions.

In the case of rigid duct connection, the maximum admissible length is 150 mm.

If the discharge air of the engine oil cooler can escape freely there must be a free space above the cooler core of 30 mm (35 mm for fully turbocharged engines). If a duct is connected, the installation space above cooler core must be 60 mm (70 mm for fully turbocharged engines).

**FIG. 1 - 11**




Dimensions always applicable as from cooler core surface

## 1.7 Admissible resistance in the cooling air system

### 1.7.1 General

Any disturbance in the free intake and discharge of cooling air represents a resistance which has to be overcome by the blower and which reduces the air volume rate. This applies in particular when air ducts are too narrow or tool long, when deflections occur in the air flow and when guards or decorative screens obstruct the intake and discharge openings. In this connection, attention should be paid to aerodynamically favorable designs, e.g. screens with adequate mesh size (e.g. 30 x 30 mm).

The effective pressure drop between the intake and exhaust side of the engine cylinders or oil cooler serves as a parameter for the cooling air volume flow rate. With free discharge of the hot exhaust air, the static pressure on the exhaust side behind the cylinders or the engine cooler equals the atmospheric pressure. The effective pressure drop then corresponds to the overpressure under the air cowling on the intake side of the cylinders or engine oil cooler. This overpressure is termed cowling pressure and can be measured with a U-tube connected to the cowling.

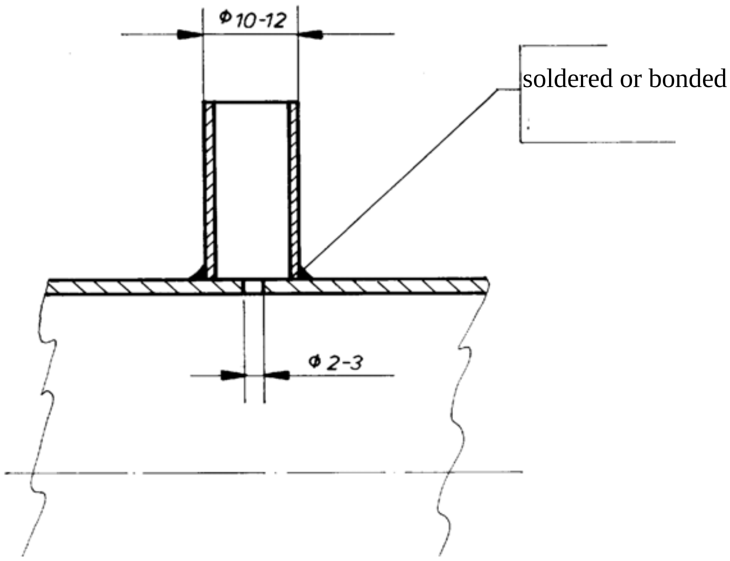
In order to obtain reproducible values the cowling pressure must always be measured at the same location. The pickup points for taking the cowling pressures are shown in the diagrams under 1.7.4.4 for the various engine models.

If large air intake and discharge ductings are involved (e.g. in buildings) pressure and flow conditions must be measured individually with the entire system.

### 1.7.2 Design of the pickup point for taking pressure at the cowling

When providing the pickup points, an even surface of 80 mm diameter must be provided on the air side of such a pickup point. Any sound-absorbent material in the vicinity of the pickup point must be removed. A bore with a diameter of 2 to 3 mm must be provided for measuring the cowling pressure. The drilling burrs must be removed whereby the bore may not be countersunk from below.

**FIG. 1 - 12**




For comparison purposes it is essential that measurements are always made at:

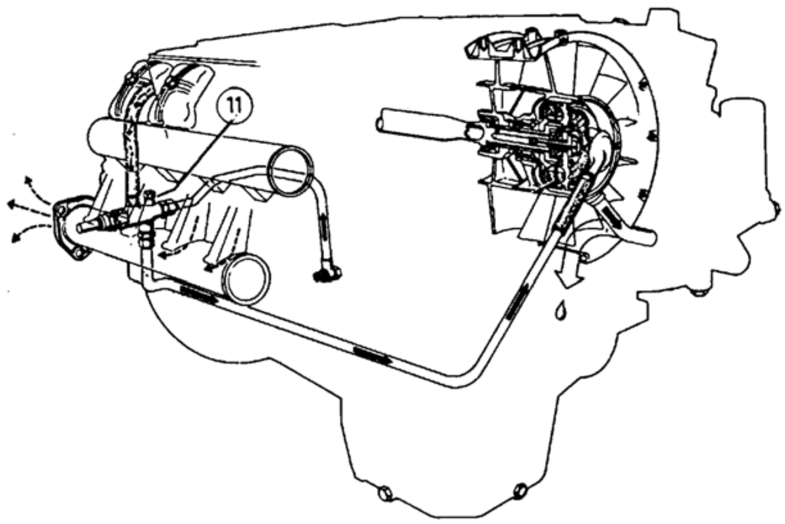
- the same engine load
- the same speed (admissible tolerance ± 0.5 %)
- the same engine temperature
- the same barometer reading (± 4 mbar) on the same day
- the same intake temperature, on the same engine

### 1.7.3 Cowling pressure measurement with non-ducted cooling air intake and hot air discharge

The nominal value of the effective pressure drop is measured on the free-standing engine as cowling pressure at high idling speed.

Note:
Hydraulic blower clutches must be fully engaged, i.e. the cooling air volume control by exhaust thermostat – fig. 1-13 - or electro-hydraulic blower control (EHG – fig. 1-14 – must be short-circuited).

**FIG. 1 - 13**

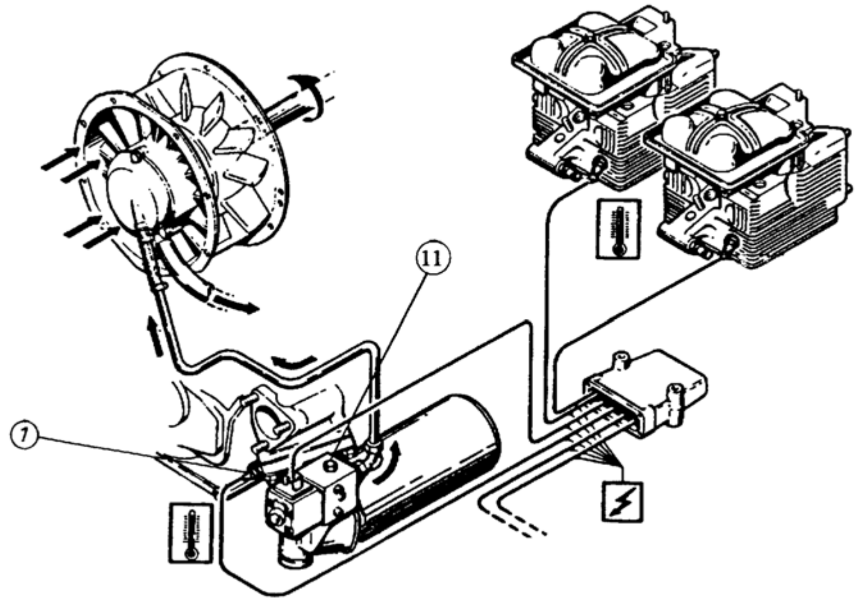



Cooling air volume control by exhaust thermostat
Short-circuit blower

(11) Short-circuiting screw with copper ring

- Remove copper ring
- Re-install set screw as far as it will go -
  thus blower control out of function, blower runs at full speed.

**FIG. 1 - 14**




Cooling air volume control by electro-hydraulic blower control (EHG) Short circuit cooling blower

Method 1:

(11) Short-circuiting screw

- Remove sealing washer on solenoid valve below short-circuiting screw.
- Re-install short-circuiting screw as far as it will go - thus blower control out of function, blower runs at full speed.

Method 2:

(1) Contact interruption

- Pull plug at 1 (oil temperature sensor) – failsafe logic of the electronics initiates full, non-controlled operation of blower.

### 1.7.4 Determination of the admissible cooling air throttling through air intake and discharge ducts

Prior to investigations the cowling pressure should be measured on the free-standing engine without cooling air intake and discharge ducts and without V-belt guard. The measured cowling pressure is a 100 % value.

### 1.7.4.1 Cooling air ducting without hot air discharge

With cooling air intake ducts, the cowling pressure may be at most 10 % lower than the value measured on the free-standing engine. A maximum pressure loss of 15 % is allowed if no temperature rise of the cooling air or combustion air takes place.

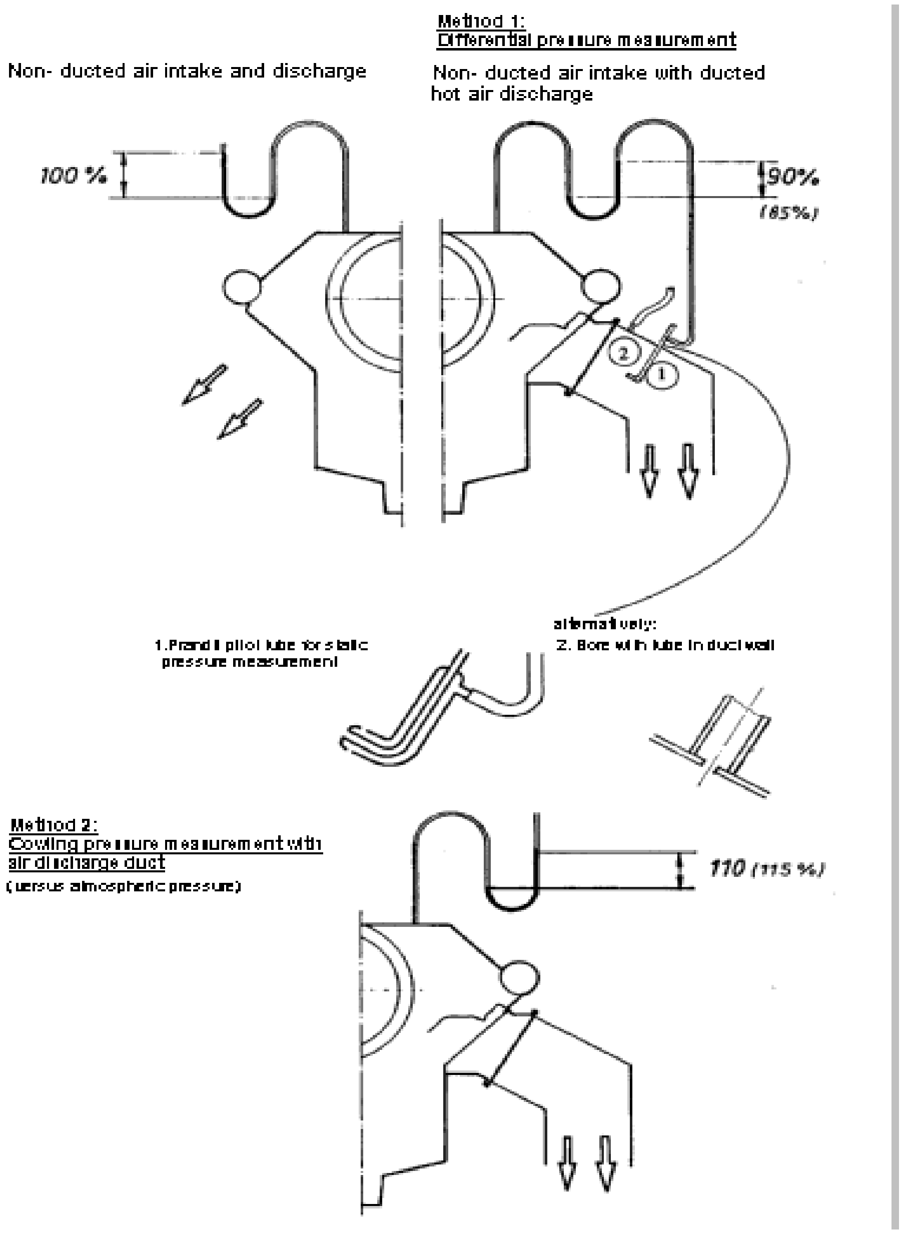
### 1.7.4.2 Hot air discharge without cooling air ducting

The measurement is made as a differential pressure measurement between the air cowling and the discharge duct by means of Prandtl's pilot tube (supplier Wilhelm Lambrecht KG, Göttingen, Germany). Again, the initial value is the cowling pressure of the free-standing engine (see diagram).

### 1.7.4.3 Cooling air intake and hot air discharge ducts

The measurements described above are to be carried out successively. The total pressure loss from both measurements must not exceed the values indicated, i.e. 10 % (15 %).

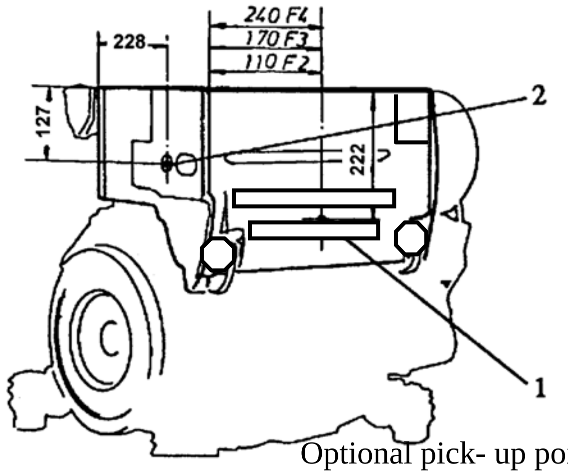
**FIG. 1 - 15**



### 1.7.4.4 Pickup points for cowling pressure measurement

**FIG. 1 - 16**

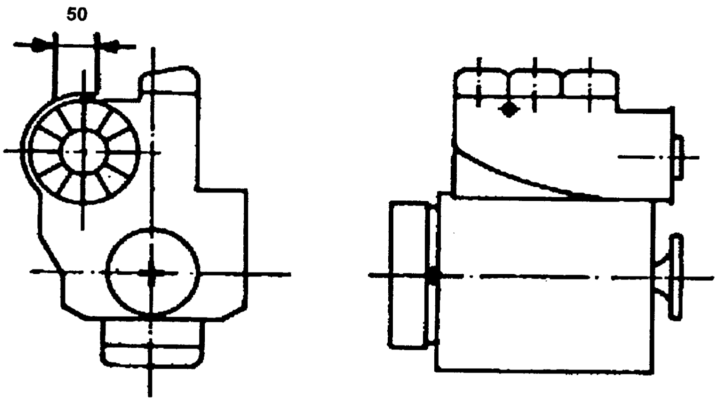
**B/F 2,3,4 L 1011F/ 2011**



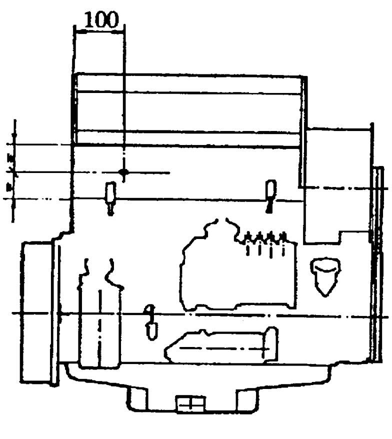

Optional pick- up point 1 or 2

**FIG. 1 - 17**

**B/F 2,3,4,5,6 L 912/913/914**



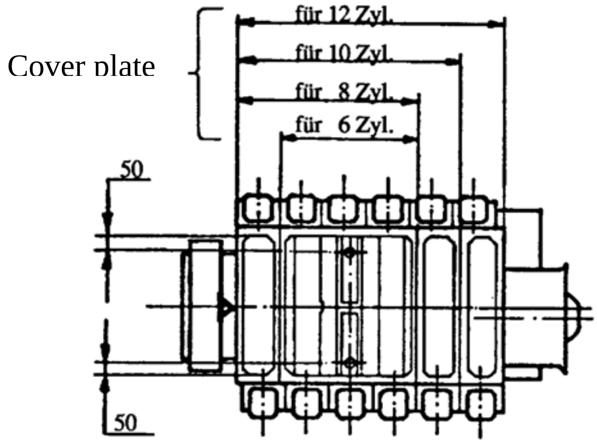

**B/F 4,6 L 913/914/C**



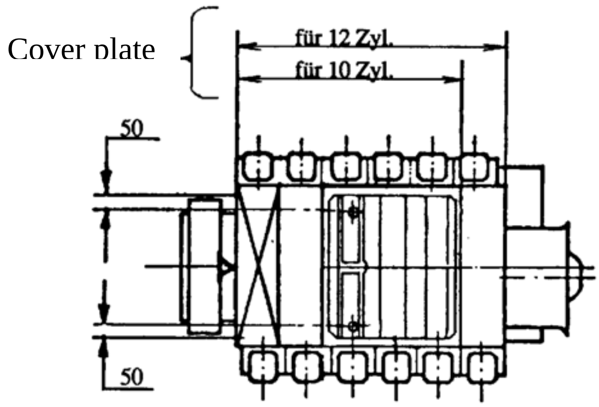

**Note:** All dimension for pick- up points refer to detachable section of crowling

## FIG. 1 - 18

**FL 413 F/FW**
**BF 12 L 413 FW**
**B/F L 513**




**F 10, 12 L 413 F/FW/513**
**BF 10, 12 L/513**
**with transmission oil cooler**




**F 6, 8 L 413 F/513**
**BF 8 L/513**

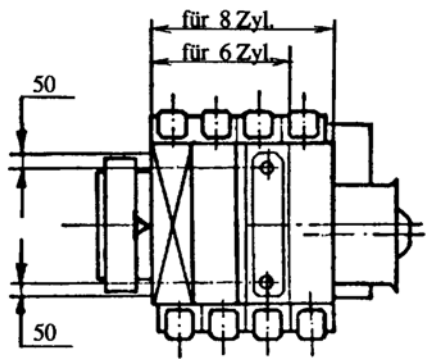
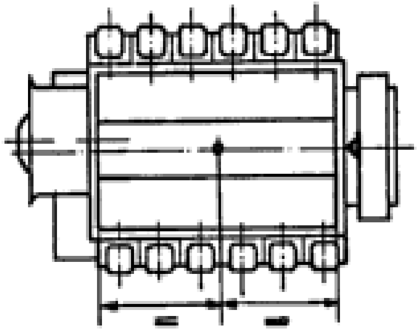


**FIG. 1 - 19**

**FL 413 F/FW/513**
**BF L 413 F/513**
**BF 12 L 413 FW/513**
with hydraulic oil cooler

**BF 12 L 513 C ***
with charge air cooler

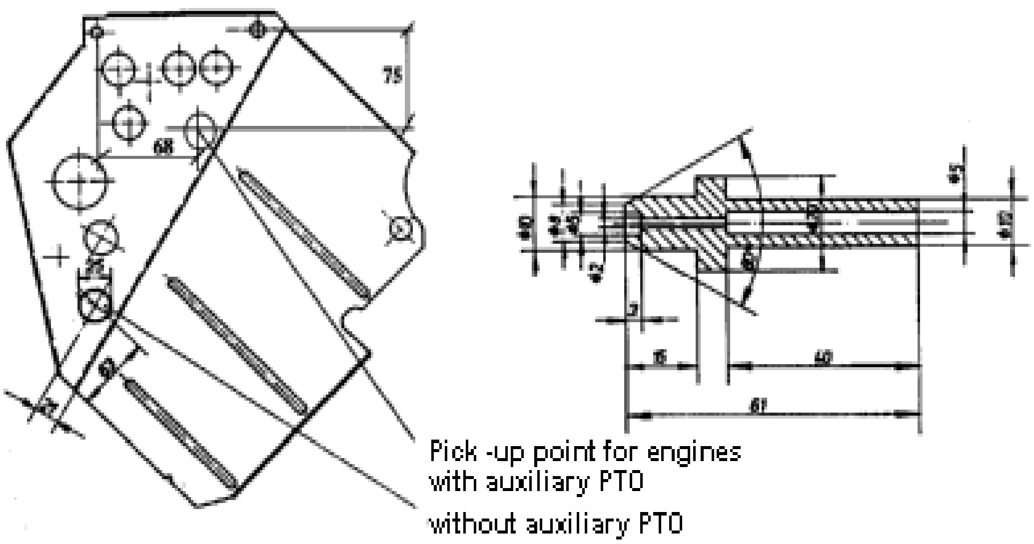


* If interfering with a crimp, pick- up point can be relocated up to 50mm in longitudinal direction of engine.

**FL 413 F**
**B/F L 513 /C**

Rear stay plate RH ( right side, when looking onto flywheel)

**Note:** The readings from pick-up top cover plate and pick-up point near star plate are not identical. Individual readings must not be combined for comparative purposes. One pick-up point must be chosen.



### 1.7.5 Minimum cross sections for air intake and discharge ducts

The minimum cross sections given in the table below can be used as design reference values for the layout of duct cross sections. They apply to duct lengths up to 4 m with an aerodynamically favorable deflection angle of up to 90°. When the engine is set into operation, the pressure situation must be rechecked.

The cross sections of the ducted air intake are sufficient for both cooling air and combustion air supply.

Reduced rated speeds (reduced blower speeds = reduced cooling air volumes) have no influence on the specified cross sections of the air ducts. Please contact our application engineering staff for special designs.

In the case of engines equipped with integrated auxiliary coolers (hydraulic, transmission oil coolers, etc.) their outer core cross section has to be added to the tabulated values (intake and exhaust air side).

**Free minimum cross sections in $m^2$ for following combinations of the cross sections I, II and III:**

**Combination of cross sections:**
Provided that the cross sections feature favorable flow characteristics, the following combination possibilities will apply:

**Table 2:**

| | **Kühlluftzuführung (Kaltluft)** | | **Kühlluftabführung (Warmluft)** | |
|---|---|---|---|---|
| | Nein | Ja | Nein | Ja |
| 1. | - | I | - | - |
| 2. | - | - | - | II |
| 3. | - | II | - | III |

Should the cross sections feature unfavorable flow characteristics, they must be enlarged – if necessary consult our application engineering staff.

*Table 3: Admissible cooling air cross sections in m²*

| *ENGINE MODEL* | *CROSS SECTION **I*** | *CROSS SECTION **II*** | *CROSS SECTION **III*** |
|---|---|---|---|
| | | | |
| *D 909 L01* | 0.010 | 0.015 | 0.020 |
| *D 910 L02* | 0.033 | 0.045 | 0.060 |
| *D 910 L03* | 0.053 | 0.068 | 0.102 |
| | | | |
| *F02L 1011 / F* | 0.026 | 0.040 | 0.060 |
| *F03L 1011 / F* | 0.041 | 0.060 | 0.090 |
| *BF03L 1011 FL* | 0.051 | 0.070 | 0.110 |
| *F04L 1011 / F* | 0.055 | 0.080 | 0.120 |
| *BF04L 1011 / FT* | 0.055 | 0.080 | 0.120 |
| *BF04L 1011 / F* | 0.065 | 0.090 | 0.140 |
| | | | |
| *F02L 2011* | 0.027 | 0.042 | 0.063 |
| *F03L 2011* | 0.044 | 0.065 | 0.098 |
| *BF03L 2011* | 0.055 | 0.081 | 0.122 |
| *F04L 2011* | 0.059 | 0.086 | 0.130 |
| *BF04L 2011* | 0.071 | 0.098 | 0.153 |
| | | | |
| *F03L 912 / W* | 0.062 | 0.090 | 0.135 |
| *F04L 912 / W* | 0.078 | 0.113 | 0.170 |
| *F05L 912 / W* | 0.100 | 0.147 | 0.220 |
| *F06L 912 / W* | 0.115 | 0.167 | 0.250 |
| | | | |
| *F03L 913* | 0.067 | 0.097 | 0.145 |
| *F04L 913* | 0.082 | 0.120 | 0.180 |
| *BF04L 913* | 0.100 | 0.144 | 0.216 |
| *BF04L 913 C* | 0.120 | 0.176 | 0.264 |
| *F06L 913* | 0.115 | 0.167 | 0.250 |
| *BF06L 913* | 0.148 | 0.214 | 0.320 |
| *BF06L 913 C* | 0.163 | 0.235 | 0.350 |
| | | | |
| *F03L 914* | 0.070 | 0.102 | 0.152 |
| *BF03L 914* | 0.074 | 0.110 | 0.160 |
| *F04L 914* | 0.087 | 0.127 | 0.190 |
| *BF04L 914* | 0.105 | 0.152 | 0.228 |
| *F05L 914* | 0.105 | 0.152 | 0.228 |
| *F06L 914* | 0.122 | 0.176 | 0.263 |
| *BF06L 914* | 0.157 | 0.226 | 0.338 |
| *BF06L 914 C* | 0.172 | 0.248 | 0.372 |
| | | | |
| *F06L 413 FW/F* | 0.180 | 0.260 | 0.390 |
| *F08L 413 FW/F* | 0.210 | 0.300 | 0.450 |
| *F10L 413 FW/F* | 0.293 | 0.422 | 0.630 |
| *F12L 413 FW/F* | 0.330 | 0.478 | 0.720 |
| *BF12L 413 FW/F* | 0.400 | 0.590 | 0.880 |
| *F08L 513* | 0.185 | 0.270 | 0.400 |
| *BF08L 513* | 0.240 | 0.350 | 0.520 |
| *BF08L 513 LC* | 0.270 | 0.390 | 0.580 |
| *F10L 513* | 0.250 | 0.360 | 0.540 |
| *BF10L 513* | 0.300 | 0.430 | 0.640 |
| *F12L 513* | 0.315 | 0.450 | 0.580 |
| *BF12L 513* | 0.354 | 0.512 | 0.767 |
| *BF12L 513 C* | 0.390 | 0.580 | 0.930 |

## 1.8 Heating up of cooling air

On its way from the environment up to a point directly in front of the blower inlet, the cooling air is allowed to rise by 10 °C.
IN exceptional cases, a temperature rise of 15 °C is admissible provided that the combustion air is not heated up too prior to entering the engine and there is no loss of cowling pressure (loss of cooling air volume).

In the case of engines with mounted V-belt guard, the cooling air temperature should be measured at the blower inlet, with disassembled V-belt guard, if a disturbance cannot be fully excluded.

Upon reassembly of the V-belt guard, the temperature at the blower inlet should be re-measured while observing the admissible temperature rise and pressure loss values. When measuring the cooling air temperature, it should be noted that the highest values are only obtained after a fairly extended operating period before they remain constant. Experience has shown that the steady-state condition is reached after about one hour of operation. Consequently, this is the minimum period for which the installation should be run with the load to be expected under actual operating conditions.

The temperatures have to be measured throughout the whole period of operation. The final readings should be taken in the steady-state condition under maximum operating load.

Since the cooling air in the blower does not mix and air drawn in at a specific blower sector is always passed to the same section of the engine, the admissible temperature rise may not be exceeded at any point at the blower inlet.
The whole inlet cross section of the cooling blower must therefore be scanned in the measurement. In practice 4 pickup points distributed evenly around the circumference are used, these just suffice for an evaluation. A mean value of the individual temperatures measured around the circumference may not be used for the evaluation.

**Table 4: Admissible combination of temperature rise and pressure drop**

| *Case* | *Cooling air heating* | *Heating up of combustion air* | *Cowling pressure loss* |
|---|---|---|---|
| *A* | *0 °C* | *0 °C* | *15 %* |
| *B* | *10 °C* | *10 °C* | *10 %* |
| *C* | *15 °C* | *0 °C* | *0 %* |

## 1.9 Cooling air filtration

When the engine is operated in particularly dust-laden ambient air such as combine harvesting, beet and fish meal handling, slag and dump sites or similar, the cooling air should be filtered.

The following possibilities are available:

### 1.9.1 Rigid screen duct of perforated plating

An air intake duct is fitted upstream of the engine blower the inlet cross section of which is covered by a perforated plate for coarse filtration purposes. The cross section of the perforated plate must be designed to the effect that the cooling air velocity within the cross sectional area is ≤ 2 m/sec.

The required free plating cross section can be determined according to the following formula:

$$F = Q_V / c$$

$Q_V$ = cooling air volume flow rate ($m^3$/sec)
c = admissible air velocity in the plating cross section (m/sec)

The customer should either ask the acquisition staff for the cooling air volume flow rate or take the value from the Technical Pocket Book.

The individual perforation diameter should be approx. 3 mm with a pitch of 5 mm. The perforated plating should be arranged in a vertical position or feature a negative inclination so that air-borne debris can fall down by gravity.

### 1.9.2 Rotating screen

Rotating screens (drums) upstream of the blower offer the advantage that, as a consequence of the centrifugal forces acting on the circumference of the perforated plate drums or rotating screen, dirt deposits (and clogging) will be avoided.

The perforated plate size of rotating screens is equal to that of the rigid screen duct. However, the screen drum rotation perpendicular to the cooling air flow may have an adverse effect as, depending on the diameter and speed of the rotating drum, high peripheral speeds of 20 to 40 m/s may occur. As a consequence, the flow resistance in the rotating drum will increase and the cooling air volume flow rate will decrease resulting in an inadmissible cowling pressure drop on the engine.

Correspondingly, large cross sections are to be selected. This usually requires a proper matching of the screen area/rotating screen speed ratio to ensure an optimum flow.

### 1.9.3 Cooling air cyclone

Filtration of cooling air via so-called cyclones upstream of the blower (precleaning by air swirl and dust collection by blowout) has been tested for some applications. Proper functioning of this type of filtration is very much dependent on the type of dust and is not suitable for fine dust particles. So please consult head office if applicable.

Some reputed manufacturers of combustion air filters offer packages of several small cyclones connected in parallel with automatic dust collection via separate scavenging air blower. These cyclone systems, which are also suitable for fine dust particles, are designed and supplied by the filter manufacturers depending on the volume of the cooling air flow and with due consideration of the admissible cooling air pressure loss. It is urgently recommended to have DEUTZ investigate and evaluate the cyclone systems after assembly to the engine blower.

### 1.9.4 Cooling air filter mats

The filtration of cooling air through so-called filter mats offers in addition to the filtering effect the advantage of a certain noise reduction on the intake air side. Filter mats are partially made of washable, synthetic knitwear or so-called fleece: their dimensioning and rating (admissible air inflow velocities, pressure losses) should be coordinated in cooperation with the respective manufacturers.

Filter mats are to be configured and arranged in such a way as to allow easy and simple maintenance as it may be necessary to clean them several times a day. When contaminated, the cooling air passage will be restricted resulting in thermal overload of the engine if maintenance is not carried out in time.

A differential pressure gauge is fitted to monitor the actual operating condition. When the pressure difference at the cooling air filter has reached the maximum admissible value, the filter mat has to be cleaned or replaced with a new one. The application engineering staff should be consulted to determine the maximum admissible pressure difference until filter maintenance becomes necessary.

In the new condition the pressure loss should not exceed abt.
5 % of the cooling air cowling pressure of the engine.

Filter mats are particularly suitable for fine-grained, aggressive dust.

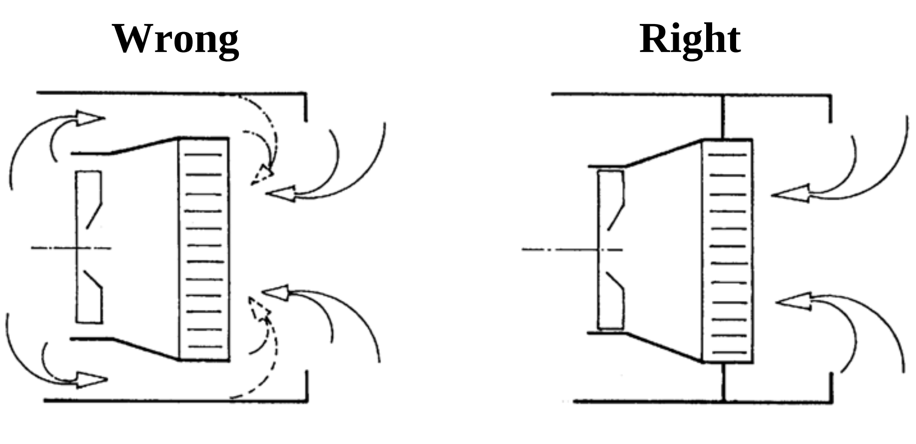
The additional installation of a cylinder head temperature measuring system (ZTS) for engine monitoring is necessary in engines which use cooling air filter mats.

## 1.10 Cooling air system B/FM 1011F / 2011

The DEUTZ engines of the B/FM 1011F / 2011 series which are completely cooled with oil are so-called liquid-cooled engines and are equipped with a separate heat exchanger of the same kind as that of conventional water-cooled engines.

When installing the air/oil heat exchangers it must be ensured that no hot exhaust air is drawn in as cooling air.

**FIG. 1 - 20**




- large radial gap at air cleaner
- no partition wall

- small radial gap at air cleaner
- built- in partition wall

The admissible heating limits for the cooling and combustion air relative to the cooling air volume loss are analogous to those applicable to air-cooled engines. However, it is essential to remember that every rise in the cooling air temperature by one degree is associated with a reduction in the cooling capacity of the cooling system.

### 1.10.1 Dimensioning of the cooling air ducts

Because of the higher cooling air requirement of the oil-cooled engines and the lower feed height of the fans – which only allow low flow resistances – the free intake and discharge air cross sections of air intake ducts in B/FM1011F/2011 engines must be designed about three times as high as in the B/FL1011/2011 engines according to the table 3 “Cooling air cross sections” above.

Generally, the cross section of the air duct is specified by the network cross section of the cooler. The cross section should be calculated if narrowing of the ducts is necessary.
The calculations of the intake and discharge air duct cross sections must be made with the relevant air volumes V (m³/s) and under consideration of a flow speed c of about 3 to 4 (m/sec) according to the law of continuity.

$$\mathbf{F_{duct} = V \ / \ c}$$

The corresponding cooling air volumes **V**(m³/s) or air masses **m** (kg/s) sshould be taken from the Technical Pocket Book or requested from the acquisition staff or Technical Sales Support at head office.

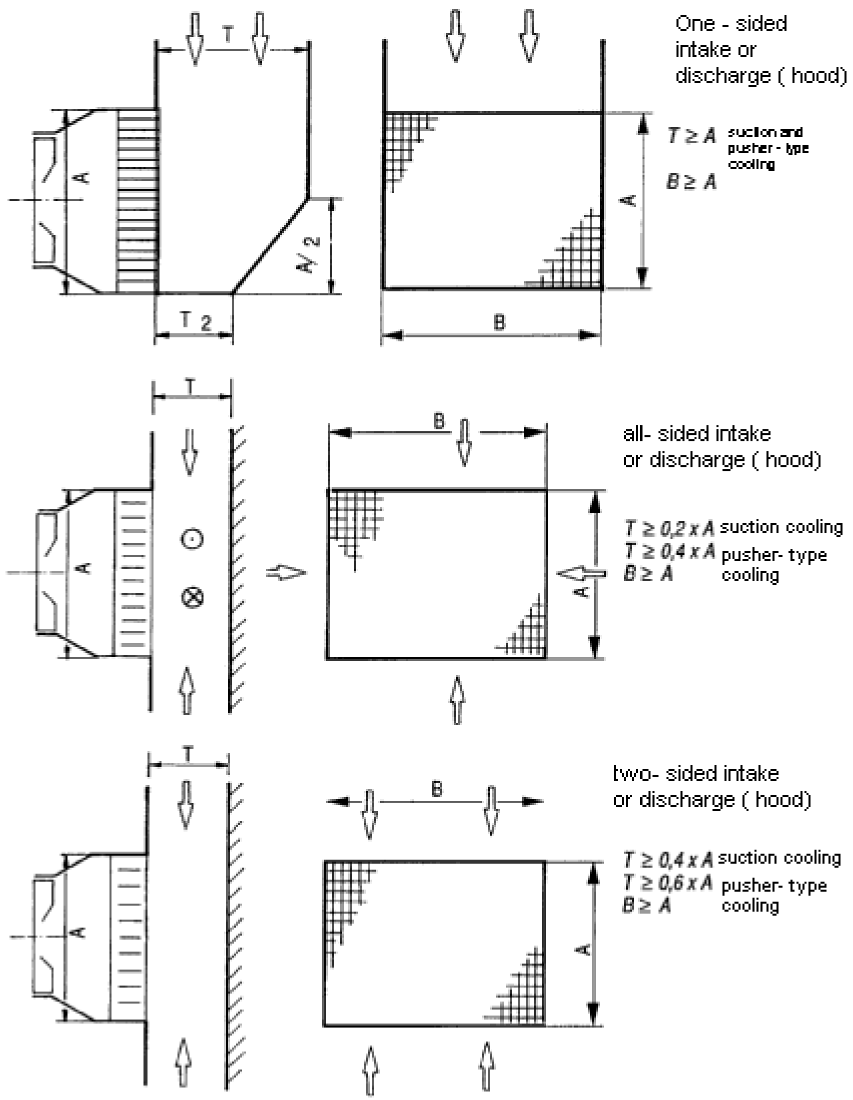
Conversion between volume and mass:

**V** (m³/s) = **m** (kg/s) / 1.168 (kg/m³)

The data in the following figure apply as reference values for dimensioning when connecting the cooling air ducts to the cooler network. A flow speed of 6 to 8 m/s can be assumed for short ducts. The change in volume of hot air (exhaust air) must be taken into account.

**FIG. 1 - 21**

The following data apply as reference examples



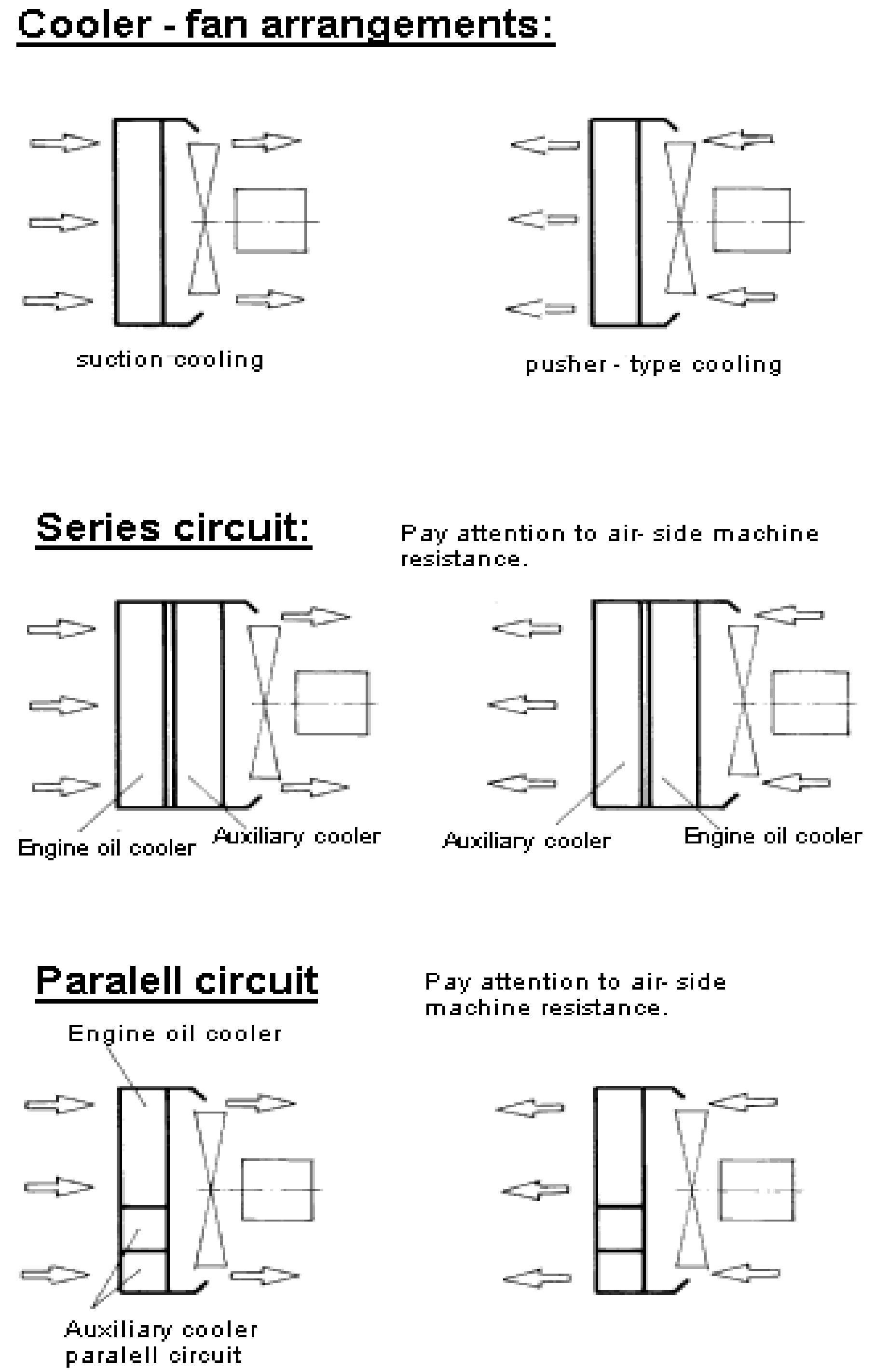

## 1.10.2 Cooler – fan arrangements

When installing auxiliary coolers for hydraulic oil or air/air coolers (intercoolers), these auxiliary coolers must either be

- connected in series with the air-oil heat exchanger of the engine (in suction fans) or
- in parallel circuit next to the air-oil heat exchanger of the engine (suction or push-type fans)

In both auxiliary fan arrangements the flow volume of the fan must be increased accordingly by increasing the speed or enlarging the fan diameter. The intake and discharge air duct cross sections must then be re-dimensioned according to the then valid air volumes and under consideration of a flow speed of abt. 3 to 4 m/s.

FIG. 1 - 22




See the following chapter for further information.

## 1.11 B/FM 1011F / 2011 – engine oil cooling (cooling oil system)

In the DEUTZ engines of the B/FL 1011 F / 2011 and B/FM 1011 F / 2011 series the engine lube oil also cools the whole cylinder head in addition to the cylinder block.

The engine oil in the B/FM 1011 F / 2011 engines is re-cooled by an external oil-air heat exchanger.

These external oil-air heat exchangers are optimized systems with respect to cooling capacity / construction / air requirement / fan size / fan power requirement and are part of the DEUTZ scope of supply.

If the cooling system is not supplied by DEUTZ and designed by a specialist OEM, the following specifications are necessary:

- The heat volume of the engine to be discharged by the cooling oil;
- Oil content of the heat exchanger (preferable below 20 % of the total oil volume in the engine oil tray);
- Oil volume flow (l/min) and
- admissible flow resistance (bar) of the cooler, oil side;
- Maximum admissible permanent oil temperature at the heat exchanger inlet;
- Maximum cooling air temperature (°C) at the cooler inlet.

  It should be noted here that with a push-type fan – the fan sucks cooling air from the engine compartment and pushes the air through the cooler – the temperature of the cooling air increases considerably due to the heat radiating from the engine crankcase and the exhaust system and is above ambient temperature.
  **You should therefore reckon with abt. 10°C to 15°C pre-heating of the cooling air before it enters the cooler**.

  The heat volume radiated by the engine can be determined as a function of the engine power P (kW) as an approximate value
  $Q_{radiated} = 165 \times P$ [kcal/h]
- Air flow of the fan ($m^3$/min) dependent on the speed and the flow resistances (mbar) through cooler network and air ducts;
- If auxiliary coolers (pre-mounted coolers, side-by-side mounting) are planned, the fan size and engine oil cooler size must be adapted.

### 1.11.1 Heat volume to be discharged

The following heat volumes must be discharged by the cooling oil in the DEUTZ diesel engines B/FM 1011F / 2011:

Specific heat volumes:

For naturally aspirated engines $c_1 = 0.52 \ldots 0.56$ {kW heat/kW engine power}

For turbocharged engines without intercooling $c_2 = 0.60 \ldots 0.62$ {kW heat/kW engine power}

With the respective engine power P (kW) this gives a
**volume of heat to be discharged:**

$$Q\,(kW) = c_1 \times P = (0.52 \ldots 0.56) \times P$$ for naturally aspirated engines

$$Q\,(kW) = c_1 \times P = (0.60 \ldots 0.62) \times P$$ for turbocharged engines

As a recommendation it applies that the re-cooling capacity of the oil-air heat exchanger should be represented at an input temperature difference between the oil inlet and the air inlet of 120°C - 40°C = 80 °C (ITD = 80 °C).

| Max. admissible oil temperature at the cooler inlet: 135 °C (2011 140 °C) |
|---|

A designed and installed cooling system must be subjected to testing for evaluation, whereby the B/FM 1011F / 2011 engine with open blocked oil thermostat is subjected to continuous load with its respective blocked capacity.

The temperature difference between the determined oil temperature at the cooler inlet and the air temperature in the free, outdoor environment gives the cooling constant of the cooling system which may have to be increased by abt. 5 °C due to the influence of contamination.

The difference between the maximum admissible oil temperature at the cooler inlet (equal to engine outlet) and the determined cooling constant raised by 5 °C gives the maximum ambient temperature up to which the oil temperature limit is held by the cooler – see the following example:

**Example:**

ambient temperature: $t_U = 25$ [°C]
Equipment test under full load up to steady state of the oil temperature,
oil temperature measured at the cooler inlet

(suction cooling): $t_{oil\ in} = 105$ [°C]

Cooling constant: $\Delta t_1 = t_{oil\ in} - t_U = 80$ [°C]

Extended cooling constant due to
influence of contamination: $\Delta t_2 = \Delta t_1 + 5 = 85$ [°C]

Maximum ambient temperature range:

$t_{Umax} = t_{oil\ max\ perm.} - \Delta t_2 = 135 - 85 =$

$t_{Umax} = 50$ [°C]

**NOTE:**
The theoretical example shows a rough determination of the cooler limit from measured temperature data. Because of the strong dependence of a cooler on the air mass flow, a correction is always necessary which takes into account the influence of the air density on the cooling air mass flow as a result of geodetic height and temperature – in addition to the factors engine load, engine room temperature and cooling air temperature at the network inlet.
Consult the application engineering staff if applicable.

### 1.11.2 Oil cooling schematic diagram

The following oil circuit schematic explains the lube and cooling oil flow through the engine and the coolers (external and engine-integrated).

**FIG. 1-23 Oil circuit schematic in B/FL/FM 1011F / 2011**

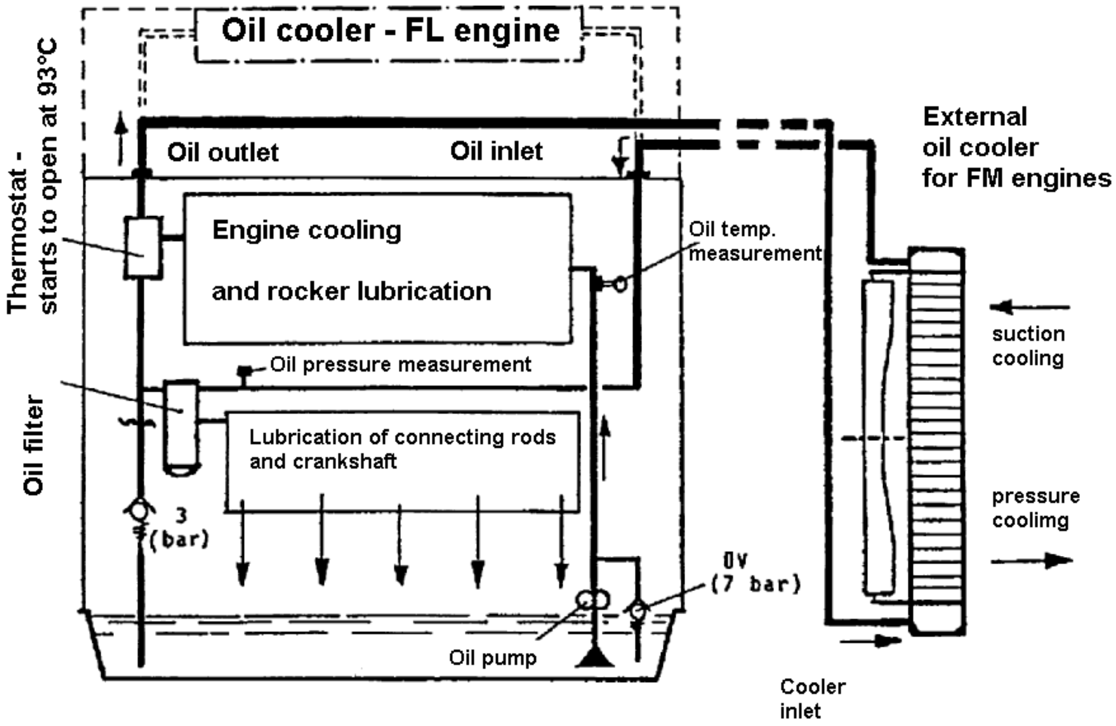
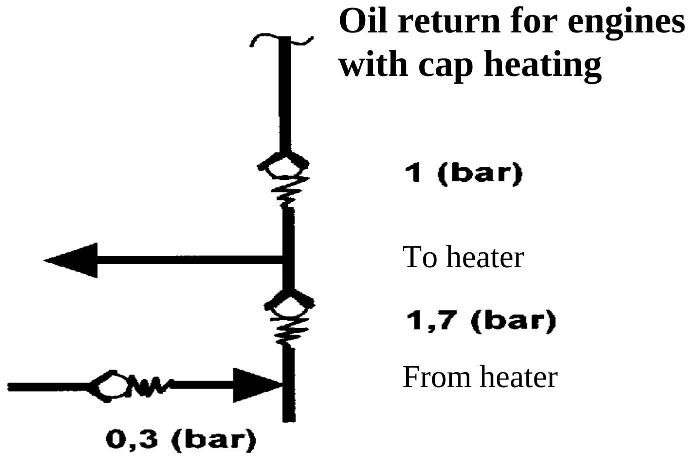



**FIG. 1-24 Branch in the oil return to the heating system**



## 1.11.3 Calculation data for B/FM 2011 engines

**FIG. 1 - 25**

# Kühlsystem - Berechnungsdaten / Cooling system - calculation data

***F2M2011***

Stand/Edition: Feb 01

| | Intermittierender Betrieb; G Leistung / Intermittend operation; G power | | | | | Dauerbetrieb; G Leistung / Continuous operation; G power | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Motordrehzahl / engine speed [$min^{-1}$] 1) | 2800 | 2600 | 2500 | 2300 | 2000 | 2800 | 2600 | 2500 | 2300 | 2000 | 1800 | 1500 |
| Motorleistung / Engine power [kW] | 24,2 | 23,0 | 22,2 | 21,0 | 18,2 | 23,0 | 21,7 | 21,0 | 20,0 | 17,4 | 16,0 | 12,5 |
| Mitteldruck / Mean eff. pressure [bar] | 6,7 | 6,9 | 6,9 | 7,1 | 7,1 | 6,4 | 6,5 | 6,5 | 6,7 | 6,7 | 6,9 | 6,5 |
| Md-Anstieg / Torque rise [ % ] | 13% | 11% | 9% | 6% | - | 13% | 11% | 9% | 6% | - | - | - |

| Engine oil cooler Oil-side resistance <0.35 bar | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kühlleistung / Cooling capacity [kW] | 12,8 | 12,2 | 11,8 | 11,1 | 9,6 | 12,2 | 11,5 | 11,1 | 10,6 | 9,2 | 8,5 | 6,6 |
| Ölmenge / Oil volume flow rate [l/min] | 39 | 37 | 35 | 32 | 28 | 39 | 37 | 35 | 32 | 28 | 25 | 21 |
| max. zul. Öltemp. Kühlereintritt [°C] Max. perm. oil temperature cooler inlet | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 |

Die Umgebungstemperatur und Aufstellhöhe muß vom Kunden definiert werden

1) Bei hiervon abweichenden Motoreinstellungen ist eine Rückfrage im Stammhaus erforderlich

Ambient temperature and erection altitude must be defined by the customer.

1) In case of deviating settings, it is necessary to consult the head office.

FIG. 1 - 26

# Kühlsystem - Berechnungsdaten / Cooling system - calculation data

## *F3M2011*

Stand/Edition: Feb 01

| | Intermittierender Betrieb; G Leistung<br>Intermittend operation; G power | | | | | Dauerbetrieb; G Leistung<br>Continuous operation; G power | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Motordrehzahl / engine speed [$min^{-1}$] 1) | 2800 | 2600 | 2500 | 2300 | 2000 | 2800 | 2600 | 2500 | 2300 | 2000 | 1800 | 1500 |
| Motorleistung / Engine power [kW] | 36,5 | 34,5 | 33,5 | 31,5 | 27,5 | 34,7 | 32,8 | 31,8 | 29,9 | 26,1 | 24,0 | 19,0 |
| Mitteldruck / Mean eff. pressure [bar] | 6,7 | 6,8 | 6,9 | 7,1 | 7,1 | 6,4 | 6,5 | 6,6 | 6,7 | 6,7 | 6,9 | 6,5 |
| Md-Anstieg / Torque rise [ % ] | 13% | 11% | 9% | 6% | - | 13% | 11% | 9% | 6% | - | - | - |

| ölseitiger Widerstand <0,35 bar<br>Engine oil cooler Oil-side resistance <0.35 bar | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kühlleistung / Cooling capacity [kW] | 20,1 | 19,0 | 18,4 | 17,3 | 15,1 | 19,1 | 18,0 | 17,5 | 16,4 | 14,4 | 13,2 | 10,5 |
| Ölmenge / Oil volume flow rate [l/min] | 35 | 33 | 32 | 29 | 26 | 35 | 33 | 32 | 29 | 26 | 23 | 19 |
| max. zul. Öltemp. Kühlereintritt [°C]<br>Max. perm. oil temperature cooler inlet | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 |

Die Umgebungstemperatur und Aufstellhöhe muß vom Kunden definiert werden
1) Bei hiervon abweichenden Motoreinstellungen ist eine Rückfrage im Stammhaus erforderlich
Ambient temperature and erection altitude must be defined by the customer.
1) In case of deviating settings, it is necessary to consult the head office.

FIG. 1 - 27

# Kühlsystem - Berechnungsdaten / Cooling system - calculation data

## *BF3M2011*

Stand/Edition: Feb 01

| | Intermittierender Betrieb; G Leistung<br>Intermittend operation; G power | | | | | Dauerbetrieb; G Leistung<br>Continuous operation; G power | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Motordrehzahl / engine speed [min$^{-1}$] 1) | 2800 | 2600 | 2500 | 2300 | 2000 | 2800 | 2600 | 2500 | 2300 | 2000 | 1800 | 1500 |
| Motorleistung / Engine power [kW] | 48,5 | 46,0 | 45,0 | 42,0 | 37,5 | 46,0 | 44,1 | 42,75 | 40,0 | 35,6 | 32,0 | 24,5 |
| Mitteldruck / Mean eff. pressure [bar] | 8,9 | 9,1 | 9,3 | 9,4 | 9,7 | 8,5 | 8,7 | 8,8 | 8,9 | 9,2 | 9,1 | 8,4 |
| Md-Anstieg / Torque rise [%] | 15% | 13% | 11% | 9% | - | 15% | 13% | 11% | 9% | - | - | - |

| Engine oil cooler Oil-side resistance <0.35 bar | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kühlleistung / Cooling capacity [kW] | 29,8 | 28,3 | 27,5 | 25,5 | 23,0 | 28,3 | 27,1 | 26,1 | 24,4 | 21,7 | 19,5 | 14,9 |
| Ölmenge / Oil volume flow rate [l/min] | 35 | 33 | 32 | 29 | 26 | 35 | 33 | 32 | 29 | 26 | 23 | 19 |
| max. zul. Öltemp. Kühlereintritt<br>Max. perm. oil temperature cooler inlet [°C] | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 |

Die Umgebungstemperatur und Aufstellhöhe muß vom Kunden definiert werden

1) Bei hiervon abweichenden Motoreinstellungen ist eine Rückfrage im Stammhaus erforderlich

Ambient temperature and erection altitude must be defined by the customer.

1) In case of deviating settings, it is necessary to consult the head office.

FIG. 1 - 28

# Kühlsystem - Berechnungsdaten / Cooling system - calculation data

## *F4M2011*

Stand/Edition: Feb 01

| | | Intermittierender Betrieb; G Leistung Intermittend operation; G power | | | | | Dauerbetrieb; G Leistung Continuous operation; G power | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Motordrehzahl / engine speed | $[min^{-1}]$ 1) | 2800 | 2600 | 2500 | 2300 | 2000 | 2800 | 2600 | 2500 | 2300 | 2000 | 1800 | 1500 |
| Motorleistung / Engine power | [kW] | 48,5 | 46,5 | 45,0 | 42,5 | 37,5 | 46,1 | 44,6 | 42,7 | 40,4 | 35,6 | 32,1 | 25,2 |
| Mitteldruck / Mean eff. pressure | [bar] | 6,7 | 6,9 | 7,0 | 7,1 | 7,2 | 6,4 | 6,6 | 6,6 | 6,8 | 6,9 | 6,9 | 6,5 |
| Md-Anstieg / Torque rise | [ % ] | 13% | 11% | 9% | 6% | - | 13% | 11% | 9% | 6% | - | - | - |
| **Engine oil cooler** Oil-side resistance <0.35 bar | | | | | | | | | | | | | |
| Kühlleistung / Cooling capacity | [kW] | 27,2 | 26,0 | 25,2 | 23,8 | 21,0 | 25,8 | 25,0 | 23,9 | 22,6 | 19,9 | 18,0 | 14,1 |
| Ölmenge / Oil volume flow rate | [l/min] | 41 | 40 | 39 | 37 | 35 | 41 | 40 | 39 | 37 | 35 | 32 | 27 |
| max. zul. Öltemp. Kühlereintritt / Max. perm. oil temperature cooler inlet | [°C] | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 |

Die Umgebungstemperatur und Aufstellhöhe muß vom Kunden definiert werden
1) Bei hiervon abweichenden Motoreinstellungen ist eine Rückfrage im Stammhaus erforderlich
Ambient temperature and erection altitude must be defined by the customer.
1) In case of deviating settings, it is necessary to consult the head office.

FIG. 1 - 29

# Kühlsystem - Berechnungsdaten / Cooling system - calculation data

## *BF3M2011*

Stand/Edition: Feb 01

| | Intermittierender Betrieb; G Leistung Intermittend operation; G power | | | | | Dauerbetrieb; G Leistung Continuous operation; G power | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Motordrehzahl / engine speed [min$^{-1}$] 1) | 2800 | 2600 | 2500 | 2300 | 2000 | 2800 | 2600 | 2500 | 2300 | 2000 | 1800 | 1500 |
| Motorleistung / Engine power [kW] | 48,5 | 46,0 | 45,0 | 42,0 | 37,5 | 46,0 | 44,1 | 42,75 | 40,0 | 35,6 | 32,0 | 24,5 |
| Mitteldruck / Mean eff. pressure [bar] | 8,9 | 9,1 | 9,3 | 9,4 | 9,7 | 8,5 | 8,7 | 8,8 | 8,9 | 9,2 | 9,1 | 8,4 |
| Md-Anstieg / Torque rise [ % ] | 15% | 13% | 11% | 9% | - | 15% | 13% | 11% | 9% | - | - | - |
| **Engine oil cooler** Oil-side resistance <0.35 bar | | | | | | | | | | | | |
| Kühlleistung / Cooling capacity [kW] | 29,8 | 28,3 | 27,5 | 25,5 | 23,0 | 28,3 | 27,1 | 26,1 | 24,4 | 21,7 | 19,5 | 14,9 |
| Ölmenge / Oil volume flow rate [l/min] | 35 | 33 | 32 | 29 | 26 | 35 | 33 | 32 | 29 | 26 | 23 | 19 |
| max. zul. Öltemp. Kühlereintritt [°C] Max. perm. oil temperature cooler inlet | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 |

Die Umgebungstemperatur und Aufstellhöhe muß vom Kunden definiert werden
1) Bei hiervon abweichenden Motoreinstellungen ist eine Rückfrage im Stammhaus erforderlich
Ambient temperature and erection altitude must be defined by the customer.
1) In case of deviating settings, it is necessary to consult the head office.

### 1.11.4 Standard cooling system for B/FM 2011 engines

The cooling systems listed below are not offered by DEUTZ, consult the named cooler or fan manufacturers where applicable:
**AKG**, 34363 Hofgeismar, Postfach 1305/1346, Phone: 05671/883.339, Fax.: 05671 3582
**Alu-Kunststoff-Technik**, 90427 Hemhofen, Eichendorffstr. 21, Phone: 09195 9447 27, Fax: 09195 9449 30
On the basis of the cooling –specific parameters, standard cooling systems including fan and speed allocation have been calculated and given here as recommendations.
The following requirements are defined for the cooling systems:

- Area of application: building machine (low-contamination air louvers)
- ambient temperature: +35 °C / 900 mbar
- fans: only suction fans
- hydraulic oil coolers; side by side arrangement, cooling capacity abt. 30 % of the engine power
  cooler ITD 40 °K, pressure resistance 25 bar (plate cooler)

**FIG. 1 - 30**

**Standardkühlanlagen B/FM2011 für den Baumaschineneinsatz**
*standard cooling systems B/FM2011 for construction machine application*

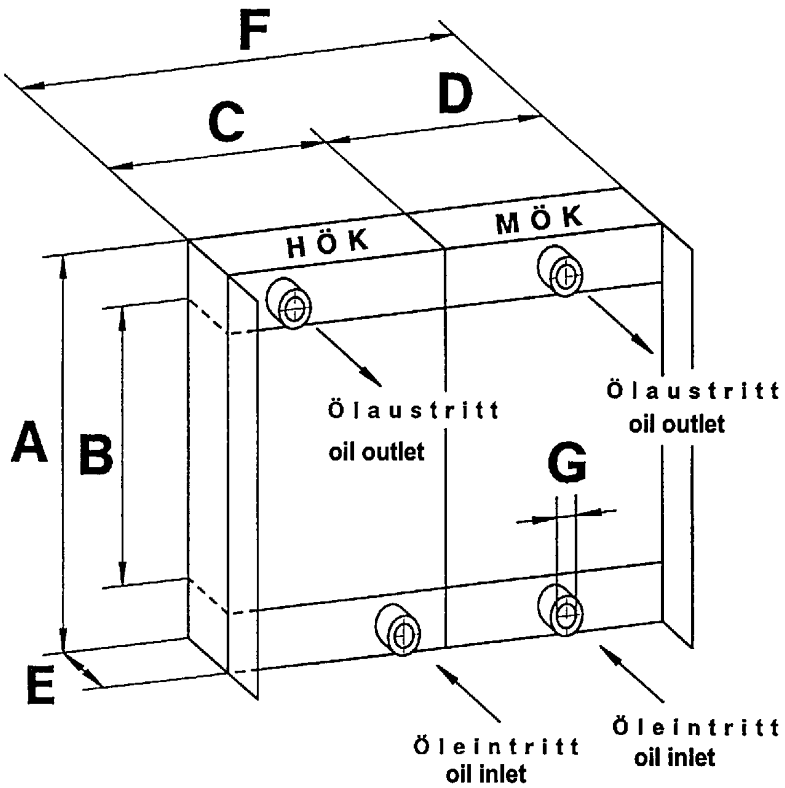
**Abgasstufe**/*emission regulation*: **COM I / EPA I**
**Sauglüfter, Kühler Hersteller** / *suction fan, cooling unit supplier*: **AKG, Hofgeismar.**
**Lüfterhersteller** / *fan supplier*: **Alu - Kunststoff - Technik**
**Ergebnisse gelten für 2 mbar zusätzlichen Einbauwiderstand und 1000 m Höhe (900 mbar).**
*Results are valid for 2 mbar additional installation resistance and 1000 m altitude (900 mbar)*

| Motor / engine | Kühlanlage / cooling system: HÖK-Side by Side | AKG-Ident-Nr | Kühlnetz-Abmaße mm | Lüfter / fan: i [1:x] | Durchm. mm | Lüfter-Typ | $n_{Lüfter}$ $min^{-1}$ | $P_{Lüfter,Norm}$ [kW] | $V_{Lüfter}$ [$m^3/s$] | $L_{Lüfter}$ [dB (A)] | Deutz Zeichn.-Nr. | MOTOR Einsatzgrenze [°C] | Q-HÖK Kühlleistung [kW] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F2M 2011 $n_{Motor}$ = 2800 $min^{-1}$ $P_{Motor}$ = 24,2 kW | MÖK | 0091.734 | 350 x 411 x 63 | 0,83 | 396 | 2 | 2320 | 0,8 | 0,65 | 87,2 | 0420 1847 EB | > 50 | - |
| | MÖK+HÖK | 0091.730 | 400 x 434 x 63 | 0,83 | 396 | 2 | 2320 | 0,8 | 0,69 | 87,2 | 0420 1847 EB | > 50 | 3,4 |
| F3M 2011 $n_{Motor}$ = 2800 $min^{-1}$ $P_{Motor}$ = 36,5 kW | MÖK | 0091.734 | 350 x 411 x 63 | 0,83 | 396 | 2 | 2320 | 0,8 | 0,65 | 87,2 | 0420 1847 EB | > 50 | - |
| | MÖK+HÖK | 0091.730 | 400 x 434 x 63 | 1,0 | 396 | 20 | 2800 | 2,1 | 1,2 | 93,0 | 0420 3379 EB | 44,5 | 4,9 |
| BF3M 2011 $n_{Motor}$ = 2800 $min^{-1}$ $P_{Motor}$ = 48,5 kW | MÖK | 0091.734 | 350 x 411 x 63 | 0,83 | 396 | 2 | 2320 | 0,8 | 0,65 | 87,2 | 0420 1847 EB | 35,3 | - |
| | MÖK+HÖK | 0091.731 | 400 x 511 x 63 | 1,0 | 446 | 21 | 2800 | 3,7 | 1,89 | 97,6 | 0420 5790 EB | 35,0 | 6,4 |
| F4M 2011 $n_{Motor}$ = 2800 $min^{-1}$ $P_{Motor}$ = 48,5 kW | MÖK | 0091.734 | 350 x 411 x 63 | 0,83 | 396 | 2 | 2320 | 0,8 | 0,65 | 87,2 | 0420 1847 EB | 47,3 | - |
| | MÖK+HÖK | 0091.731 | 400 x 511 x 63 | 1,0 | 446 | 21 | 2800 | 3,7 | 1,89 | 97,6 | 0420 5790 EB | 43,7 | 6,4 |
| BF4M 2011 $n_{Motor}$ = 2800 $min^{-1}$ $P_{Motor}$ = 65,0 kW | MÖK | 0091.734 | 350 x 411 x 63 | 1,0<br>1,2 | 396 | 2 | 2800<br>3360 | 1,4<br>2,6 | 0,95<br>1,32 | 92,0<br>96,7 | 0420 1847 EB | 32,1<br>43,9 | - |

Kühlsystem - Berechnungsdaten siehe TB, t-Öl max: 135 °C
Q-HÖK bei ETD = 40 K, Ölmenge = 50 l / min.
Kühlerbauart für MÖK und HÖK in der druckfesten Stab / Platte - Ausführung.
Lüfter-Flanschbild I: Zentr.: 82,6 mm, Lochkreis: 96,8 mm, 4 x 9 mm,
Bausätze Kraftabnahme siehe Variantenübersicht Abschnitt 'Kraftabnahme' (017) / *Completion power take off see section 'power take off' (017)* im Taschenbuch bzw. ELTAB / in pocket book

**FIG. 1 - 31**

## Ölleitungsanschluß MÖK / HÖK (Prinzipdarstellung)
***oil piping connections*** *(schematic view)*




**Standardkühlsystem B/FM 2011 für Baumaschineneinsatz**
***Standard cooling system B/FM 2011 for construction machine application***

| AKG Ident-Nr. *Part-No.* | Kühlerart und Bauweise *cooler type and design* | Maße / Dimensions A | B Block *block* | C Block *block* | D Block *block* | E Block *block* | F | G Anschluss *connection* | Motor *engine* |
|---|---|---|---|---|---|---|---|---|---|
| 0091 730 | MÖK + HÖK side by side Plattenbauweise plate design | 500 | 400 | 253,3 | 180,6 | 63 | 434,4 | M 26x1,5 | F3M 2011 |
| 0091 731 | | 500 | 400 | 305,4 | 206,5 | 63 | 512,4 | | F4M 2011 |
| 0091 732 | | 550 | 450 | 305,4 | 206,5 | 63 | 512,4 | | BF4M 2011 |
| 0091 734 | MÖK Plattenbauweise plate design | 450 | 350 | — | 412,3 | 63 | 412,3 | | F3M 2011 B/F4M 2011 |

### 1.11.5 Admissible resistances of oil pipes and coolers

**Oil pipes:**
The external engine oil cooler is connected on the oil side by hoses. See chapter 5.1 for dimensioning of the hoses.

Recommendation: For a total hose length up to 2 m with abt. 4 bends (90°) the in side diameter should be at least 20 mm.

The max. admissible hose resistance (supply and return) is

$\Delta p_{hose,\ tot.} \leq 0.5$ (bar)

- at max. engine speed and
- hot oil (100 °C, viscosity SAE 15/W40).

The applied hoses must have
- pressure resistance up to 30 bar
- at a temperature resistance of –40 °C to +140 °C

**Cooler:**
The max. admissible cooler resistance on the oil side may be:

$\Delta p_{oil\ heat\ exchanger} \leq 0.5$ (bar)

- at max. engine speed and
- hot oil (100 °C, viscosity SAE 15/W40).

**Recommendation:**
The resistance of the oil pipe and the oil cooler reduce the oil pressure for the engine lube oil supply. To keep this influence low, it is recommended to restrict the cooler flow resistance to $\Delta p_{oil\ heat\ exchanger} \leq 0.5$ bar.

**Total resistance:**
The recommendation gives a total resistance of the pipes and coolers of

$\Delta p_{total} \leq 1.0$ (bar)

at a maximum rated engine speed and hot oil.

For speeds below the max. rated engine speed, the total resistance can be assumed as follows:

Rated speed 2800 / min = 1.0 bar Total resistance

Rated speed 1500 / min = 0.6 bar Total resistance

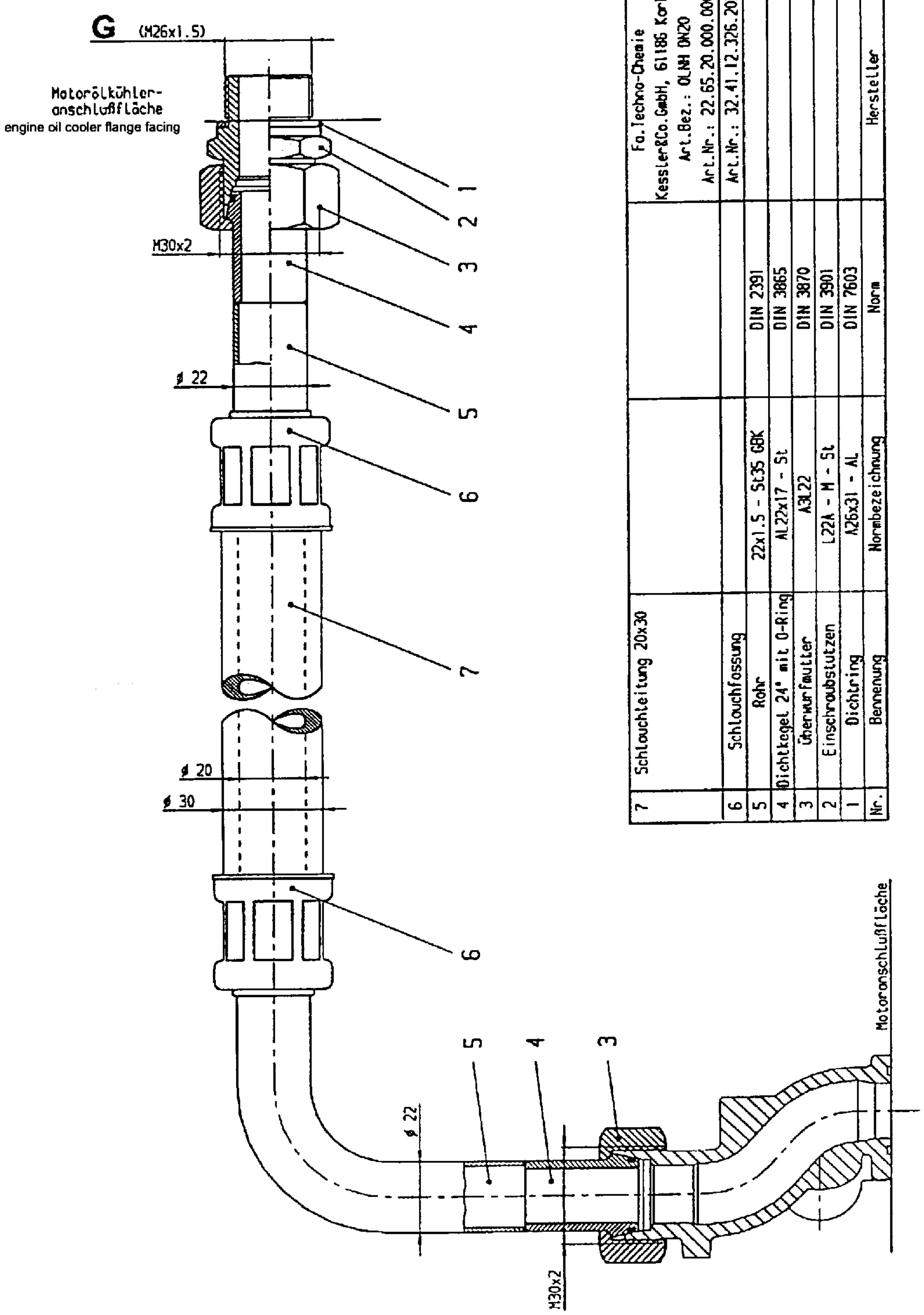
Interpolate linearly intermediate speed

## 1.11.6 Technical installation notes

- The hose connections must be made with the appropriate crimp fittings and screw unions. The connections are prepared on the engine.

**FIG. 1 – 32**

**Schlauchleitung**
**hose pipe**




| Nr. | Benennung | Normbezeichnung | Norm | Hersteller |
|---|---|---|---|---|
| 7 | Schlauchleitung 20x30 | | | Fa.Techno-Chemie Kessler&Co.GmbH, 61186 Karben Art.Bez.: OLNH DN20 Art.Nr.: 22.65.20.000.000 |
| 6 | Schlauchfassung | | | Art.Nr.: 32.41.12.326.203 |
| 5 | Rohr | 22x1.5 - St35 GBK | DIN 2391 | |
| 4 | Dichtkegel 24° mit O-Ring | AL22x17 - St | DIN 3865 | |
| 3 | Überwurfmutter | A3L22 | DIN 3870 | |
| 2 | Einschraubstutzen | L22A - M - St | DIN 3901 | |
| 1 | Dichtring | A26x31 - AL | DIN 7603 | |

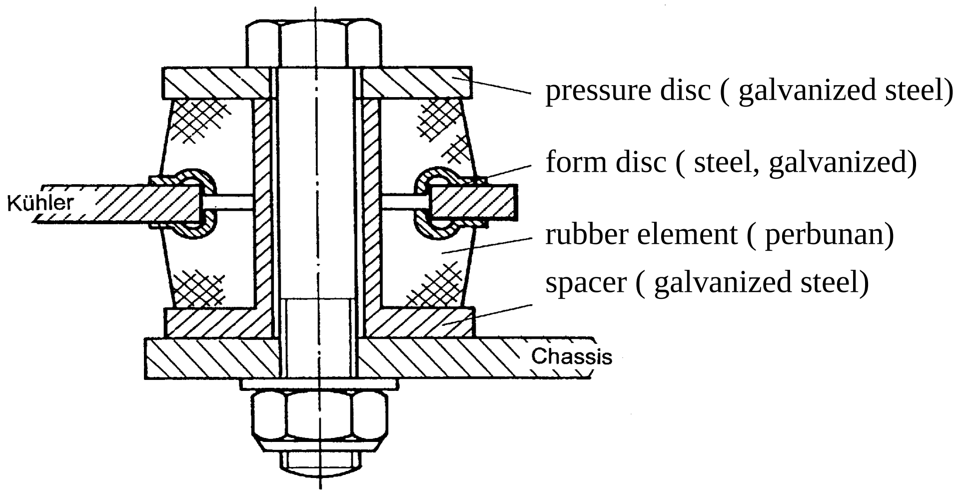
- In case of a standing cooler arrangement in front of the engine the oil inlet must always be connected at the bottom cooler end (automatic breathing).

- In cooler systems above engine (e.g. horizontal) you must make sure that the supply line is fed once “below the center of the crankshaft” when laying (engine outlet to the cooler inlet). This prevents air getting into the cooler (or oil leaking from the cooler into the oil tray) at engine standstill.

- Make sure that coolers are installed without tension. Vibrations should be avoided depending on the type of cooler.

- External forces due to engine oscillation, shock and vibrations through the equipment frame should be kept away from the coolers as far as possible. The coolers must therefore be mounted flexibly remotely from the engine on appropriate mounts which are included in the scope of supply of the cooler manufacturers – see the figure below:

**Fig. 1 – 33**




- The pipes must be connected flexibly to the cooler to avoid forces being exerted through piping into the cooler.

- When mounting the pipes to the cooler connections, make sure that the cooler nozzles are protected from too high a torsional stress by holding with suitable tools whilst tightening the screw unions.

- The hose pipes must have rubber qualities which withstand a pressure of 30 bar and temperatures of –40 °C to +140 °C.

- Alternatively to the crimp fittings with screw unions the hoses can also be installed on the engine and cooler with pipe nozzles with crimp and hose clips – this type of connection must always be tested however with the participation of the clip manufacturer. Such connections are always the responsibility of the customer. DEUTZ will accept no responsibility for engine damage due to lack of oil pressure owing to leaking hose clip connections.

- As a protection against contamination and clogging of the cooler network it is recommended to install an appropriate filter in such a way that it can be easily dismantled.

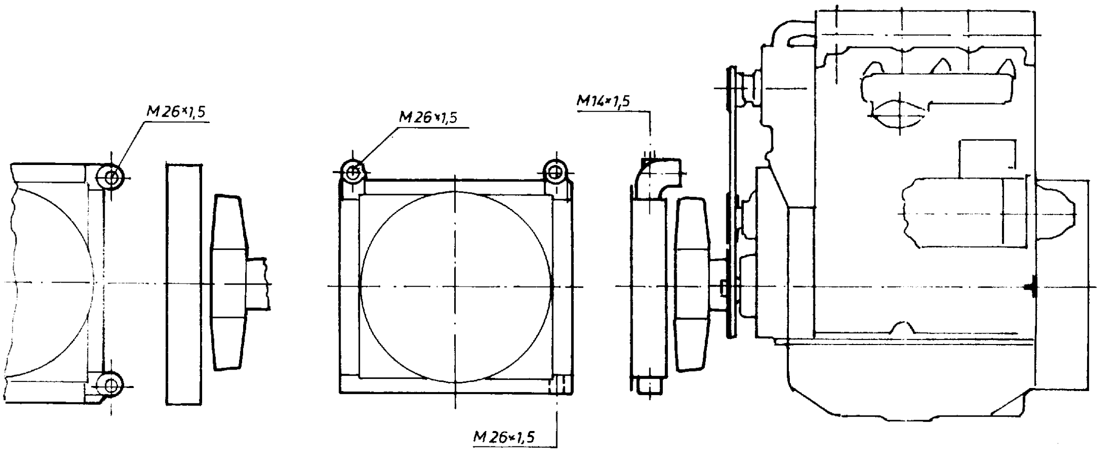
- The inclined filter mounting (negative) in front of the vertical cooler leads to partial self-cleaning.

- The cooler networks must be protected by appropriate upstream screens depending on the installation position and equipment application.

### 1.11.7 Cooler and fan arrangements

The following figures show the possible cooler locations in fan installations on the engine and with separate fan drives.

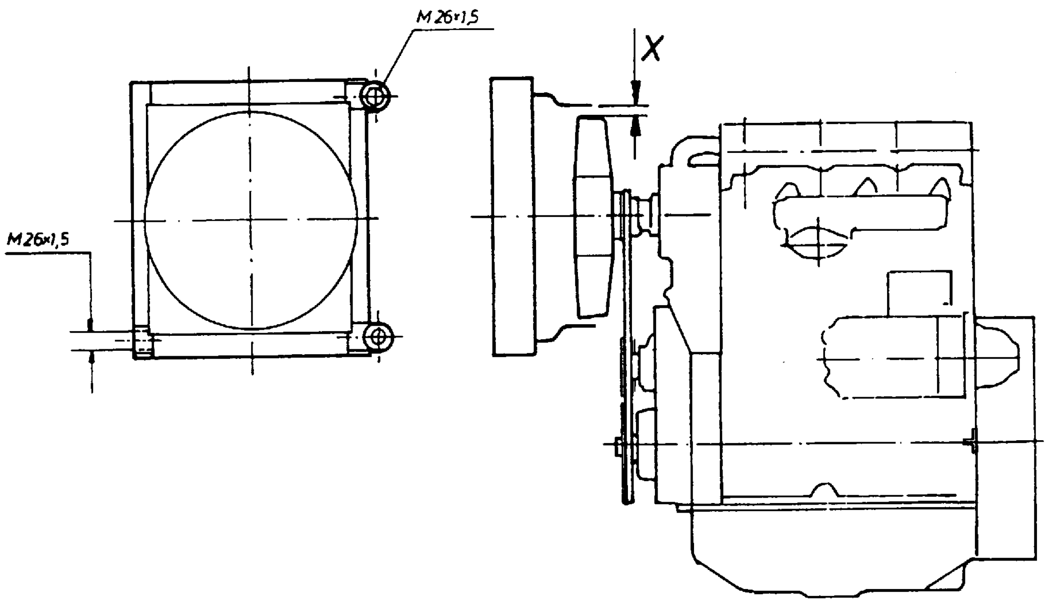
**FIG. 1 – 34** **Cooler systems with mechanical fan drive**




**admissible cooler locations for self breathing**

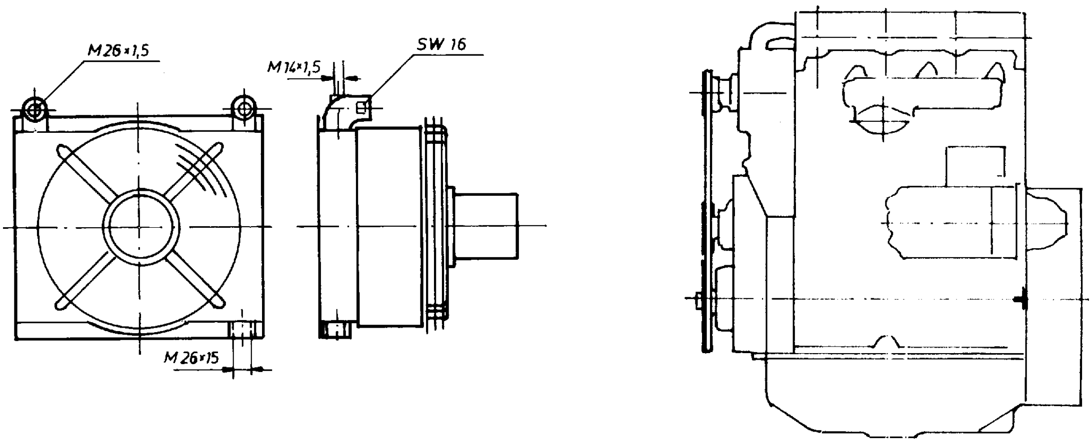
| | |
|---|---|
| position of connections | position of connections |
| top outlet | top inlet and outlet |
| bottom inlet | |

**FIG. 1 - 35**




With flexibly mounted engine and rigidly mounted cooler there must be an annular clearance of x ~ 10 – 20 mm between cooler duct and

**FIG. 1 - 36 Separate cooler system with electric fan drive**



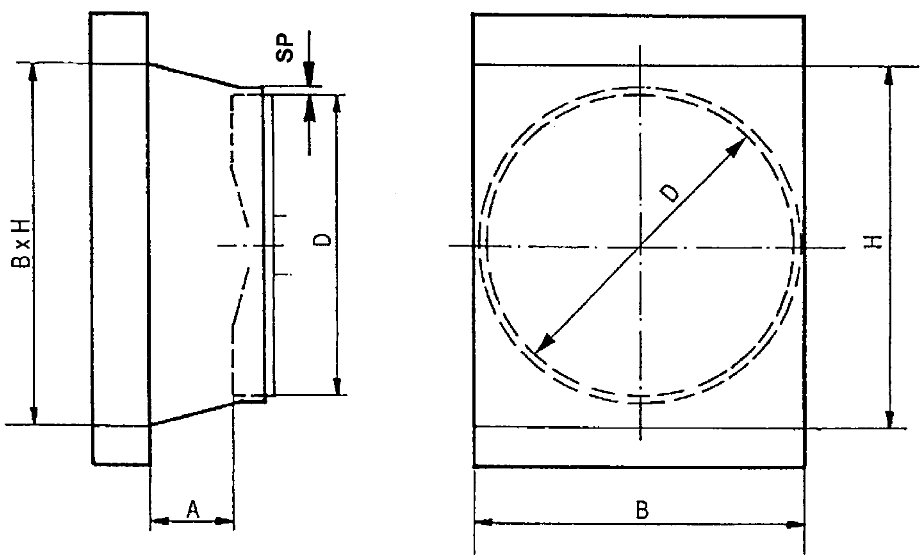

- The coolers must always be arranged so that there is no air permanently entrapped in the cooler
- The oil coolers with the mounted electric fan drive must always be installed vertically (see figure) so that the electric motor is always in a horizontal operating position.
- Pay attention to correct alignment downwards of the water drain hole on the electric motor housing.

### 1.11.8 Central arrangement of cooler and fan

In the central arrangement of cooler and fan, make sure that the outside fan contour is always inside the network contour of the cooler.
The ratio of the effective cooler surface $F_K$ to the fan surface $F_D$ should never be greater than $F_K / F_D = 1.8$

| Recommended is: | $F_K / F_D = 1.5$ |
|---|---|

**FIG. 1 - 37**



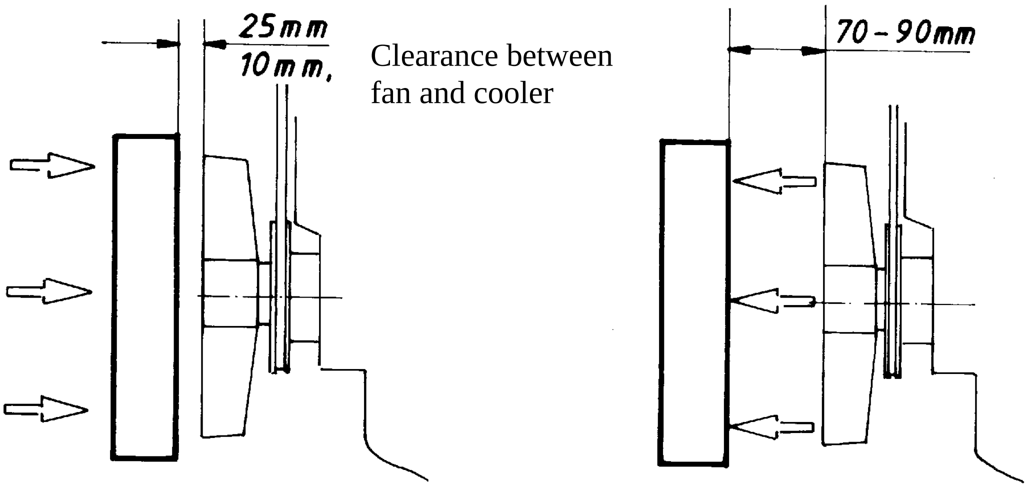

$F_K = B \times H$ $F_D = (\pi \times D^2) / 4$

## 1.11.9 Air ducts between cooler and fan

### Installation without ducting

A safety margin of 25 mm must be provided between the oil cooler and the suction intake fan due to the fan blade deflection, the production tolerances and the axial fan movement in case of flexible engine mounting. This margin can be minimized (10 mm) when an axial offset can be ruled out in the engine/fan allocation due to mounting measures. The margin must be increased to 70 to 90 mm for a push-type fan.

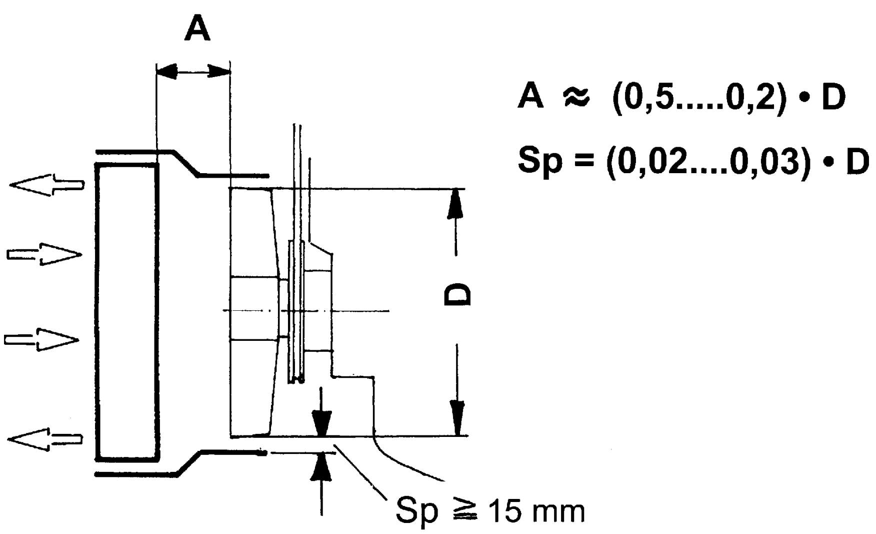
FIG. 1 - 38




### Installation with ducting

When using an air duct between the cooler and the fan, the distance A between the cooler network and the fan on the engine must be as shown in the figure below – whereby even greater distances are admissible at A.

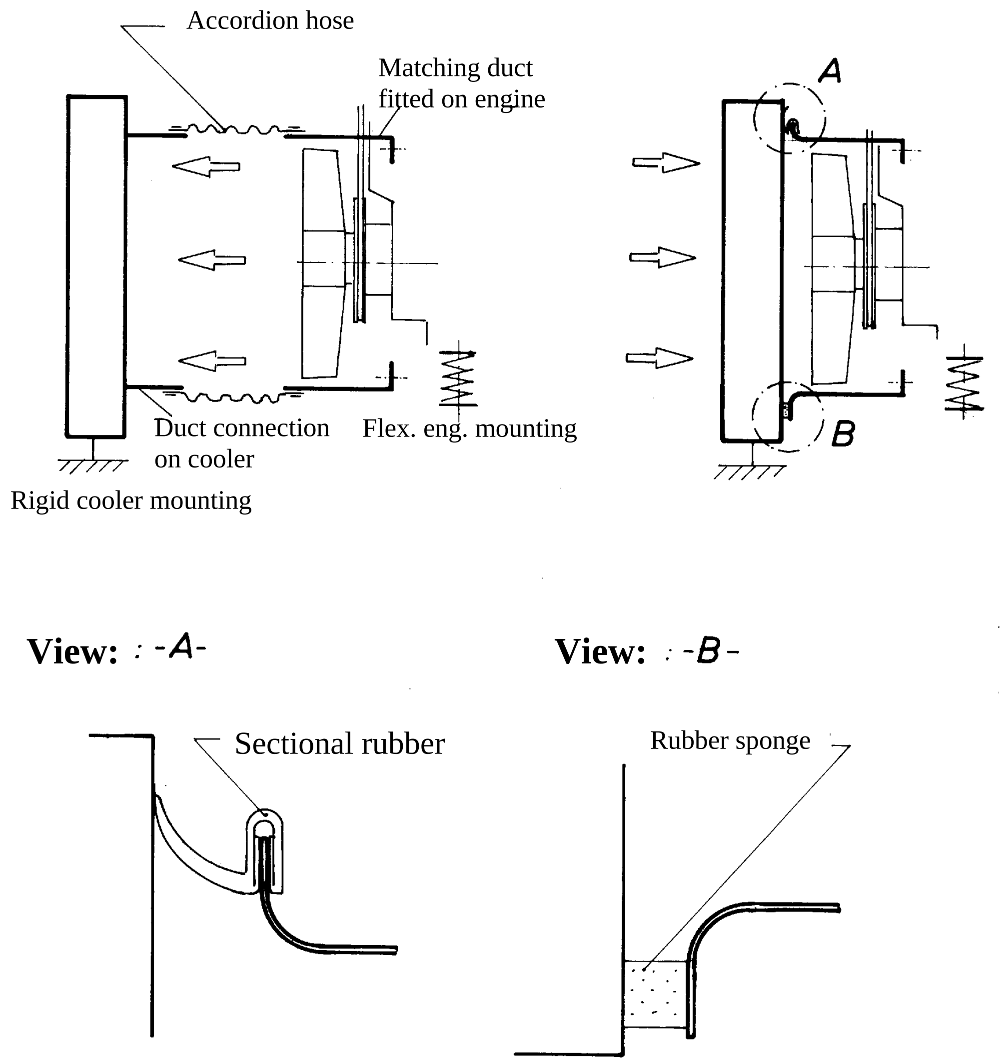
FIG. 1 – 39




The radial distance between the duct and the fan must, however, be so great that there is no touching when starting up and shutting down the flexibly mounted engine. A minimum gap of 15 mm must be provided.

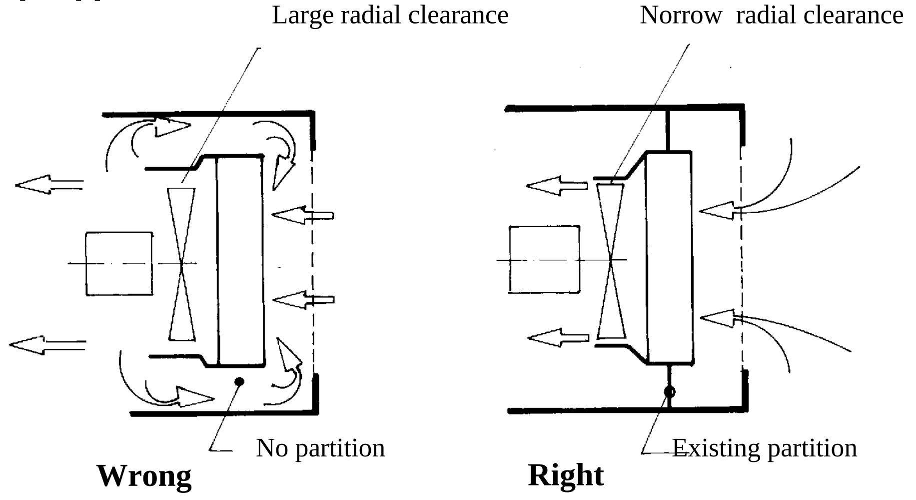
To keep the radial gap low, it is recommendable to mount a separated duct with a flexible adapter – see figure:

**FIG. 1 - 40**




When installing the cooling system, make sure that no hot air can be sucked in.

**FIG. 1 - 41**



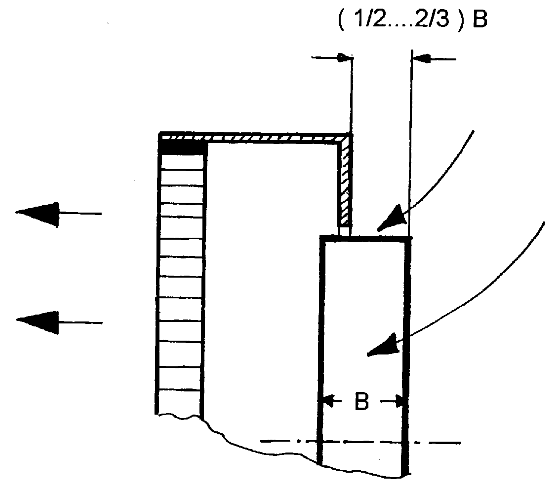
## 1.11.10 Position of the fan in the hood

### Pusher-type fan:

With the pusher-type fans (fan pushes the air through the cooler), the air is usually taken from the engine compartment. This provides a more effective engine compartment cooling but due to the warmer cooling air a fan with a greater diameter or faster fan is required and possibly a larger cooler.

To avoid restriction of the cooling air flow by mounting the fan close to the engine (increased resistance, loss of cooling air volume, increased noise), the cylindrical part of the hood should end at least the level of half the width B of the fan.

**FIG. 1 - 42**

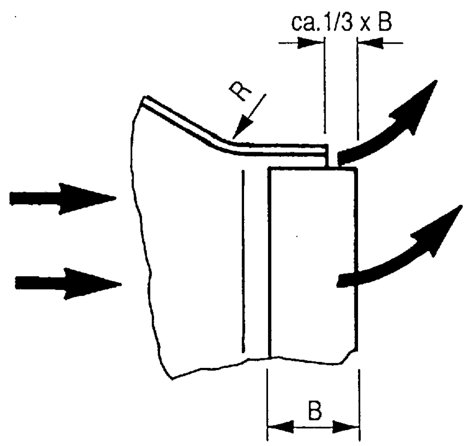



### Suction fan:

The coolers/fans offered in the scope of supply contain the so-called suction cooling, i.e. the fan sucks the air through the cooler and pushes the heated air past the engine into the engine room.

As a rule short installation conditions lead to a close to engine mounting situation for the cooling system at the top end of the engine. The discharge situation can be improved for the suction fan when the width B of the fan protrudes from the hood by at least 1/3.

**FIG. 1 - 43**



### 1.11.11 Fan mounts

For the mechanical drive of the fan there is the direct mounting on the crankshaft (fan speed = engine speed) and the mounting alternative of a separate fan on a console on the engine.

#### 1.11.11.1 Fan on the crankshaft

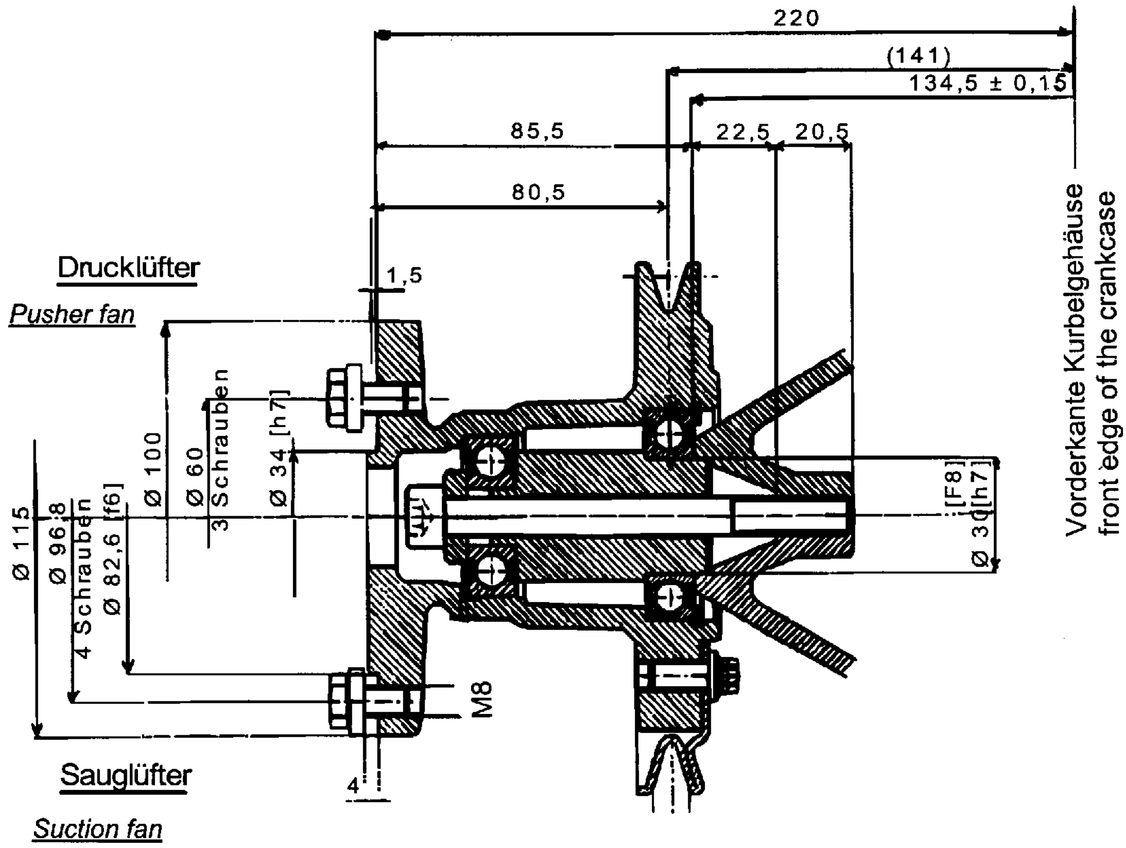
The fan mounted on the crankshaft is designed for fans with a max, admissible mass moment of inertia up to 0.015 kgm² . Please consult DEUTZ for greater mass moments of inertia.

#### 1.11.11.2 Fan mounted on fan block (high level fan mounting)

Different transmissions can be implemented in this case and particularly greater fan diameters without exceeding the lower engine contour.
This fan version is of particular advantage when several coolers are to be driven (side by side or in front).

The dimensions of the fan flange are shown in the diagram below:

**FIG. 1 - 44** **Fan flange**



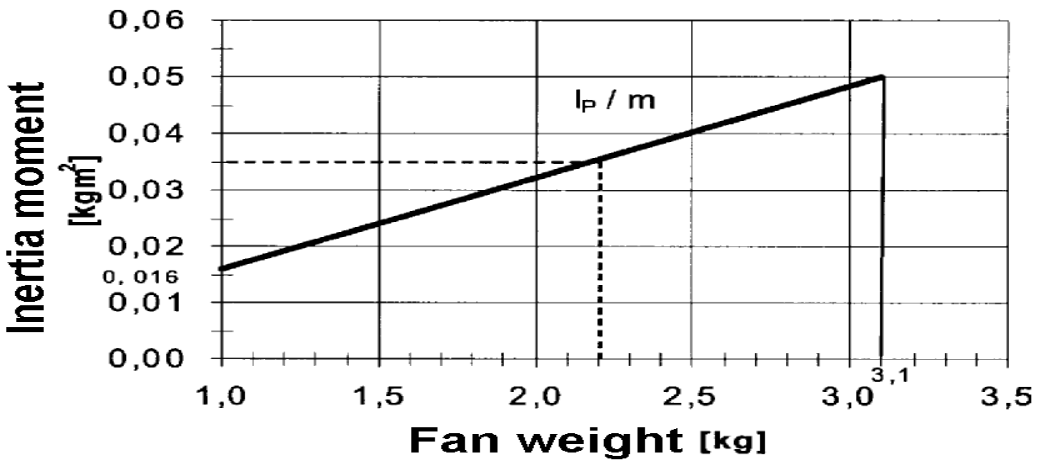

The basic conditions of figures 1-45 and 1-46 must be satisfied for the fan mounting with fan console. The values must be seen in relation.

When determining the speed limit, condition 1 must be satisfied before the fan speed is determined as a function of the fan mass in condition 2.

**Condition 1:** According to the ratio $I_P / m_L$, the following applies for geometrically similar fans for a mass inertia ratio of **$I_P/m$ = 0.016 m²**

Example: Determination of the admissible polar mass moment of inertia **$I_P$** for a fan with the mass $m_L$ = 2.2 kg

**FIG. 1 - 45**

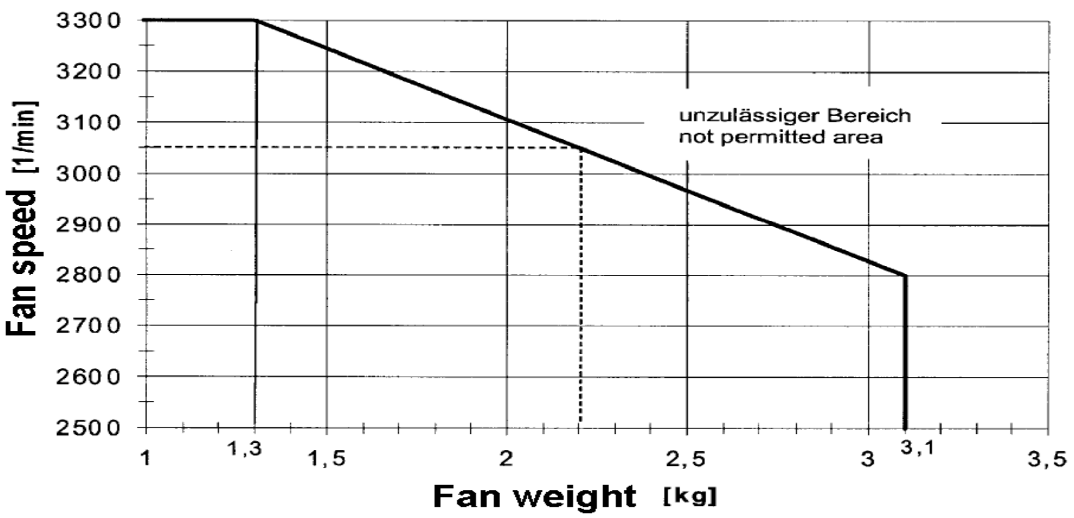



Result: $I_P$ = 0.016 m² * 2.2 kg = 0.035 kgm²; the selected fan may not exceed a maximum mass moment of inertia of $I_P$ = 0.035 kgm² .

**Condition 2:** Between the fan mass and the fan speed the following relation must be satisfied

Example: Determination of the max. admissible speed of the fan with 2.2 kg mass – it follows according to diagram a max. admissible fan speed of 3050 1/min

**FIG. 1 - 46**




**NOTE:**

**The center of gravity distance from the fan mount and fan to the engine may not be increased – e.g. by mounting an adapter between the fan hub and the fan.**
**If fans with a low speed and a higher mass moment of inertia are to be operated, it must be released by DEUTZ technology.**

### 1.11.12 Compensating vessel

In oil-cooled engines, no compensating vessel is required in the cooling oil circuit because degassing and breathing takes place through the engine oil tray and crankcase breathing.

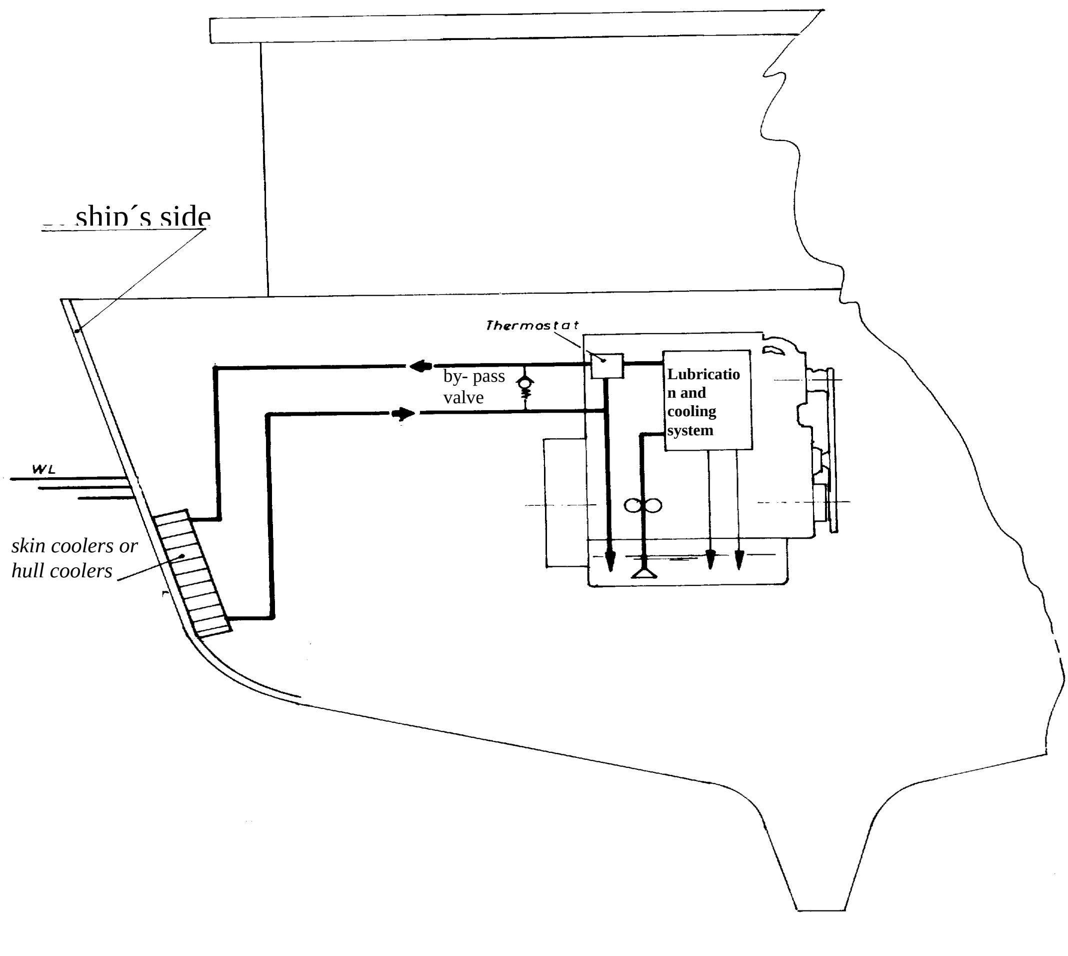
### 1.11.13 Two-circuit cooling system (skin effect cooling)

In the FL 1011 E engine, an oil/water or oil/oil two-circuit cooling system can be set up instead of the oil-air heat exchanger.

The engine oil heat is passed through a liquid heat exchanger as process heat to another circuit.

Another two-circuit cooling system can be represented by so-called skin coolers or hull coolers – as for ships.

**FIG. 1 - 47**



# 2. COMBUSTION AIR SYSTEM

## 2.1 General

Experience has shown that in more than 75% of all cases premature engine wear is attributable to the influence of dust. To avoid this problem, particular attention should be drawn to filtration of the combustion air and to a proper layout of the air cleaners and clean air piping.

In this connection, the following references should be observed:

- Only fresh air is allowed to be drawn in as combustion air; it must be taken from a dust-free engine environment which is not heated up.
- Combustion air piping shall have sufficiently large cross sections to keep the flow resistance at a minimum.
- At the raw air side (combustion air piping to cleaner), high resistances result in increased intake vacuum pressure and reduce the maintenance intervals for dry-type air cleaners. The vacuum pressure governor (service indicator) also records the raw air pipe resistance.
- Pipe bends with favorable flow characteristics should be used for any necessary deflections in the combustion air piping.
- Also after an extended period of operation, the intake pipe between the air cleaner and the engine, the so-called clean air side, must be absolutely tight and shall resist the mechanical stresses caused by engine vibrations and pressure pulsations as well as the temperatures involved.
- The type and size of the filters should be selected according to the expected operating stresses (accumulation of dust).

It is not always possible to realize ideal conditions, i.e. to mount the air cleaner directly on the engine without the need of any air piping. In some cases, it is necessary to mount the air cleaner separately from the engine, e.g. in case of danger of heating up in the room or by vibration or simply to make it easily accessible for maintenance work.

## 2.2 Intake vacuum pressure

To achieve a practically "complete" combustion of fuel in diesel engines, the cylinders are supplied with an air surplus (oxygen).

If the resistance (intake vacuum pressure) at the combustion air side is too high, combustion will be "incomplete" because of the deficiency of air (lack of oxygen), i.e. the fuel consumption will increase.

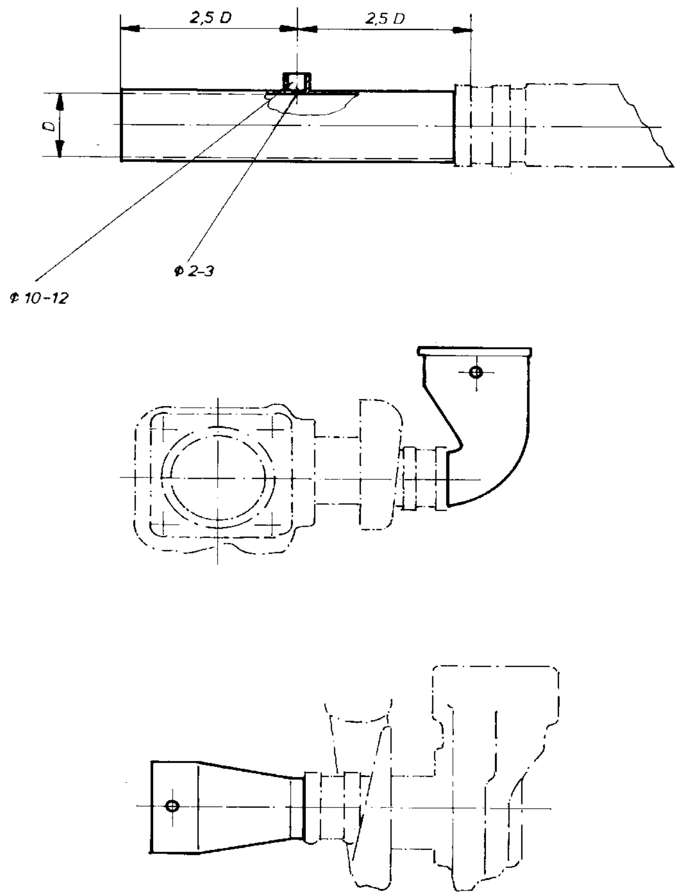
This condition is counteracted by limiting the intake vacuum pressure. See the following chapter, table 1, 2, 3.

## 2.3 Measuring the intake vacuum pressure

The measurement is to be made within a straight pipe section before the air duct or charging elbow. A straight length of at least two and a half times the diameter of the intake pipe must be available before and after the pickup point. If this is not possible, the measurement should at least be made in the neutral fiber of the pipe bend.

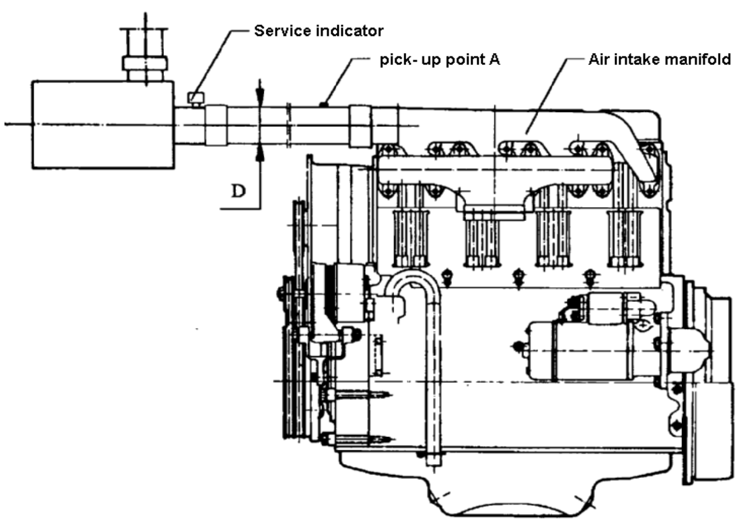
The vacuum pressure of the intake system is measured best with a water-filled U-tube:

**FIG. 2 - 1**




a) **Naturally aspirated engines** without loading at rated speed (pickup point position A: 2.5 x dia. before inlet of combustion air into the air intake manifold of the engine).

**FIG. 2 - 2**



If the measurement at rated speed should be difficult, the measurement can also be made at maximum idling speed and converted with the following formula

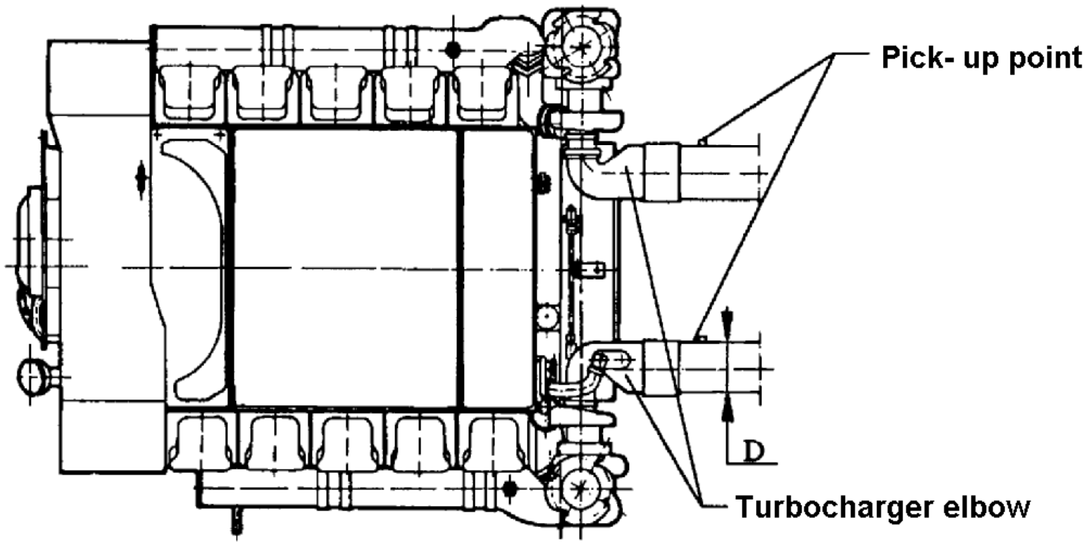
$$P = P_{max} / [n_{max} / n]^2$$

$p$ = Intake vacuum pressure at rated speed (cf. admissible pressure)
$p_{max}$ = Intake vacuum pressure measured at the highest idle speed
$n$ = Rated speed
$n_{max}$ = Maximum idling speed, at which measurement was made

.

**b)** **Turbocharged engines** at full load and rated speed
(pickup point position A: 2.5 x D in front of inlet of combustion air into the charger elbow of the engine).

**FIG. 2 - 3**




## 2.4 Maximally admissible intake vacuum pressure

The total intake vacuum pressures referred to in the following tables 1, 2 and 3 are values which must not be exceeded when measured on the engine. They apply to the entire intake system (filter including raw air and clean air piping).

The intake vacuum pressure values indicated separately for filters and piping are reference values which may be handled in a variable manner, if the total intake vacuum pressure is not exceeded.

No distinction is made between automotive and equipment engines.

**Maximally admissible intake vacuum pressure**

## Table 1

Admissible intake vacuum pressures for oil-bath air cleaners for engines installed in vehicles, equipment and electric power generating sets.

Applicable to naturally aspirated and turbocharged engines.

| Engine | **2011** Filter | **D909 / 910** | **2011** Pipings | **D909 / 910** | **2011** Total intake vacuum pressure | **D909 / 910** |
|---|---|---|---|---|---|---|
| 1-cylinder | 15 mbar | 10 mbar | 5 mbar | 5 mbar | 20 mbar | 15 mbar |
| 2-cylinder | 25 " | 15 " | 10 " | 5 " | 35 " | 20 " |
| 3-cylinder | 30 " | 20 " | 15 " | 5 " | 45 " | 25 " |
| 4-cyl. and upwards | 35 | | 15 " | | 50 " | |

## Table 2

Admissible intake vacuum pressure for contaminated dry-type air cleaner for engines installed in vehicles, equipment and electric power generating sets.

Applicable to naturally aspirated and turbocharged engines.

**See table 1 for values for D909 / D910 engines**

| Engine | Filter** mbar | mmWS | kPa | Pipings* mbar | mmWS | kPa | Total intake vacuum pressure mbar | mmWS | kPa |
|---|---|---|---|---|---|---|---|---|---|
| 1-cylinder | 20 | 200 | 2.0 | 5 | 50 | 0.5 | 25 | 250 | 2.5 |
| 2-cylinder | 35 | 350 | 3.5 | 10 | 100 | 1.0 | 45 | 450 | 4.5 |
| 3-cylinder | 45 | 450 | 4.5 | 10 | 100 | 1.0 | 55 | 550 | 5.5 |
| 4-cyl. and upwards | 50 | 500 | 5.0 | 15 | 150 | 1.5 | 65 | 650 | 6.5 |

* When a pipe is fitted upstream of the dry-type air cleaner (raw air side), the initial resistance of the cleaner is increased by the amount of the pipe resistance. This entails shorter maintenance intervals of the dry-type air cleaner, as the service indicator reacts accordingly earlier.
If this pipe is installed downstream the dry-type air cleaner (clean air side), the service indicator senses the actual cleaner resistance and not the pipe resistance downstream. This must be considered when selecting and arranging the service indicator, if the admissible pipe resistance can not be observed.

** The resistance of the cleaners when new is correspondingly lower depending on the required service life.

## Table 3

Admissible intake vacuum pressure on oil-bath and contaminated dry-type cleaner elements for engines installed in electric power generating sets with rating categories **COP,PRP,LTP**.
Applicable to naturally aspirated and turbocharged engines.

**See table 1 for values for D909 / D910 engines**

| Engine | Filter mba | mmWS | kPa | Pipings mbar | mmWS | kPa | Total intake vacuum pressure mbar | mmWS | kPa |
|---|---|---|---|---|---|---|---|---|---|
| 1-cylinder | 15 | 150 | 1.5 | 5 | 50 | 0.5 | 20 | 200 | 2.0 |
| 2-cyl. and upwards | 20*** | 200*** | 2.0 | 5 | 50 | 0.5 | 25<br>35*** | 250<br>350*** | 2.5<br>3.5*** |

*** Vacuum pressure governor with switch point 20mbar can be replaced by 35mbar vacuum pressure governor, if the pressure is picked up near the inlet of the turbocharger – still in the large diameter range of the connecting pipe.

If, in individual cases for installation reasons, the total intake vacuum pressure should require to be exceeded, consult application engineering.

Low initial resistance values are recommended to obtain adequately long maintenance intervals. The general layout of the cleaners depends on the laboratory testing period taking into account the respective engine application (see 2.8.5, Reference examples).

To ensure an adequate service life of the cleaner elements under normal dust conditions, the following intake vacuum pressure at the clean air nozzle of the cleaner (without raw air pipe upstream of the cleaner) should not exceed the following values in new condition:

| | | | |
|---|---|---|---|
| | 1-cylinder engines | ≤ 1.0 kPa ≤ 10 mbar | ≤ 100 mmWS |
| | 2-cylinder engines | ≤ 1.5 kPa ≤ 15 mbar | ≤ 150 mmWS |
| | 3-cylinder engines | ≤ 2.0 kPa ≤ 20 mbar | ≤ 200 mmWS |
| from | 4-cylinder engines | ≤ 2.5 kPa ≤ 25 mbar | ≤ 250 mmWS |

It is recommended, where possible, to keep the indicated resistance values below the indicated values, as this is positively influencing the power and performance characteristics of the engine.

For genset engines according to table 3:

| | | | |
|---|---|---|---|
| | 1-cylinder engines | ≤ 0.8 kPa ≤ 8 mbar | ≤ 80 mmWS |
| from | 2-cylinder engines | ≤ 1.0 kPa ≤ 10 mbar | ≤ 100 mmWS |

All indicated values apply to measurements at the engines. The reason why lower limit values are required for lower numbers of cylinders is due to pulsation, i.e. the effects on the power and smoke emissions are thus identical for all numbers of cylinders.

## 2.5 Monitoring the intake vacuum pressure

The flow volume resistance of the dry type air cleaners increases strongly with increasing soiling of the paper cartridge unlike wet and oil-bath air cleaners.

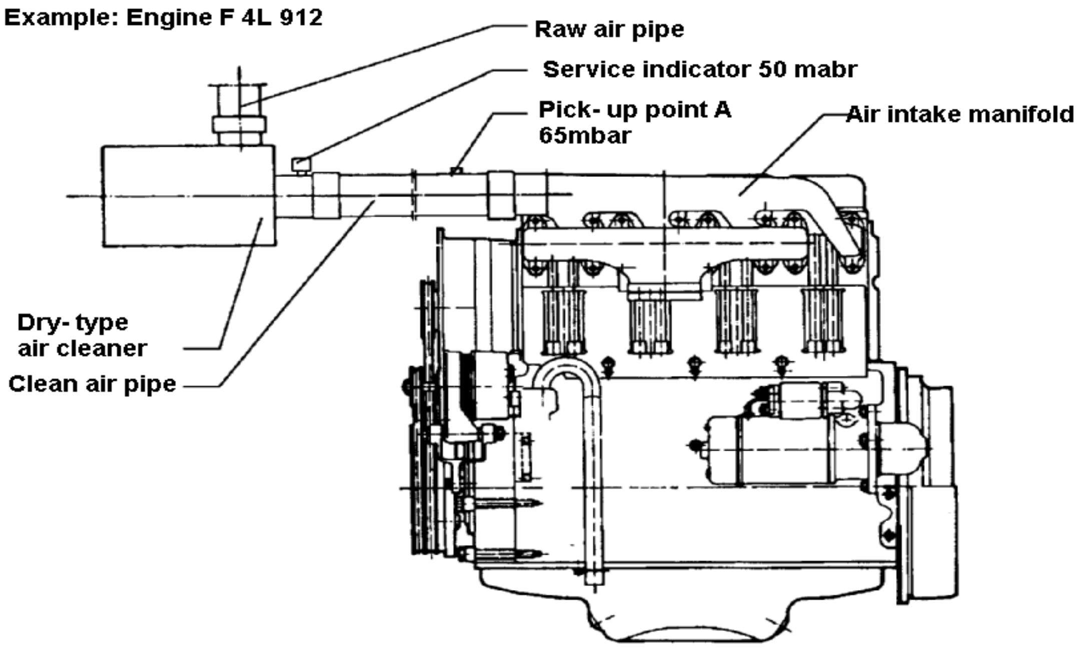
Therefore a service indicator is prescribed for monitoring the suction intake vacuum pressure when installing dry type air cleaners.
The service indicator should be mounted on the clean air side. In most cases, the cleaner manufacturer provides the cleaner clean air nozzle with a connection facility.

Wet-type and oil-bath cleaners have no such connection facility for a service indicator; for that reason, in practice, service indicators are not used for these types of cleaners.

These indicators are commercially available with various switch points, e.g. 20, 30, 35, 50 or 65 mbar.

When determining the switch points, the resistances in the pipes and the contaminated dry-type air cleaner as well as the arrangement of the cleaner and the service indicator in the suction intake system must be considered.

FIG. 2 - 4




**AS an example:**
Admissible total resistance at "A" (see table 2) is
650 mmWS = 65 mbar = 6.5 kPa

**Assumptions:**

| | |
|---|---|
| Resistance of clean air pipe: | 150 mmWS = 15 mbar = 1,5 kPa |
| Resistance of raw air pipe: | 100 mmWS = 10 mbar = 1.0 kPa |
| Total line resistance: | 250 mmWS = 25 mbar = 2.5 kPa |

Maximum admissible resistance of the contaminated cleaner:
650 - 100 - 150 = 400 mmWS = 40 mbar = 4.0 kPa

Theoretical switching point of the service indicator is given by the sum of the resistances of raw air pipe and contaminated cleaners
100 + 400 = 500 mmWS = 50 mbar = 5.0 kPa

**Selected:**
Service indicator with a switching point of 500 mmWS = 50 mbar = 5.0 kPa.

If the service indicator is located within the clean air pipe or the cleaner is mounted directly upstream of the engine, proceed analogously.

## 2.6 Air cleaner systems

### 2.6.1 General references

The evaluation of practical experience has shown that the issue of combustion air cleaning must be treated with utmost care.

The following statements are generally applicable in this respect:

- The service life expected from today's engines requires the use of dry-type air cleaners with safety element (paper air cleaners).
- Dry-type air cleaners require careful handling when serviced.
- Dry-type cleaners are dependent on a well-functioning parts supply (replacement filter strainers) at the engine site.
  If regional problems are to be expected as regards the spare parts supply,
  the use of a combination of oil-bath- and dry-type air cleaners (ÖTK) is recommended.
- The installation instructions of the respective manufacturers must be observed when installing the air cleaners.
- Air cleaners must be mounted in such a way that they are easily accessible for maintenance works.
- The service indicators must be arranged in a position well visible for the operating staff.
- The combustion air cleaner versions supplied by DEUTZ are described in detail in the sales documentation of the individual engine series.
- If an air cleaner system especially requested by the customer is not part of the DEUTZ scope of supply, the OEM is fully responsible for the correct layout and execution. If the engine should be damaged as a consequence of mistakes in the cleaner system, DEUTZ refuses any claims under engine warranty.

### 2.6.2 Wet-type air cleaners

The use of wet-type air cleaners is not admissible.

### 2.6.3 Oil-bath air cleaners

In view of their obsolete technical standard, oil-bath air cleaners are hardly used today – in particular for reasons of handling, as the environmental-friendly disposal of the sludge-laden used oil from the oil-bath air cleaner requires additional expenditures.

For layout, installation, and maintenance of the oil-bath air cleaners, observe the directions given by the manufacturer of the air cleaner.

### 2.6.4 Dry-type air cleaners (paper air cleaners)

Dry-type air cleaners with built-in precleaners have a good filtration efficiency (irrespective of engine speed and inclination) and, thus, contribute to a long service life of the engine at low wear.

Dry-type cleaners should be provided with a safety cartridge. The safety cartridge is to prevent dust entering the clean air piping during maintenance of the main cartridge or when further using damaged main cartridges.

Paper quality:
With test dust AC coarse-grained, the filtration efficiency of the air cleaner must amount to 99.9% (for cleaner dimensioning see section 2.8).

### 2.6.5 Combination oil-bath- and dry-type air cleaner (ÖTK)

In case of operating conditions with a high generation of dust as well as regional problems with the spare parts supply, we recommend the use of a combination of oil-bath air cleaner with following dry-type air cleaner. Here, the oil-bath air cleaner acts as an excellent preliminary filter.

If required, contact the head office of DEUTZ, as systems of that kind are not available by series.

## 2.7 Maintenance

### 2.7.1 Oil-bath air cleaners

The oil-bath air cleaner should be serviced at the latest when the contamination has reached about half the level of the oil-bath or the oil in the oil tank has become viscous. This applies generally for all types of oil-bath air cleaners.

A correctly dimensioned oil-bath air cleaner does not lose oil during operation; therefore, do not refill with oil between maintenance due to the danger of drawing in oil.

### 2.7.2 Dry-type air cleaners

The main cartridge of the dry-type air cleaner must always be cleaned when the maximum admissible resistance is signaled by the service indicator. The quickest and safest way to service the cartridges is to replace the contaminated main cartridge by a new one.

**Clean the main cleaner cartridge as follows:**

- Dismantle cartridge
- hold the open end downward and knock carefully against your flat hand
- blow out with max. 5 bar compressed air from inside to outside
- clean seals
- check condition
- mount cartridge again

The main cartridge must be renewed after a maximum 5 cleaning operations or after one year; immediate replacement is required in case of damage.

When servicing the main cartridge, the safety cartridge remains clamped at the cleaner bottom. The number of main cartridge servicings (exchange or cleaning) should be indicated in the marking spaces on the safety cartridge.

**The safety cartridge must be renewed:**

- after the main cartridge has been serviced 5 times
- after 2 years at the latest
- if the service indicator responds immediately after maintenance the main cartridge
- after operation with a defective main cartridge

**Safety cartridges must not be cleaned.**

Possible dust agglomeration on the evacuator valve should be removed by occasionally compressing it.

### 2.7.3 Combination of oil-bath and dry-type air cleaner

The applied cleaner types are serviced as described under oil-bath and dry-type air cleaners.

## 2.8 Calculation data for combustion air volume flow rate

### 2.8.1 Calculation of the combustion air flow rate

The air volume flow rate for **4-stroke naturally aspirated engines** is determined as follows:

$$Q_M = \frac{V_H \times n \times \eta}{2 \times 1000} \quad (m^3 / min)$$

$Q_M$ = theor. air volume flow rate ($m^3$/min) n = Rated engine speed (1/min)
$V_H$ = total piston displacement ($dm^3$) $\eta$ = volumetric efficiency abt. 0.9

The air volume flow rate for **4-stroke turbocharged engines** (consumption-optimized, with and without charge air cooler) is roughly determined as follows:

$$Q_M = 0.095 \times P \ (m^3/min)$$

P = rated engine power (kW)

**Turbocharged engines** whose exhaust gas qualities must meet the **higher** requirements of the recent national and international **exhaust gas regulations** partly require a higher combustion air volume flow rate.
A rough calculation is given below:

$$Q_{MI} \cong 0.10 \times P \ (m^3/min)$$

P = rated engine power (kW)

If necessary, the actual combustion air volume flow rates must be inquired from the head office.

### 2.8.2. Air volume flow rate "QW" for determining the initial resistance of a cleaner

The combustion air flow is subject to pulsation depending on the number of cylinders, as a consequence of which the filter resistance increases. Therefore, when laying out the combustion air cleaners, the theoretical air volume flow rate is to be multiplied by the pulsation factor "f".
In the first step, the essential air volume "QW" is found which determines the initial resistance of the new air cleaner.

$$QW = Q_M \times f \quad (m^3/min) \qquad \text{or} \qquad QW = Q_{MI} \times f \quad (m^3/min)$$

**Table 4:**

| Number of cylinders per cleaner | Pulsation factors f (reference values) naturally aspirated | turbocharged engines |
|---|---|---|
| i = 1 | f = 2.5 | f = - |
| i = 2 | f = 1.7 | f = - |
| i = 3 | f = 1.3 | f = 1.0 |
| i = 4 | f = 1.1 | f = 1.0 |
| i ≥ 5 | f = 1.0 | f = 1.0 |

The initial resistance is taken from the diagram of characteristic resistance lines. Such diagrams may be obtained from the manufacturers of the air cleaners.

### 2.8.3 Air volume "$Q_S$" for determining the service life of the air cleaner (lab test life)

For the air cleaner layout in the second step, the air volume $Q_S$ is required. This value must be used in all assessments concerning air cleaner service life and lab test life – see 2,80,5.

$$Q_S = Q_M \times k \quad (m^3/min) \qquad \text{or} \qquad Q_S = Q_{MI} \times k \quad (m^3/min)$$

The load factor **"k"** considers the reduced pulsation intensity upon increasing air cleaner contamination.

**Table 5:**

| Number of cylinders per cleaner | Load factors k (reference values) naturally aspirated | turbocharged engines |
|---|---|---|
| i = 1 | k = 1.3 | k = - |
| i = 2 | k = 1.2 | k = - |
| i = 3 | k = 1.1 | k = 1.0 |
| i ≥ 4 | k = 1.0 | k = 1.0 |

From the diagrams – resistance behavior when cleaner is passed by contaminated air at laboratory dust concentration (1000 mg dust per $m^3$ air) – of the manufacturers, the dust volumes are resulting accumulated until the admissible value of air cleaner resistance is reached.
With the aid of this dust volume related to the air volume flow rate, the lab test life (h) of the air cleaner can be calculated.
Alternatively, the manufacturers indicate the lab test life curves of the air cleaner as a function of the air volume flow rate.

### 2.8.4 Determining the practical service life of an air cleaner

Before determining the cleaner size, the dust concentration expected for the respective engine application, must be estimated. The table of the reference examples is a selection aid for dimensioning the dry-type air cleaner.

From the laboratory service life, the practical service life of the cleaner can be determined using the following relation:

$$\text{Praxisstandzeit}\,[h] = \frac{\text{Laborstaubkonzentration } 1000 \text{ bzw. } 880 \text{ mg}/\text{m}^3}{\text{Praxisstaubkonzentration mg}/\text{m}^3} \times \text{Laborstandzeit}$$

In the case of vehicles, normally servicing of the air cleaner depends on the km-performance. For converting the practical hours into driven kilometers, the following relation shall be applied:

| |
|---|
| Driven kilometers[km] = Practical service life[h] x mean velocity [km/h] |

## 2.8.5 Reference examples for dimensioning the dry-type air cleaners including preliminary filter

## FIG. 2 - 5 Table 6

| Group | Engine application | Mean dust concentration in mg/m³ | Lab test life in hours as per SAE at 880 mg/m³ | Lab test life in hours as per ISO at 1000 mg/m³ |
|---|---|---|---|---|
| **Normal dust load** | | | | |
| 1 | Trucks, long-distance<br>Gensets<br>Marine propulsion units<br>Rotary snow ploughs | up to 4 | 2.3 – 4.5 | 2 - 4 |
| 2 | Trucks, distributor traffic<br>Rail-mounted vehicles<br>Crane trucks<br>Concrete mixers<br>Pump sets<br>Welding sets | up to 8 | 4.5 – 9.1 | 4 - 8 |
| 3 | Trucks, building site traffic<br>Busses in urban traffic<br>Light fork lifts<br>Small compressors<br>Concrete pumps<br>Rubber-tyred rollers<br>Sweeping machines | up to 12 | 9.1 - 14 | 8 - 12 |
| **Medium dust load** | | | | |
| 4 | Tractors for agriculture and forestry<br>Field choppers<br>Dump trucks<br>Trenchers<br>Contractor's gensets<br>Vibratory rollers | up to 20 | 14 - 23 | 12 - 20 |
| 5 | Heavy fork lifts<br>Large compressors<br>Light hydraulic excavators<br>Wheel loaders<br>Graders<br>Combine harvesters | up to 30 | 23 - 34 | 20 - 30 |
| **Severe dust load** | | | | |
| 6 | Busses, interurban traffic<br>Road grooving machines<br>Underground equipment<br>Drilling machines | up to 40 | 34 - 45 | 30 - 40 |
| 7 | Heavy hydr. excavators<br>Dozers<br>Track-laying machines<br>Off-road tractor trucks | up to 50 | 45 - 57 | 40 - 50 |
| **Extreme dust load** | | | | |
| 8 | Dust development up to zero visibility | up to 1000 | Special measures | Special measures |

## 2.9 Combustion air pipings

### 2.9.1 General

Combustion air pipings between air cleaner and engine ("clean air piping") must be absolutely air-tight and resist the mechanical stresses caused by engine vibrations and pressure pulsations. The same applies to the charge air piping between turbocharger/charge air cooler/engine air intake manifold.

Seamless steel tubes and cast tubes (gray cast/aluminum) are suitable for this purpose; welded sheet metal pipings may also be used, provided they are seal-welded and internally trimmed. The inner surfaces must be cleaned and be free from welding beads, initial rust deposits, scale, mould sand and similar (can be removed by etching) and must be protected against corrosion.

Stove pipes, folded, spot-welded or riveted tubes are not admissible.

**Surface treatment of sheet tubes** (e.g. of steel as per DIN EN 10025):

**For pipings between air cleaner and engine**:
Externally: Immersion-painting
Internally: Immersion-painting

For pipings between turbocharger and intercooler (hot side):
Externally: Prime surface
Internally: Preserve surface with water-resistant oil
or
galvanize and yellow chromate (Attention: only useful if air temperatures are below 100°C because otherwise the galvanic coating will be damaged)

For pipings between intercooler and engine (cold side):
Externally: Prime surface,
or alternatively galvanize and yellow chromate
Internally: Preserve surface with water-resistant oil
or
or galvanize and yellow chromate

Self-supporting pipes or lines are to be checked for their vibration characteristics in accordance with the equipment installation and may have to be supported on the equipment or engine.

In the case of flexibly mounted engines, it is often necessary to rigidly fasten the air cleaning system to the equipment. In this case, a flexible element must be incorporated in the combustion air pipe (ribbed hose, bellows).

Plastic tubes may be used as combustion air piping at the raw air side. Observe the admissible ambient temperatures for the plastic tubes – also regarding fatigue strength and light effect.

For the clean air piping system (tubes between air cleaner and engine or between engine and intercooler or turbocharger and engine), plastic tubes must not be used without previous laboratory examinations regarding temperature / compressive strength / pulsation and admissible vibration. DEUTZ does not conduct such lab tests.

**NOTE:**
For engines with closed-circuit crankcase breathing system (standard for DEUTZ), it must be considered that the combustion air between turbocharger – intercooler (if existing) – engine inlet is containing oil. Therefore, make sure that the material of used hoses, sleeves or plastic tubes is heat- and oil-resistant and is provided with an oil-locking layer (e.g. fluorine elastomers) to avoid that oil emerges from the pipe.

### 2.9.2 Ribbed hoses

**• Ribbed hoses for clean air pipings between air cleaner and engine**

Ribbed hoses are used to connect two pipes which vibrate against each other as a result of engine movement. Attention should be paid to engine movements due to external impact.

If possible, the main direction of vibration should be across the longitudinal axis of the ribbed hose. Minimum spacing of the pipe 150 mm,

Maximum distance without support or holder 500 mm.

The ribbed hose should be laid without pre-tension, straight or slightly curved. The ribs must not have any contact with each other so as to prevent chafing through. Highly flexible ribbed hoses with permanent Teflon sheathing may have slight contact in an environment with a very low dust concentration. In this connection, the detailed installation instructions of the hose manufacturers are referred to.

Ribbed hoses as per DEUTZ specification ***** H3482 - 2 have proved in service.

The material and configuration of the plastic and rubber ribbed hoses available on the market in most cases do not comply with the requirements with regard to vibration and temperature resistance. They should only be used after extended endurance tests.

***** Among other items, the DEUTZ specification is as follows:
Hose to be composed of two rubber layers with textile reinforcement.
Layer 1 (inside) of high-quality rubber / Neoprene, 55 ± 5 Shore, lube oil- and temperature-resistant from –35°C to + 110°C. Ribbed hoses to be provided with a wire spiral embedded in layer 1.
Textile reinforcement wound around layer 1.
Layer 2 (outside) Neoprene, 55 ± 5 Shore, lube oil-resistant and resistant against cracking under the influence of light.
The ends of the wire spiral must not be within the sleeve area of the ribbed hose.
Resistance against vacuum pressure: -0.2 bar at + 110 °C.

**• Ribbed hoses for charge air pipes of intercoolers:**

If intercoolers are mounted remote of the engine, ribbed hoses are also used as flexible pipe connections between turbocharger and intercooler as well as between intercooler and air intake piping of the engine.

Because of the high combustion air temperatures and pressures behind the turbocharger, the requirements to these hoses are high. These ribbed hoses are provided with external, exposed metallic supporting rings and meet the DEUTZ Works Standard H 3482 – 5 (Part 5*)

***** Among others, the DEUTZ works standard specifies the following:
Wall structure of silicon caoutchouc with four spiral-wrapped textile layers of aramide fabric.
Inner and outer surface totally made of silicon caoutchouc (color red).
Admissible operating temperature range – 50°C up to + 200°C (shortly up to 250°C) at an operating pressure of up to 2 bar. Bursting pressure 8 bar at room temperature.
Resistance against the influence of light and ozone, resistant when being wetted with diesel fuel and engine lube oil. Inner lining with an oil-locking layer (e.g. fluorine silicon)
The outer supporting rings are made of steel (similar to X5 Cr Ni Mo 1810 as per D1N 17440).

The ribbed hoses are supplied for example by:

| | |
|---|---|
| Messr. Thermopol, | Representation DLC Germany, 66849 Landstuhl, Phone: 06371 914 -914 / Fax -915 |
| Messrs. Matzen, | 19258 Boizenburg, Phone: 0388476660 |
| Messrs. Rubber Design, | 2995 ZG Heerjansdam (NL), Phone. |
| Messrs. Hutchinson, | 68169 Mannheim, Phone: 062132170 |

- When installing these ribbed hoses in the charge air pipe, the axial hose expansion must be considered which might require additional support of the sheet metal pipes and/or the intercooler.

**Note:** Because of the low resistance to tear-off propagation of the material silicon caoutchouc, the risk of surface damage must be avoided.

**• Ribbed hoses for charge air pipes behind intercooler:**
Analogously to H 3482-5, similar requirements are made to the material; however, the temperature resistance can be reduced to 100°C (a works standard has not been prepared up to now – as far as –50°C are not compellingly required, the H3482-2 can be applied).

Wall structure of silicon caoutchouc with four spiral-wrapped textile layers of aromatic polyamide.
Outer surface continuously made of silicon caoutchouc (color black).
Admissible operating temperature range –50°C up to +100°C (shortly up to 110°C) at an operating temperature of up to 2 bar. Bursting pressure 8 bar at room temperature.
Resistance against vacuum pressure: -0.1 bar at +100°C.
Resistance against the influence of light and ozone, resistant when being wetted with diesel fuel and engine lube oil.
Inner coating with an oil barrier layer (e.g. flourosilicone).
The outer supporting rings are made of steel (similar to X5 Cr Ni Mo 1810 as per DIN 17440).

The ribbed hoses are supplied for example by:

| | |
|---|---|
| Messrs. Mündener Gummiwerke, | 34334 Hann. Münden, Tel: 055417010 |
| Messrs. Hutchinson, | 68169 Mannheim, Phone: 062132170 |
| Messrs. Rubber Design, | 2995 ZG Heerjansdam (NL), Phone. |
| Messrs. Phoenix, | 21048 Hamburg, Phone 0407667-1 |

- When installing these ribbed hoses in the charge air pipe, the axial hose expansion must be considered which might require additional support of the sheet metal pipes and/or the intercooler.

### 2.9.3 Rubber sleeves

Rubber sleeves are only used to connect two pipes in alignment and which do not move against each other. Also the rubber sleeves must meet the material requirements as per DEUTZ specifications, however without wire coil. Distance between pipe ends 5 to 15 mm. The fabric inlay is not required for rubber muffs with wall thicknesses ≤5 mm.

**• Rubber sleeves for intake pipes** (raw and clean air pipes)
For the connection of pipes in the clean and raw air system (in front of and behind air cleaner), sleeves or rubber hoses must be used, the material of which meets the requirements of the DEUTZ Works Standard H 3407 – 1.

| | |
|---|---|
| Temperature resistance: | -40°C ... +110°C |
| Overpressure resistance: | 1 bar (at 110°C) |
| Resistance against vacuum pressure: | -0,1 bar (at 110°C) |
| Material: | Chloroprene rubber |
| Insert: | Fabric insert |
| Resistant against: | light, ozone, fuel, lube oil |

**• Rubber sleeves for charge air pipes, hot (between turbocharger and charge air cooler)**
The rubber sleeves in this line section must meet the material requirements of the DEUTZ company standard H 3407 - 8. These sleeves must have an inner barrier layer against permeation by oil in particular.

| | |
|---|---|
| Temperature resistance: | -50°C ... +200°C (shortly 250°C) |
| Overpressure resistance: | 3 bar (at 200°C) |
| Material: | Silicone caoutchouc (outer layer red) with inside layer of fluourosilicone |
| Insert: | Fabric of aramide fiber material, 5 layers |
| Resistant against: | light, ozone, fuel, lube oil |

• **Rubber sleeves for charge air lines, cold** **(between intercooler and engine)**

These sleeves must partly meet the requirements as per DEUTZ Works Standard H 3407-8 – in view of the low temperature level of the cooled charge air, the requirements to the temperature resistance of the used material can be reduced. The necessity of an oil-locking layer, however, must be maintained.

| | |
|---|---|
| Temperature resistance: | -50°C ... +100°C (shortly 110°C) |
| Overpressure resistance: | 2 bar (at 110°C) |
| Material: | Ethylene acrylic caoutchouc (EAM) |
| Insert: | Fabric of aramide fiber material, 5 layers |
| Resistant against: | light, ozone, fuel, lube oil |

**Suppliers of the sleeves mentioned here are for example**:

The above-mentioned suppliers of ribbed hoses are also specialized suppliers of shaped elements.
For sleeves on hot steel pipes, the following suppliers can still be mentioned:
Messrs. Bauerle, 70174 Stuttgart, Phone: 071118778-0

## 2.9.4 Shaped rubber elements

• Shaped rubber elements (e.g. transition pieces or elbows) as connection elements in air pipes must also comply with the mentioned DEUTZ specifications for materials – depending on their position in the pipe system for the combustion air.

• Shaped rubber elements in ***air intake pipes*** (vacuum pressure) must comply with the DEUTZ delivery instructions 0161 0093 US 8093-35 which, among others, specify the following:

| | |
|---|---|
| Material: | Chloroprene rubber |
| Pressure resistance: | -0,1 bar at +110 °C (here, absolutely tight) |
| Restriction: | maximally 10 % of outer diameter |
| Hardness: | 55 to 75 Shore A |
| Behavior upon cold: | At 40°C the shaped rubber element must permit compression to half the inner diameter without cracking or rupture formation |
| Temperature resistance: | -40 °C to + 110 °C |

• Shaped rubber elements are not suitable for accepting relative movements of the engine, unless they are suitably designed.

• **Attention:** The temperature resistance of a shaped rubber element which is mounted to the turbocharger socket (intake side) must at least be + 130°C.

## 2.9.5 Hose clamps

The ribbed hoses, rubber sleeves and shaped rubber elements, if any, are fastened to the pipe ends with hose clamps.

### Admissible are hose clamps with clamping jaws and screw-nut union:

- Width of the clamp strap at least 15 mm.
- Hose outer diameter and hose clamp inner diameter must correspond, as the clamping range of the clamping jaw clips is small.
- Minimum tensile strength for the clamp strap: 400 N/mm2

## Table 7: Tightening torques:

| Strap width in **mm** | 15 | 20 | 25 |
|---|---|---|---|
| Tightening torque in **Nm** | 4 | 12 | 30 |

The indicated tightening torques were determined on rubber sleeves with fabric insert.

## Hose clamps with screw drive are also admissible:

- Width 13 mm
- Minimum tensile strength for the clamp strap: 400 N/mm²

## Table 8: Tightening torques:

| Clamping diameter in **mm** | | Tightening torque in **Nm** for rubber sleeves and rubber hoses | |
|---|---|---|---|
| above | up to | without fabric insert | with fabric insert |
| 8 | 18 | 2 | 2 |
| 18 | 30 | 3 | 3 |
| 30 | 48 | 4 | 4 |
| 48 | 78 | 4 | 5 |
| 78 | 108 | 4 | 5 |
| 108 | 158 | 4 | 6 |

Note:
The hose clamp strength permits a 1.5-fold increase of the tightening torques indicated in the table. The initial tightening forces obtained with the tightening torques may be affected by the temperature-dependent settling properties of the rubber sleeves and rubber hoses. In these cases, it is recommended to re-tighten the clamps to the required torque so that a permanently constant preload is ensured.

Clamps made of stainless steel or provided with anti-corrosion coating, embossed, non-perforated strap material.
Sharp edges on the inside of the clamp are not admissible.
Lock and strap to be of same material.
Continuous lock fastening.

The hose clamps must match the hose diameter. By no means, a hose binder cut from a roll and tightened by a cotter pin must be used at these points.

To ensure proper seating of the rubber sleeves or ribbed hoses, observe the following:

- The connecting ends of sheet metal pipes are to be provided with a crimp as per DIN 71550 (plug-on length of the rubber element 35 mm, hose clamp arranged behind the crimp).

- Cast iron or steel pipings with a wall thickness of more than 2 mm do not require a crimp, if the seat for the rubber sleeves is machined (cast tube) or drawn seamlessly (steel pipe) and the surface quality corresponds to Rt = 40. A crimp is required if case pipes are not processed. The surface must be cleaned and the model partition seam may not be visible.

Of course, the connecting pipe ends must be smooth, round and free from burrs. In the case of welded sheet metal pipes, it is necessary to smooth the weld seams.

## Hose clamps with self-adjustment of the screw drive:

In the case of these screw clamps, the settling behavior of the sleeves or hoses is compensated by a self-adjustment of the screw drive via plate springs or helical springs. In this way, a permanent uniform preload is made sure.

Hose- and sleeve connection with clamps of this kind are characterized by an excellent permanent tightness.

These clamps are supplied by:

| | | |
|---|---|---|
| Messrs. Breeze Pebra GmbH<br>PEBRA-Schellen (Type HKFK) | 78665 Frittlingen, | Phone: 0742694920 |
| Messrs. Rasmussen<br>GBS-Norma-Schellen | 63461 Maintal, | Tel.: 06181 403-0 |

## Spring-loaded clamps as self-adjusting hose clips:

A newer kind of hose clamps is represented by the spring clips of spring steel 50 Cr V4 according to DIN 3021-1 and –4.
These clips are suitable for sealing silicone and fluorosilicone sleeves and pipes which can be used in the temperature range from -50 °C to +150 °C. Due to its spring properties, this clip adapts to changes in the pipe caused by setting and creeping of the elastomer.

Hose- or sleeve connections with spring-loaded clamps are also characterized by an excellent permanent tightness.

These spring-loaded clamps can be used in the following areas:

- Coolant circuit (up to 3bar overpressure)
- Fuel system (up to 7bar overpressure)
- Air intake system vacuum pressure
- Charge air system (up to 2bar overpressure)

These clamps are available with diameters of 13mm to 90mm and in widths of 12mm and 15mm.

These clamps are supplied by:

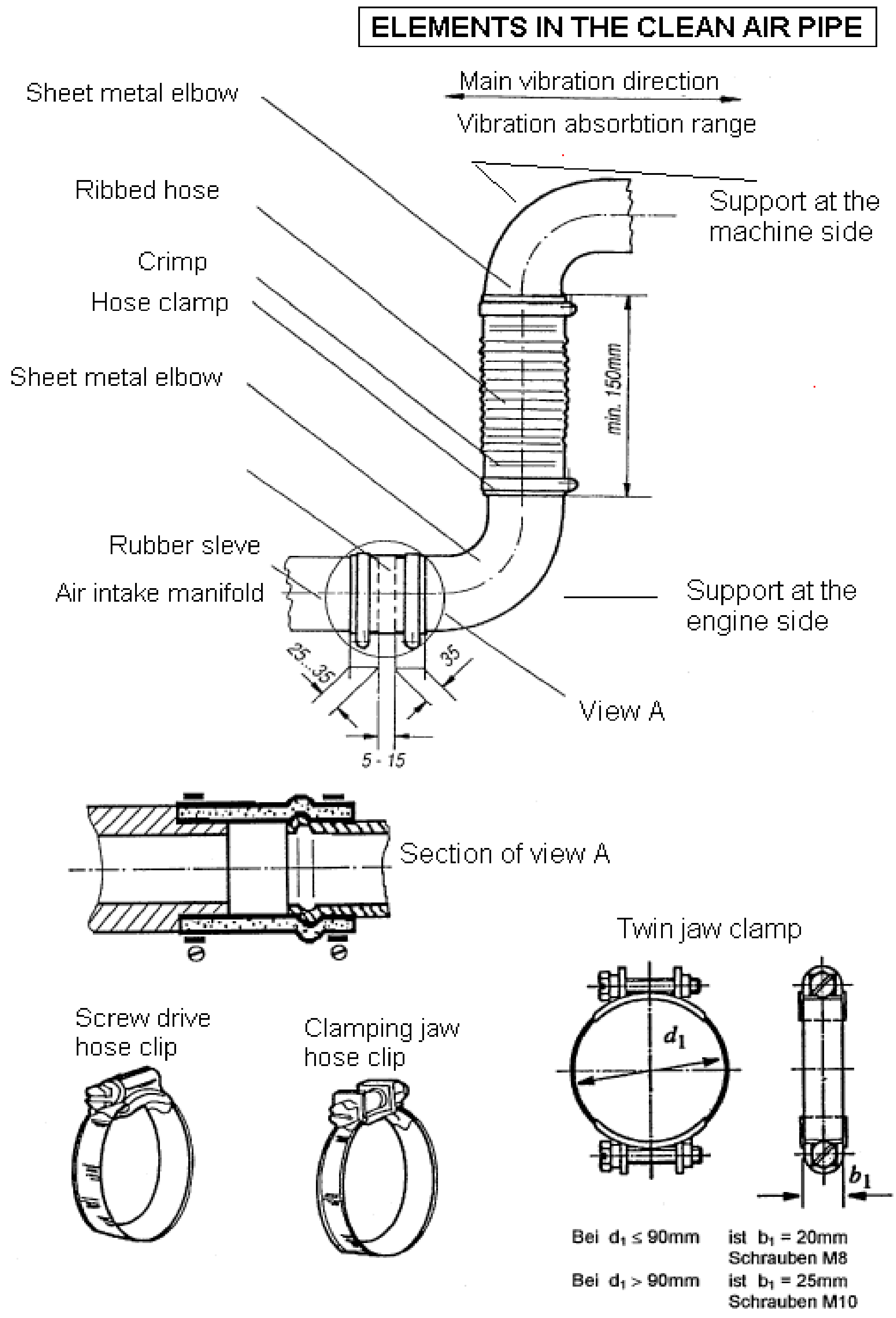
| | | |
|---|---|---|
| Messrs. Rasmussen | 63461 Maintal, | Tel.: 06181 403-0 |

## Hose clamps with TWIN clamping jaws:

This is a split clamp with two screw-nut connections (Type B2 as per DIN 3017-2).

These clamps are particularly suitable for fastening the sleeves and hoses in the charge air pipes between turbocharger – intercooler – engine inlet to generate suitably high pressing forces for sealing.

**FIG. 2 -6**




∗ **Attention: Due to internal pressure and pulsation, a flexible connection must be provided between the engine and ongoing pipes. In addition the ongoing pipe must be fixed mechanically.**

### 2.9.6 Passages of clean air pipes

The passages of clean air pipes through engine cowlings or sound insulating walls must be executed such that the pipes cannot chafe through. Check for reciprocal vibrations; if necessary, enlarge the passages for the piping and fill the annular gap towards the pipe with foam rubber or a similar material.

### 2.9.7 Layout of the combustion air pipes

#### 2.9.7.1 Naturally aspirated engines

When designing the piping for the intake system, the diameter of the intake pipe on the engine should be taken as a basis.

For comparison purposes, a theoretical piping length is assumed exceeding that of the actual pipe length.

The theoretical piping length comprises the following:

1. The measured piping length before and behind the air cleaner.
2. An allowance of 1000 mm of theoretical pipe length per 90° elbow, if it has good flow properties, i.e. if it is laid out as circular bend with an as large radius as possible and with an allowance of 2000 mm, if its flow properties are unfavorable.
3. An allowance of 500 mm of theoretical pipe length per 45° elbow, if it has good flow properties and with an allowance of 1000 mm, if its flow properties are unfavorable.
4. An allowance for every element of ribbed hose having the length of the ribbed hose.

Up to a theoretical pipe length of 2 m, the diameter of the intake pipe can be maintained for the entire pipe.

When the theoretical pipe length exceeds 2 m, the diameter of the piping must be increased as follows compared with the air intake pipe on the engine (connection via a conical adapter with an angle of taper of abt. 15°):

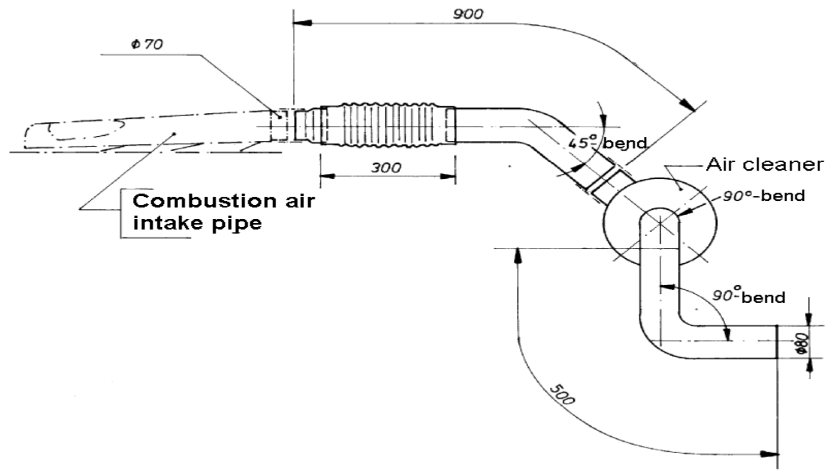
**Table 9**

| Theoretical pipe length | Diameter increase compared with intake pipe |
|---|---|
| over 2 m to 4 m | 10 mm |
| over 4 m to 6 m | 20 mm |
| over 6 m to 10 m | 30 mm |
| over 10 m to 15 m | 40 mm |

**Example:**

A line as shown in the figure below is planned. The length of the intake pipe inlet is 900 mm and contains a ribbed hose of 300 mm in length and a 45° bend among other things. There is a 500 mm length of pipe with a 90° bend in front of the air cleaner.
The intake pipe has a diameter of 70 mm.

**FIG. 2 -7**




The theoretical piping length is given by:

| | | | |
|---|---|---|---|
| 1. 900 + 500 | = | 1400 mm | measurable length |
| 2. 500 + 1000 | = | 1500 mm | allowance for bend 1 x 45° and 2x 90° (favorable to flow) |
| 3. | = | 300 mm | allowance for the folded pipe length already contained in the measured length |
| | = | 3200 mm = 3.20 m | |

Since the theoretical pipe length is 3.2 m and therefore between 2 and 4 m, the pipe diameter must be enlarged 10 mm according to the table. The air feed lines must have a diameter of 80 mm (70 + 10). All diameters which do not fit must be adapted by conical adapters (taper angle 15°).

### 2.9.7.2 Intake air pipes in 3-cylinder engines

Certain versions of the air intake pipes lead to an unfavorable resonance behavior of the intake air in 3-cylinder naturally aspirated engines and influence the gas change to such an extent that the engine suffers a lack of combustion air.

This lack of air worsens the engine values on the one hand – the stronger, the closer the engine is to maximum performance. On the other hand lack of air worsens the cold start behavior (production of white smoke).

Therefore note when designing the suction intake air pipe:

- Keep pipe lengths as short as possible
- Pipe diameters well above 70 mm or greater
- Avoid strong deflections of the pipe
- Minimize air cleaner resistance, i.e. it is better to install the bigger air cleaner

It may have to be clarified which of the measures gets the desired result by conducting tests.

### 2.9.7.3 Turbocharged engines

As exhaust gas turbochargers operate with high internal air velocities, the diameters of the connections cannot be taken as a basis for the piping diameter.

The close relationship between the degree of turbocharging, engine power and the exhaust gas volume flow rate suggests the engine output as reference value for dimensioning the piping system.

Therefore, a reference value for the minimum cross sections of the **intake pipe of naturally aspirated engine** can be determined as a function of the theoretical pipe length (see the Suction intake engines section for determination).

**Table 10:**

| Theoretical piping length | Required minimum cross sections* of the intake pipe | |
|---|---|---|
| | turbocharged engines with and without LLK including Euro I | turbocharged engines with LLK for Euro II and higher value |
| to 2 m | 0.71 cm²/kW | 0.79 cm²/kW |
| over 2 to 4 m | 0.90 cm²/kW | 1.00 cm²/kW |
| over 4 to 6 m | 1.09 cm²/kW | 1.21 cm²/kW |
| over 6 to 10 m | 1.27 cm²/kW | 1.42 cm“/kW |
| over 10 to 15 m | 1.48 cm²/kW | 1.65 cm²/kW |

***** However not below connection diameter of engine or cleaner.

For V-engines the data for every side apply, i.e. for every row of cylinders half the engine performance must be inserted.

### 2.9.7.4 Turbocharged engines with intercooler

In the case of turbocharged engines with charge air cooling, the compressed combustion air behind the turbocharger is forced under pressure through a cooler (air/air cooler) to the cylinders.

If the charge air cooler is mounted on the engine (engine-integrated), the dimensioning of the pipe between the turbocharger and the cooler or cooler and engine inlet must be specified by DEUTZ.

If the charge air cooler is mounted remotely from the engine (engine external), the dimensioning of the pipe between the turbocharger and cooler or cooler and engine inlet (cylinder head) must be performed according to the following reference values.

**Table 11:**

| Theoretical pipe length | Required minimum cross sections of the charge air line | |
|---|---|---|
| | turbocharged engines with intercooler including Euro I | turbocharged engines with intercooler for Euro II and higher |
| to 2 m | 0.29 cm²/kW | 0.32 cm²/kW |
| over 2 to 4 m | 0.33 cm²/kW | 0.36 cm²/kW |
| over 4 to 6 m | 0.37 cm²/kW | 0.40 cm²/kW |
| over 6 to 10 m | 0.42 cm²/kW | 0.46 cm“/kW |
| over 10 to 15 m | 0.47 cm²/kW | 0.52 cm²/kW |

If, on that basis, a pipe diameter is resulting which is smaller than the diameter of the pipe sockets of the intercooler, the diameter of the cooler pipe socket is selected as pipe diameter for the charge air pipe.

## 2.10 Intercooler (air-air cooler)

### 2.10.1 Installation position

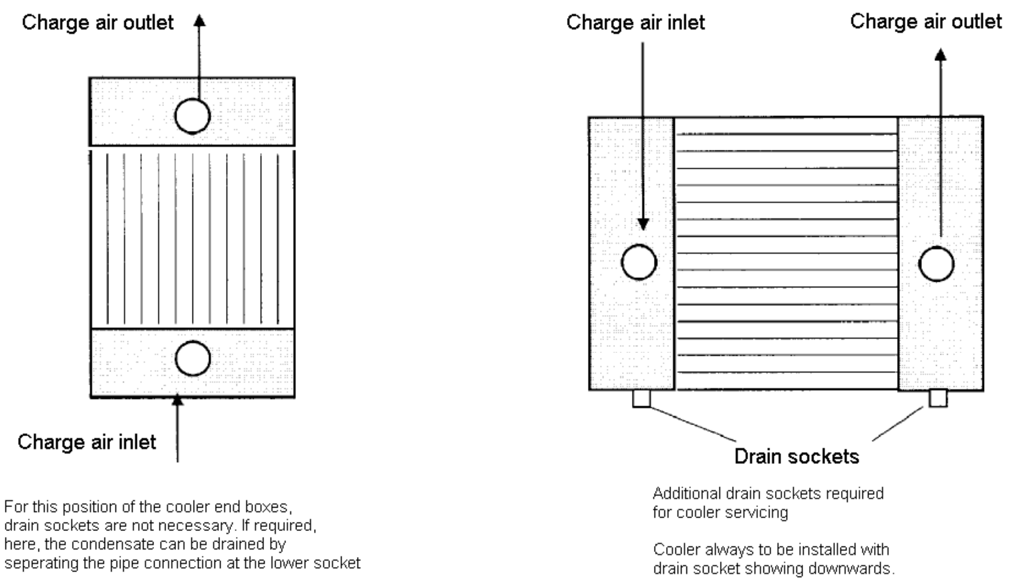
The coolers used for cooling the charge air are so-called air-air coolers, i.e. the charge air is recooled with the cooling air.

When connecting the intercoolers to the charge air piping system of the engine, observe the references given under "charge air pipes".

As regards the layout of intercoolers, contact the head office.

For the installation of intercoolers, make sure that the oil- and water condensate generated in the cooler can be drained.
Therefore, depending on the position of the cooler end boxes with their connection sockets, drain plugs are required for servicing the intercooler.

**FIG. 2 -8**




### 2.10.2 Admissible pressure loss in the intercooler

For the engine series dealt with in these installation instructions the charge air cooler is designed and installed by DEUTZ. If a “remote mounted charge air cooler” solution is necessary, its design must be agreed with the “Technical Support” team at the DEUTZ head office.

## 2.11 Heating up of combustion air

In exceptional cases, the combustion air may be heated up to max. 10°C above the ambient temperature. For thermal load reasons you should always aim not to have any heating up of the combustion air.

The measurement is to be made at the inlet of the combustion air intake manifold or before the turbocharger inlet. In cases where any heating up between the air cleaner inlet and intake manifold can be excluded, it is sufficient measure at the air cleaner inlet.

## 2.12 Combustion air noise

The combustion air noise is often very annoying on road vehicles and construction equipment with cab because of its low-frequency portions.

A possible remedy is the installation of resonators or Venturi pipes, if the position of the combustion air intake or of the cleaner or the pipe routing cannot be changed.

## 2.13 Crankcase breathing system

During the combustion process of the diesel engine, certain quantities of leakage gas enter the crankcase through the piston ring gaps. The crankcase breathing system serves for disposing of such leakage gases.

For such purpose, a breather pipe connects the inside of the crankcase via a control valve with the clean air side of the combustion air intake system (e.g. engine intake pipe).

In the case of engines with exhaust gas turbocharger, the suction side of this breather pipe is connected between combustion air cleaner and turbocharger.

The crankcase breather pipe is normally mounted to the engine and connected such that no further installation measures must be considered by the OEM.

If, however, the routing of the breather pipe must be changed, the following has to be observed when re-routing the pipe:

- The pipe must always be routed such that no oil can accumulate in the pipe.
- The used hoses must absolutely be resistant to oil and be lined with an oil-locking layer.

## 2.14 Pre-loading of hydraulic oil tanks

To reduce to the tendency of hydraulic systems to form cavitations, closed circuits are used, where the hydraulic oil is pressurized in the hydraulic oil tank (pre-loaded oil). To that end, normally an air compressor is required.

When using turbocharged engines for driving hydraulic systems, the charge air pressure can be used for pre-loading the hydraulic oil. Via a pick-up from the charge air line (for charge air coolers, always use the cold charge air pipe), the charge air pressure can act onto the hydraulic oil surface in the tank.

A check valve must be switched between the withdrawing points at the charge air pipe and the hydraulic oil tank to ensure that the oil or the medium is not relieved into the charge air system. Upon the selection of the check valve, a sufficiently high temperature resistance must be ensured as the charge air is flowing through the valve.

The use of the charge air pressure for pre-loading is only permitted, if the required air volume does not exceed 1% of the combustion air volume of the engine at rated speed.

# 3. EXHAUST GAS SYSTEM

## 3.1 General

The exhaust gases are routed off the engine in pipes. To reduce the noise in this connection, a silencer is required. This necessarily leads to resistances in the exhaust gas system which, however, must not exceed the admissible total resistance as stated in the table. The total resistance of an exhaust system comprises the resistance due to the piping including elbows plus the silencer and other components, e.g. engine brake.

## 3.2 Permissible resistance in the exhaust gas system

The resistance data given in the following tables represent values which must not be exceeded when measured on the engine at rated power and rated speed. They apply for the entire exhaust system.

No difference is made between automotive and equipment engines.

**Table 1:**
Admissible exhaust back pressure for **automotive and equipment engines as well as genset engines***
**Applicable to naturally aspirated and turbocharged engines.**

| Engine | only silencer | | | Overall exhaust gas system (incl. silencer, pipes, catalytic converters, particle filters etc.) | | |
|---|---|---|---|---|---|---|
| | mmWS | mbar | kPa | mmWS | mbar | kPa |
| 1-cylinder | 200 | 20 | 2.0 | 265 | 26.5 | 2.65 |
| 2-cylinder | 370 | 37 | 3.7 | 485 | 48.5 | 4.85 |
| 3-cylinder | 480 | 48 | 4.8 | 635 | 63.5 | 6.35 |
| From 4 cylinders upwards | 570 | 57 | 5.7 | 750 | 75 | 7.5 |

* Engine power for genset engines as per power class VIc.

**Table 2:**
Admissible exhaust back pressure for **genset engines with COP, PRP, LTP performance**
**Applicable to naturally aspirated and turbocharged engines.**

| Engine | only silencer | | | Overall exhaust gas system (incl. silencer, pipes, catalytic converters, particle filters etc.) | | |
|---|---|---|---|---|---|---|
| | mmWS | mbar | kPa | mmWS | mbar | kPa |
| 1-cylinder | 200 | 20 | 2.0 | 270 | 27 | 2.7 |
| From 2-cylinders upwards | 200 | 20 | 2.0 | 300 | 30 | 3.0 |

The values for the exhaust gas back pressure of the silencers or other systems for the after-treatment of exhaust gas are reference values and can be variably handled, provided the exhaust gas back pressure of the overall exhaust gas system is not exceeded. It must not be exceeded with the exhaust brake flap opened, should an exhaust brake be installed or in case of other resistance-increasing components.

**Due to the prevailing installation conditions, in the individual case, it cannot be avoided to exceed the exhaust gas back pressure. In such cases, the head office (Technical Support) must be contacted to verify whether the existing exhaust gas back pressure values are still admissible.**

## 3.3 Measuring the exhaust gas back pressure

The exhaust gas back pressure is measured best with a water-filled U-tube:

a) **Naturally aspirated engines** at full load and rated speed
immediately behind the exhaust gas manifold.

If no full loading of the engine is possible, the measurement can also be made alternatively without load at high idle speed (HLL). The resistance may not exceed 60 % of the admissible full load value.

b) **Turbocharged engines** only at full load and rated speed
behind the exhaust gas turbine.

If the engine cannot be run at full load, the measurement can be made at high idle speed (control down speed, P factor abt. 6 to 10 %).

The exhaust gas back pressure value must be multiplied by factor P. The resulting value may not exceed the admissible full load value:

| | |
|---|---|
| p = 2.8 | for turbocharged engines without charge air cooling |
| p = 3.6 | for turbocharged engines with charge air cooling |

This method only permits a rough estimate of the exhaust gas back pressure to be expected upon full load operation of the turbocharged engine at its rated speed.

If an exhaust brake is fitted, the flap must always be open when the measurement is made.
If the exhaust brake is directly mounted to the exhaust gas manifold or directly to the turbine, the pick-up point is to be located behind the exhaust brake at a distance corresponding to the 2- up to 3-fold pipe diameter. The measured value will then be added to the resistance value of the exhaust brake.

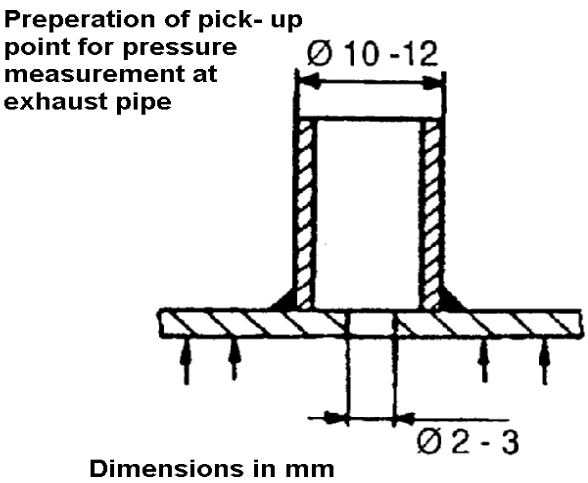
### Notes:

- Measurement of the exhaust back pressure leads to incorrect values in 1 to 2-cylinder engines and 6-cylinder V-engines due to the strong pulsation. To smooth this pulsation, a settling space of abt. 30 to 50 dm3 must be left between the exhaust system and the exhaust manifold for the measurement. The pickup point is then at the exhaust system inlet.
- Engines fitted with PTO's which cannot be uncoupled may have to yield high drag powers when operating at high idling speed or idling at rated speed. When measuring the exhaust back pressure, increased values may result which, multiplied by the above factors, may exceed the specified limit values. To have an estimate of the actual exhaust gas back pressure, it is therefore recommended to measure, at the same time with the exhaust gas back pressure, also the exhaust temperature (within the area of the pressure pick-up point) as well as the combustion air temperature at (the inlet of the intake pipe). DEUTZ application engineering should be consulted; they will assess, whether the measured exhaust gas back pressure is admissible.

### Exhaust pickup point:

A bore with a diameter of 2 to 3 mm must be provided for measuring the exhaust gas back pressure. The burs resulting from drilling must be removed and the inside of the bore must remain sharp-edged.

**Fig. 3-1**




**a) Pickup point for the exhaust back pressure and exhaust temperature in naturally aspirated engines**

**Fig. 3-2**

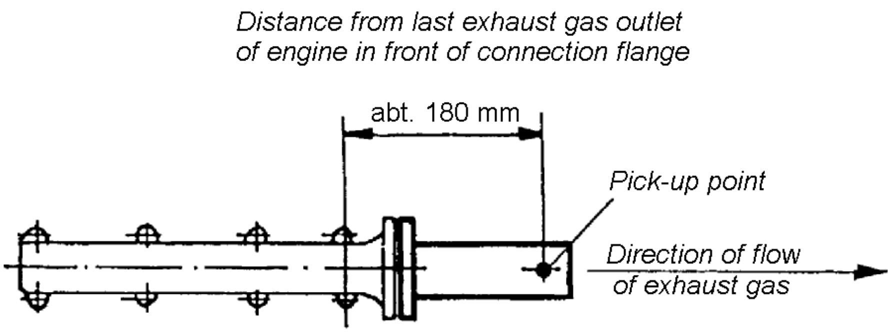
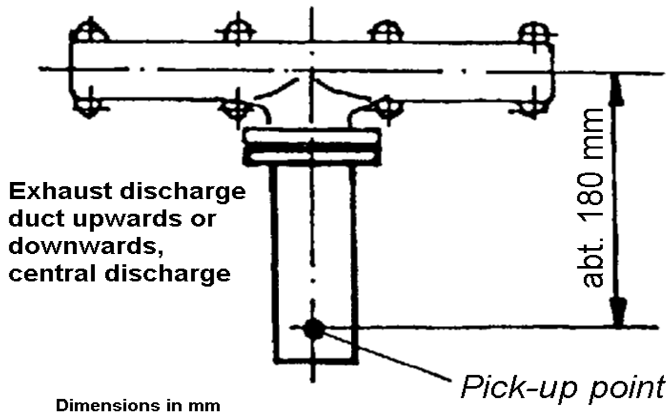
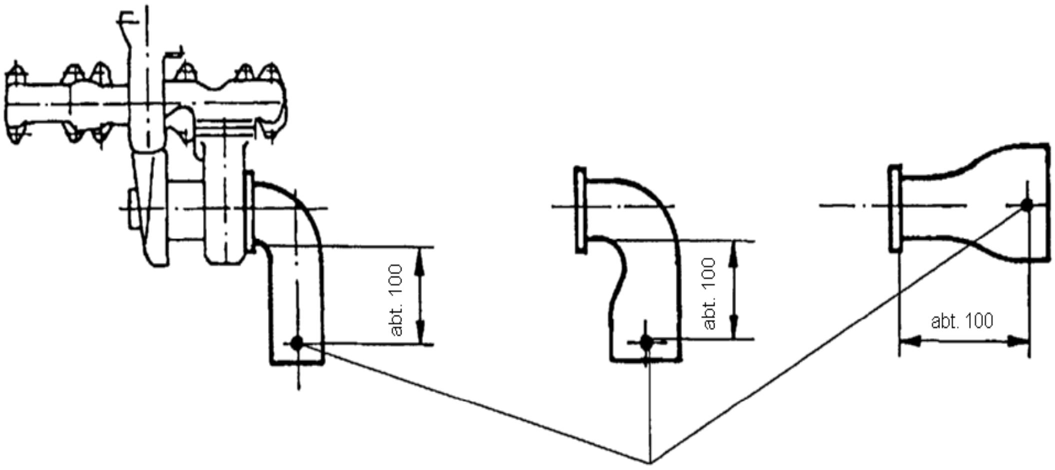



**Fig. 3-3**



### b) Pickup points for the exhaust back pressure and exhaust temperature in turbocharged engines

**Fig. 3-4**




*Pick-up point in continuation of the neutral fibre*
Measures in mm

## 3.4 Dimensioning of exhaust gas pipes and determination of the piping resistance

The reference value for laying out the exhaust gas piping is the internal diameter of the engine exhaust gas pipe; it is not admissible to reduce the diameter beyond this value.

The nomographs at the end of this chapter indicate the mostly used pipe diameters which must be observed as far as possible. Diameter increases between exhaust gas manifold and ongoing pipe or to the silencer must be bridged by suitable adapters (angle of taper 15°). The transitions are included in the pipe length calculations. The line resistance can also be taken from the graphs at the end of the chapter.

**The graphs are sub-divided as follows:**

| | |
|---|---|
| for naturally aspirated engines | Stroke of up to 280 mm |
| for turbocharged engines | Stroke of up to 280 mm |

When designing the exhaust system, the total of the individual resistances for silencers, pipes, compensators, etc. may not exceed the total resistances specified in the tables under “Admissible resistances”. Only the choice between increased line resistance and reduced silencer resistance or vice versa is admissible.

From the graphs, the specific resistance $\Delta ps$ [mbar/m-pipe] can be read at a specific engine power in [kW] and a specific pipe diameter [mm]. Moreover, the “Additional pipe lengths” for elbows for different elbow radii for the individual pipe diameters can be determined with the graphs, i.e. an elbow with a given curve $r_m/D$ corresponds to a certain straight pipe length. When determining the pipe resistance, these "extra" pipe lengths" must be added to the existing straight pipe run.

Examples for determining the piping resistances may be taken from the graphs.

For given lengths and resistances, the necessary pipe diameters can be similarly determined with the aid of the graphs.

Exhaust pipes of V-engines can be laid by combining the exhaust connections of the engine in one pipe. The lengths and pipe diameter of the combination must be taken into account in determining the line resistance.

Half the engine power must be used to determine the two pipes from the connecting flanges on the engine to the combination.

The total resistance which acts on the respective row of cylinders in V-engines is made up of the determined resistance of the pipe after a row of cylinders plus the resistance of the combined exhaust system.

## 3.5 Silencer and end pipe lengths

The silencers offered in the respective scope of supply are matched to our engines in respect of noise and resistance. In the case of other silencers, it is necessary to check at least the resistance so as to avoid power losses.

The acoustic effect of the silencer is relatively strongly influenced by the length of the end pipe. For silencers used under normal conditions, an end pipe length of 700 – 1200 mm is normally sufficient.

Where large-volume, multiple-chamber heavy-duty silencers are used with internal matching, the influence of the end pipe length can normally be neglected.

## 3.6 Flexible exhaust pipe joints

Where engines are flexibly mounted or the exhaust pipe is not fixed directly to the engine, a "flexible element" must be provided in the exhaust pipe behind the engine for the absorption of relative movements, shock-induced spring deflections or thermal expansion. The following "flexible elements" are suitable for that purpose:

a) **Metal hoses:**
They are suitable for the absorption and/or compensation of bending stresses (induced by engine movement) and thermal expansion. When installing metal hoses, it must be ensured that they are fitted in parallel to the crankshaft. In this way, primary stress will always be a bending stress. Depending on the design, the direction gas flow must be observed. Metal hoses are not gas-tight.

b) **Corrugated pipe (axial compensators):**
Corrugated pipes can absorb tensile, compressive and bending stresses. When engines are flexibly mounted, make sure that the following items are considered:

1. When installing corrugated pipes, make sure that these are mounted, if possible, directly behind the exhaust gas manifold and in parallel to the crankshaft. Thus, it is avoided that the direction of thermal expansion is in line with the direction of vibration stresses.

2. Install the corrugated pipes with tensile preload, i.e. length to be increased by about 40% of the expansion to be expected on the straight pipe section to follow. With the exhaust gas temperature to be expected, steel pipes, for instance, will expand by about 5 to 6 mm of pipe length.

3. Install mating flange screw connection by means of a loose, turnable flange so as to avoid torsional installation stresses when aligning the flange hole patterns.

4. If possible, stress should be limited to bending.

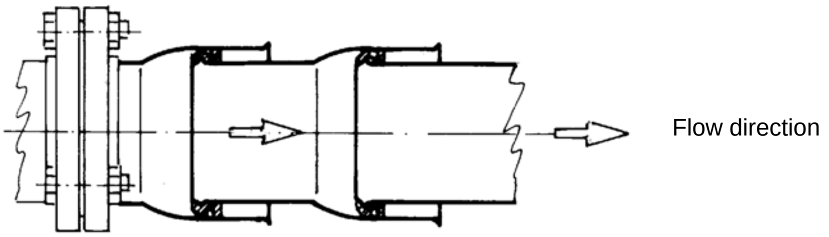
5. Corrugated pipes can emit an intense air-borne sound. To reduce this sound emission, use corrugated pipes with internal shield tube.

Corrugated pipes are gas-tight.

**c) Exhaust joints**

Exhaust joints are a system of pipe elements plugged one into the other, which are connected by multiple-disc seals (see diagram).

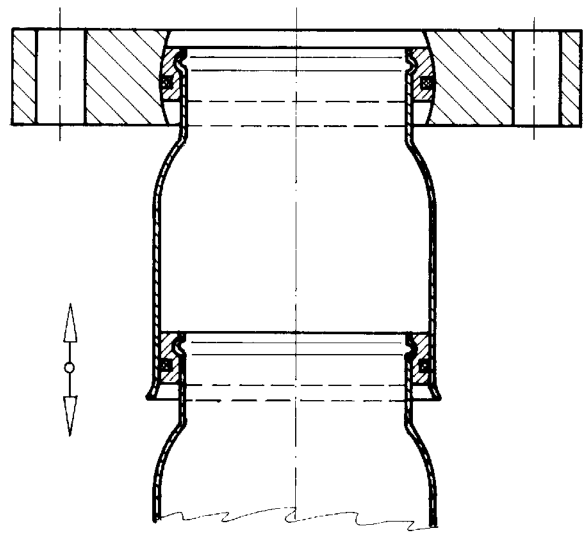
**Fig. 3-5**




When installing the joints, ensure that the central piece remains easy to slide and to turn.
For an optimal compensation of relative movements, avoid excessive misalignments of the opposing pipe openings.
Positioning of the joints should always be horizontal or suspended (with expanded end down to avoid the penetration of water) with the gas flow always in the direction of pipe-to-pipe extensions. This will ensure stability of the central piece because of the gas force (and the natural weight) and avoid vibrations (destruction).

With a second version of exhaust joints, the movable central piece is mounted directly in the flange so as to allow turning and pivoting, see diagram; thus, no characteristic movements can be induced due to gas forces or natural weight.

**Fig. 3-6**



Silencer joints are not gas-tight and must, therefore, not be used in rooms.

## 3.7 Exhaust brake (exhaust brake flap)

When actuating the exhaust brake flaps to increase the engine braking power, the injection pump must be set to zero delivery.

**Caution when engine is operated with converter unit:**

Timely, speed-dependent opening of the brake flaps and subsequent setting of the injection pump control lever to low idling will prevent engine shutdown while the equipment is in operation. Alternatively, the control lever can be set to the "low idling" position and the brake flaps actuated simultaneously.

Normally, the exhaust brake flaps are actuated by a control lever with pivoted cylinder serving as actuator. This compressed air circuit for actuation of the exhaust brake flap simultaneously incorporates an air cylinder serving to actuate the injection pump control lever or – in the case of so-called double-lever pumps – is directly acting on the shutdown lever.

As a consequence of simultaneous actuation of exhaust brake flaps and injection pump control lever via a linkage, which is actuated by only one air cylinder, malfunction may occur in some cases due to the setting tolerances and the friction losses of the linkage mounting. It is therefore recommended to always trigger the components individually with air cylinders.

Exhaust brake flaps are normally fitted directly at the outlet of the exhaust gas manifold or of the turbocharger. The integrated air cylinders for actuating the brake flaps are exposed to high thermal stresses. It is therefore recommended to use so-called heat-resistant air cylinders (up to 145°C operating temperature/ambient temperature).

As exhaust flaps are matched to the relevant engine design, it is recommended to only use such flaps which are included in the DEUTZ scope of supply.

## 3.7 Nomograms for determining the exhaust gas resistance

**Figur 3 - 7**

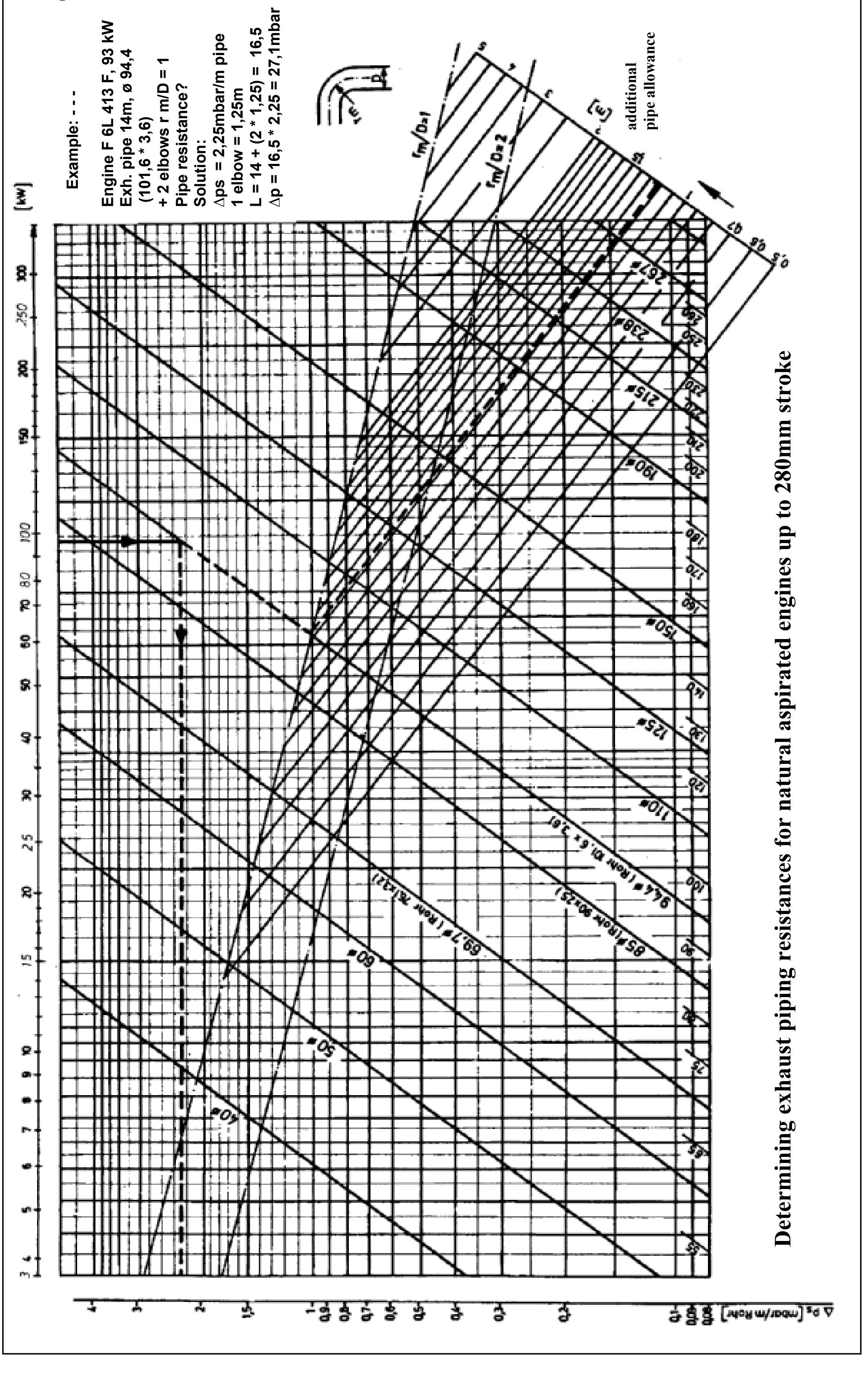
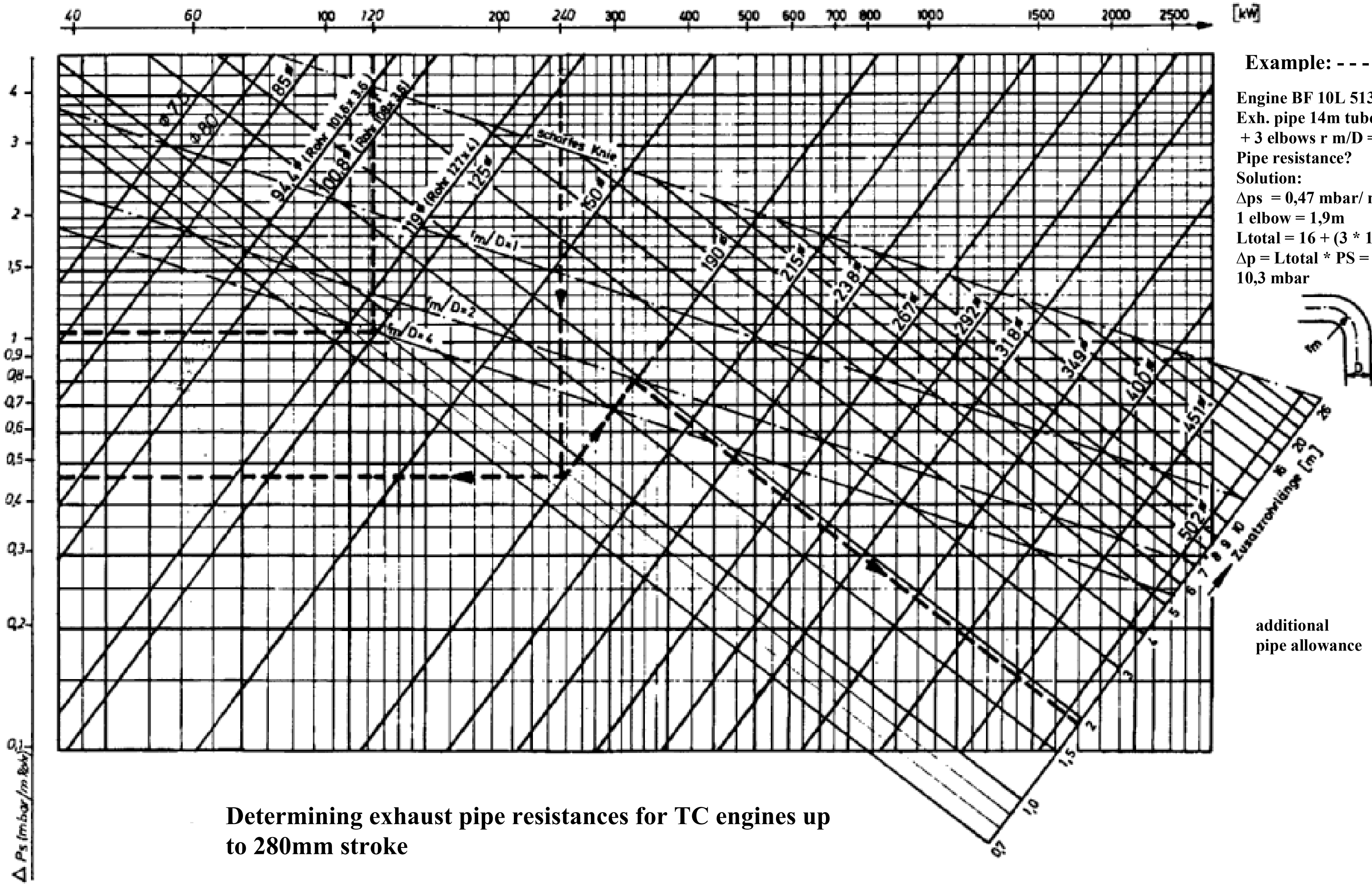


**Fig. 3 - 8**




**Example: - - -**

**Engine BF 10L 513, 240 kW**
**Exh. pipe 14m tube 190 (194*2)**
**+ 3 elbows r m/D = 2**
**Pipe resistance?**
**Solution:**
**Δps = 0,47 mbar/ m pipe**
**1 elbow = 1,9m**
**Ltotal = 16 + (3 * 1,9) = 21,7**
**Δp = Ltotal * PS = 21,7 * 0,47 ~ 10,3 mbar**

**Determining exhaust pipe resistances for TC engines up to 280mm stroke**

## 3.9 Water scrubbers

In the case of water scrubbers, the exhaust gas is directed through a water bath in which the exhaust gas is cooled and some particles are washed out.

Water scrubbers are water tanks with several inner baffle plates and separating facilities connected behind, which feature a considerable flow resistance even without water filling.

Therefore, upon measurements of the exhaust gas back pressure, the scrubbers must be examined with and without water filling.

**When assessing the resistance, the remaining water level in the scrubber must be regularly topped up.**

Dimensioning of the water scrubber (water volume and separating chamber) will be up to the equipment manufacturer, as this will mainly depend on the installation space available for the water scrubber. The water storage capacity should be approximately the same as the fuel tank capacity. The water filler neck of the scrubber should be largely dimensioned to permit rapid filling.

## 3.10 Exhaust gas catalytic converters

When using catalytic converters, the manufacturer shall give suitable instructions for the design, the determination of the size and for the installation as well as for monitoring and servicing.

Depending on the design and material used, the flow resistance of the catalytic converter will change in the course of time. Therefore, we recommend to provide a lockable exhaust back pressure pick-up point in front of the catalytic converter so that the back pressure can be checked from time to time.

Catalytic converters should be connected to the engine as close as possible to minimize exhaust heat losses. If necessary, the exhaust gas piping behind the engine or the turbocharger must be insulated against the catalytic converter.

Catalytic converters have a good silencing effect so that it may be possible to install them instead of the standard exhaust silencer. For verification purposes, the noise emission at the exhaust outlet should be measured.

The limit values determined for the exhaust gas back pressure also apply to the use of the catalytic converters. When laying out catalytic converters and the relevant piping system, it must be ensured that the exhaust gas back pressure limits are not exceeded.

## 3.11 Exhaust gas heat exchangers

For utilizing the exhaust gas heat, heat exchangers can be used to transmit the exhaust gas heat to the media of heating circuits.

For dimensioning of the exhaust gas pipes of an exhaust gas system, the additional exhaust gas resistance due to the exhaust gas heat exchanger must be observed. The maximally admissible exhaust gas back pressure limits for the engine must not be exceeded.

Exhaust gas heat exchangers have a certain silencing effect which can be considered for the layout of the silencer.

The technical data of an exhaust gas heat exchanger must be inquired from the manufacturer.

**Notes:**

- Exhaust gas heat exchangers must always be provided with a controllable bypass so that, in case of a failure (clogging, pipe rupture in the heat exchanger etc.) the exhaust gas flow can be directed around the heat exchanger to protect the engine.

- When installing exhaust gas heat exchangers, it is absolutely necessary to provide for pick-up points in the line system for measuring the exhaust gas back pressure. Via these pick-up points, cyclical exhaust gas back pressure measurements are made to monitor the exhaust gas back pressure and to determine the time for cleaning of the exhaust gas back pressure of the exhaust gas heat exchanger.

- Exhaust gas heat exchangers are maintenance parts – they must be cleaned (removing of soot deposits). Therefore, the installation must be made in such a way that the servicing works can be performed without any problem.

- Exhaust gas heat exchangers must not be operated in the engine coolant circuit.

## 3.12 Exhaust gas end pipe/water penetration guard

With the exhaust gas end pipe, the exhaust gas flow of an exhaust gas system is directed into the open atmosphere so that operator and engine are not hindered.

The end opening of the exhaust gas end pipe must be designed such that no water (rain, snow) can enter.

Therefore, exhaust gas end pipes must be equipped with a water penetration guard in the form of exhaust gas flaps or 90° pipe elbows. Alternatively, at the lower end of an end pipe, a water draining slot (Venturi-type) can be provided for.

## 3.13 Condensed water separator

In the case of very long, vertical exhaust gas end pipes (stack), separators of condensed water are necessary (cooling down of the exhaust gas and condensation of the water steam).

The condensed water separator must be arranged at the deepest point of an exhaust gas system to ensure that the collected water cannot flow back and/or clog pipe cross sections (icing with the engine standing still).

Condensed water separators must be provided with a drain cock for draining the water.

The volume of a condensed water separator depends on the water volume to be expected in view of the mode of operation of the engine (engine load, exhaust gas temperature) and the insulation of the exhaust gas end pipe – the manufacturer of the system is responsible here and gives suitable recommendations, also regarding servicing.

## 3.14 Heat insulation

A heat insulation of the surfaces of exhaust gas manifolds at the engine and the following exhaust gas turbochargers is generally not permitted and always require a consultation with DEUTZ.

In view of the higher permanent temperature load by heat insulations, exhaust gas manifolds and exhaust gas turbochargers must be made of particularly heat-resistant material.

If admissible at all, exhaust gas turbochargers are permitted to be insulated only partly, i.e. only the hot exhaust gas turbine may be insulated. In this case, the oil-lubricated shaft connection between compressor and exhaust gas turbine must be left free for cooling purposes (free dissipation).

| |
|---|
| The insulation of the exhaust gas manifold and the turbochargers must always be seen as a function of the engine application and the blocked engine power. Therefore, in the individual case, always DEUTZ must be consulted. |

## 3.15 Particulate traps

The exhaust gas emission of a diesel engine contains solid matter – so-called particulates – the size of which varies predominantly between 0.05 and 15 microns. These particulates do not only consist of particulate carbon, but also of hydrocarbons from the fuel and lube oil residues which are partly adsorbed by the particulate carbon. Further particulates result from the sulfur content in the fuel as well as from metallic abrasion.

The particulate trap serves for filtering the exhaust gas with 99% of the soot particles being retained. With reference to the overall particulate matter, the retention efficiency is about 70%.

Among others, ceramic monoliths are used as filtering elements; their channels are alternatingly closed forcing the exhaust gas to flow through the porous partitions where the particulate matter is filtered out.

The ceramic monolith is gas-tight and shock-proof and designed as a honeycomb accommodated in a stainless steel housing.

The filter size depends on the exhaust gas volume flow rate and a maximally admissible retention of solid matter (soot), which is also limited by the exhaust gas back pressure.

**Maximally admissible exhaust gas back pressure:**

The limit values as per 3.2 apply.

For engines with strongly intermittent operation, a temporary increase of the overall exhaust gas back pressure of an exhaust gas system due to the particulate collection of the filter is admitted up to a limit of 200 mbar (from 4-cylinder engines). For the related deterioration of the engine parameters (fuel consumption, engine power, exhaust gas quality, reliability and service life), DEUTZ will not be liable.

When the limit for particulate loading has been reached, the filter must be regenerated by exchanging the filter element or burning off the filter loading which mainly consists of soot.

For further details on the particulate trap technology and the existing regeneration systems, contact the manufacturer.

For the installation of the particulate trap, the following essential items should be considered:

- Particulate traps are excellent exhaust gas silencers thanks to their design. The silencing effect corresponds to that of resonance and absorption silencers. Therefore, when installing particulate traps, it is not necessary to install standard silencers.
- Particulate traps are available in various sizes and are matched to specific engine series to keep the exhaust back pressure within acceptable limits for the engine.
- Particulate traps are to be mounted in the equipment or chassis free from stress. If necessary, flexible elements have to be provided.
- The pipe connection between engine exhaust gas manifold and particulate trap must always be highly flexible and gas-tight to reduce the transmission of engine vibrations to the filter.
- End pipes behind the particulate trap should be kept as short as possible to reduce the exhaust back pressure.
- The pipe connections between the engine and the particulate trap must also be kept as short as possible. Lone pipes increase the exhaust back pressure on the engine. To make up for this, the particulate trap loading rate would have to be reduced (shorter particulate trap loading rate before regeneration of the filter).
- In the case of particulate trap systems with automatic regeneration, the position of the exhaust gas end pipe outlet at the equipment or the vehicle must be in accordance with the safety requirements. During filter regeneration, exhaust gas temperatures existing at the end pipe may reach 500 to 550°C at the end pipe outlet (basis: at ambient temperature 25°C).
- The particulate trap and the electronic control box must be installed such that they are easily to service.

More detailed and specific installation instructions will be provided with the respective particulate trap supplied with accessories and descriptions.

# 4. FUEL SYSTEM

## 4.1 General

An adequate supply of the injection pump with fuel at all times is a pre-condition for proper starting and performance behavior of diesel engines.

DEUTZ diesel engines are laid, for example, for diesel fuels as per DIN EN 590. DEUTZ engines are certified with the respective certification fuel and are suitable for operation with normal fuels. For other diesel fuel requirements, see the Technical Memo 0199-3005 in the appendix or ask at head office.

The respective legal regulations must be observed regarding installation and operation of systems for storing, filling and conveying of combustible liquids.

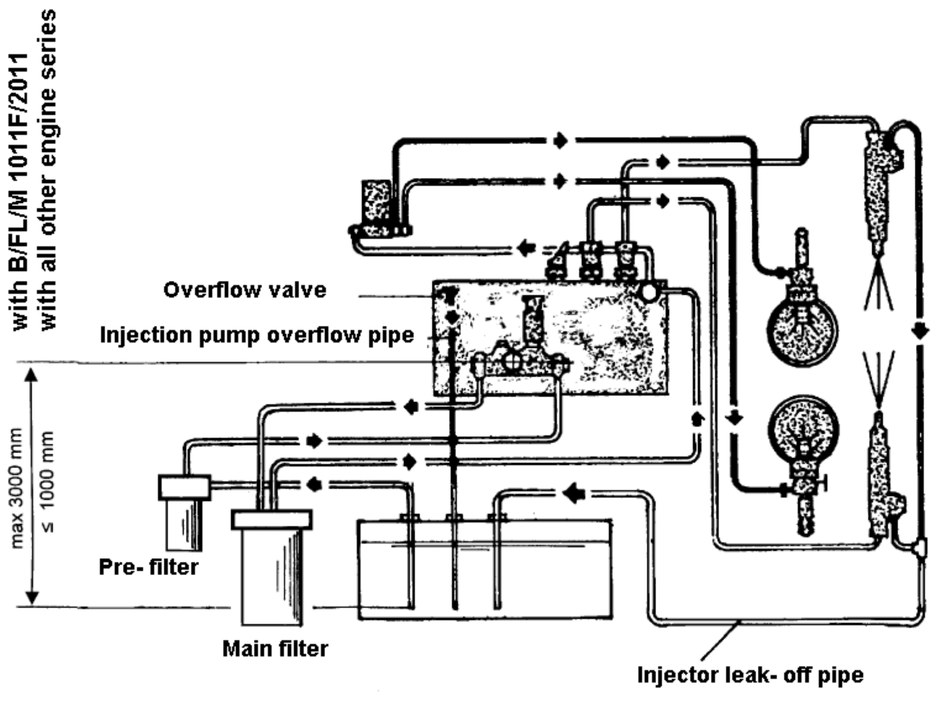
## 4.2 Fuel feed pump (assignment fuel tank – feed pump)

Diaphragm and piston pumps are used as engine-integrated fuel feed pumps.

Diaphragm pumps are used for engine ratings up to abt. 90 kW, piston pumps above that. All 2011 engines have piston pumps however.

The maximum difference in height between the suction point in the low fuel tank and the fuel feed pump may not exceed 1 m (maximum total resistance 0.1 bar in high level tank).

**Fig. 4-1**



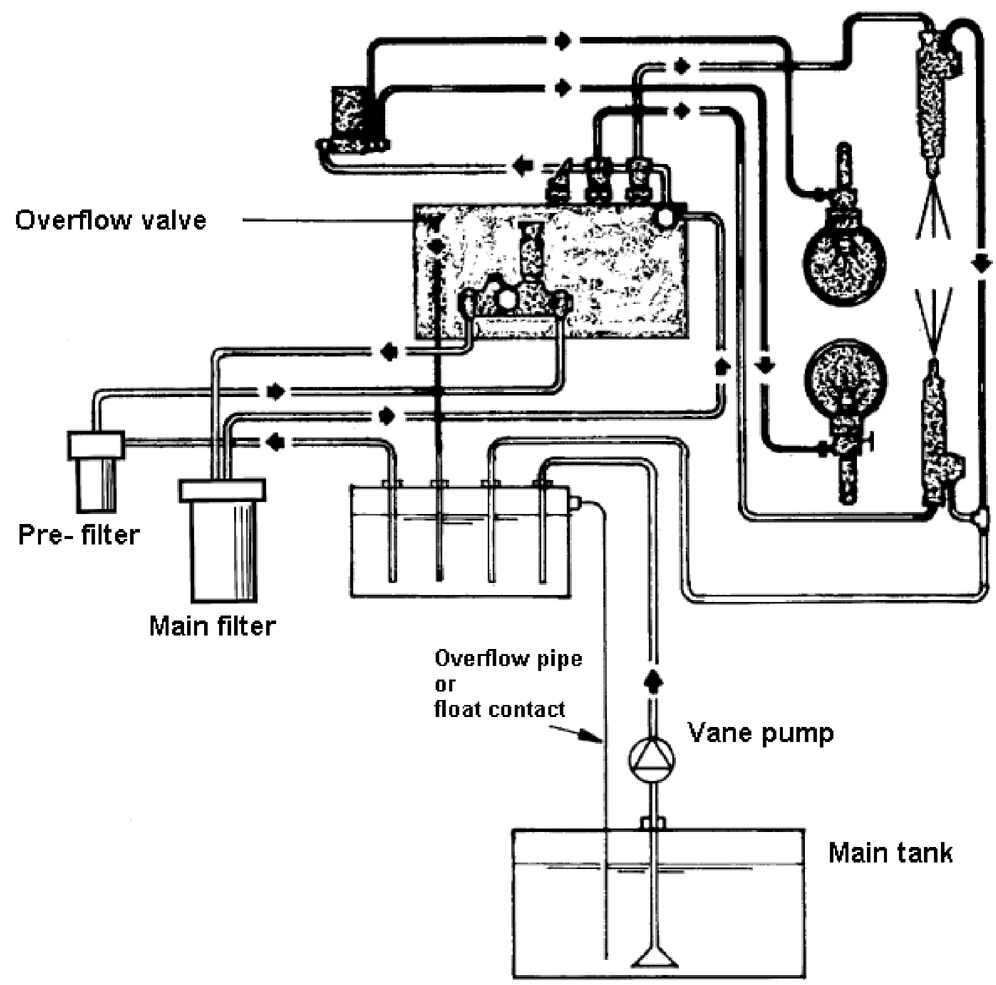

<u>Remark to diagram:</u>
The diagram shows the circuit situation for engine series B/FL 513 with low tank. In almost all other series, nozzle leak oil lines and E-pump overflow line are combined in the engine and fed to the fuel tank as a single line. With a high-level tank the lines can also be combined in the B/FL 513.

**Low tank and service tank**

In the case of higher suction heads, an elevated service tank can be used which, for example, is filled from the main tank with a rotary pump or an electric feed pump.

An overflow pipe can be laid between the high-level tank and the main tank or the feed pump of the main tank is intermittently activated upon float contact in the high-level tank.

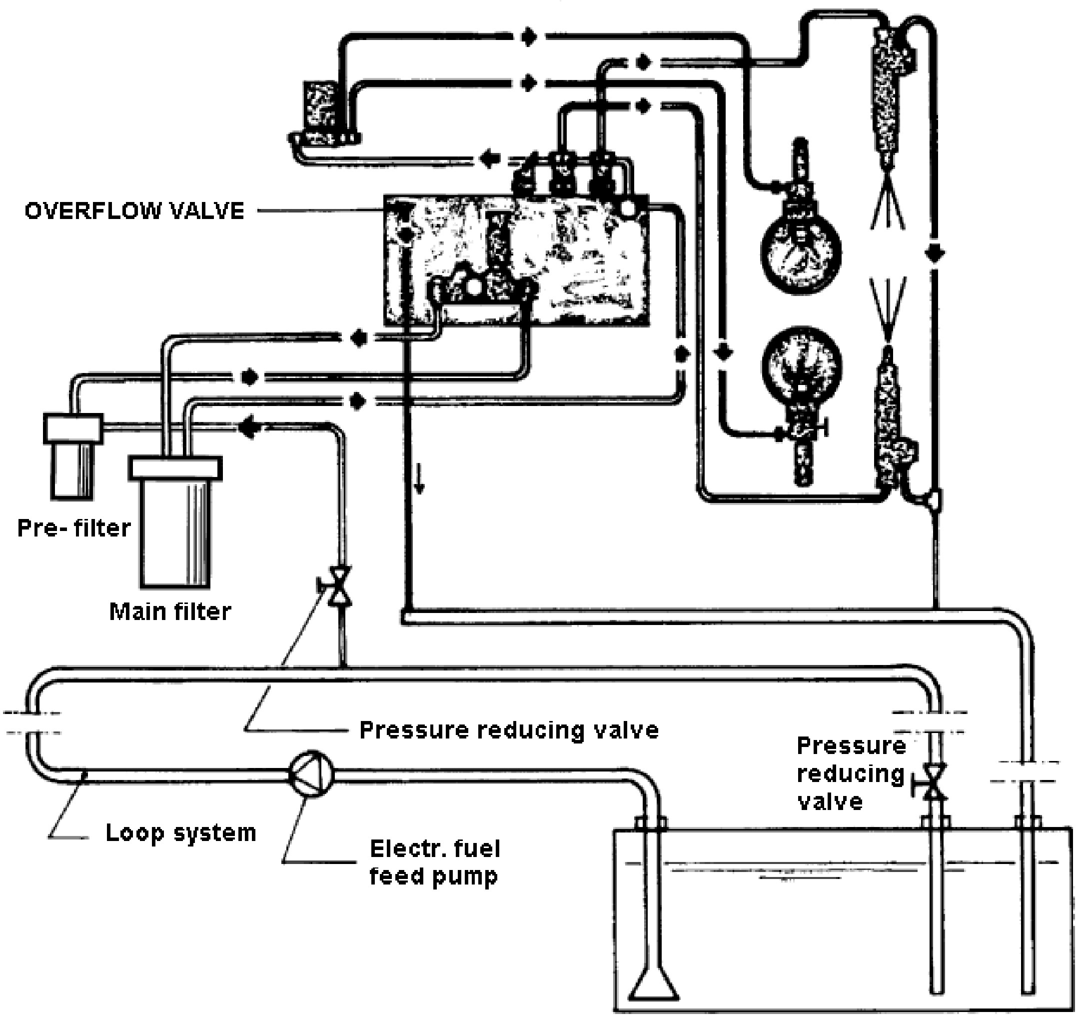
**Fig. 4-2**



**Low tank and loop system**

Instead of the service tank or, for example, at a larger distance from the tank or in the case of multiple-engine installations, a loop system may be provided. In this case, the pressure in the loop system is allowed to fully act on the inlet of the fuel feed pump, unless a value of 0.2 bar is exceeded. If this pressure should be exceeded, however, a pressure limiter will have to be installed between the tapping point in the loop system and the fuel feed pump.

**Fig. 4-3**

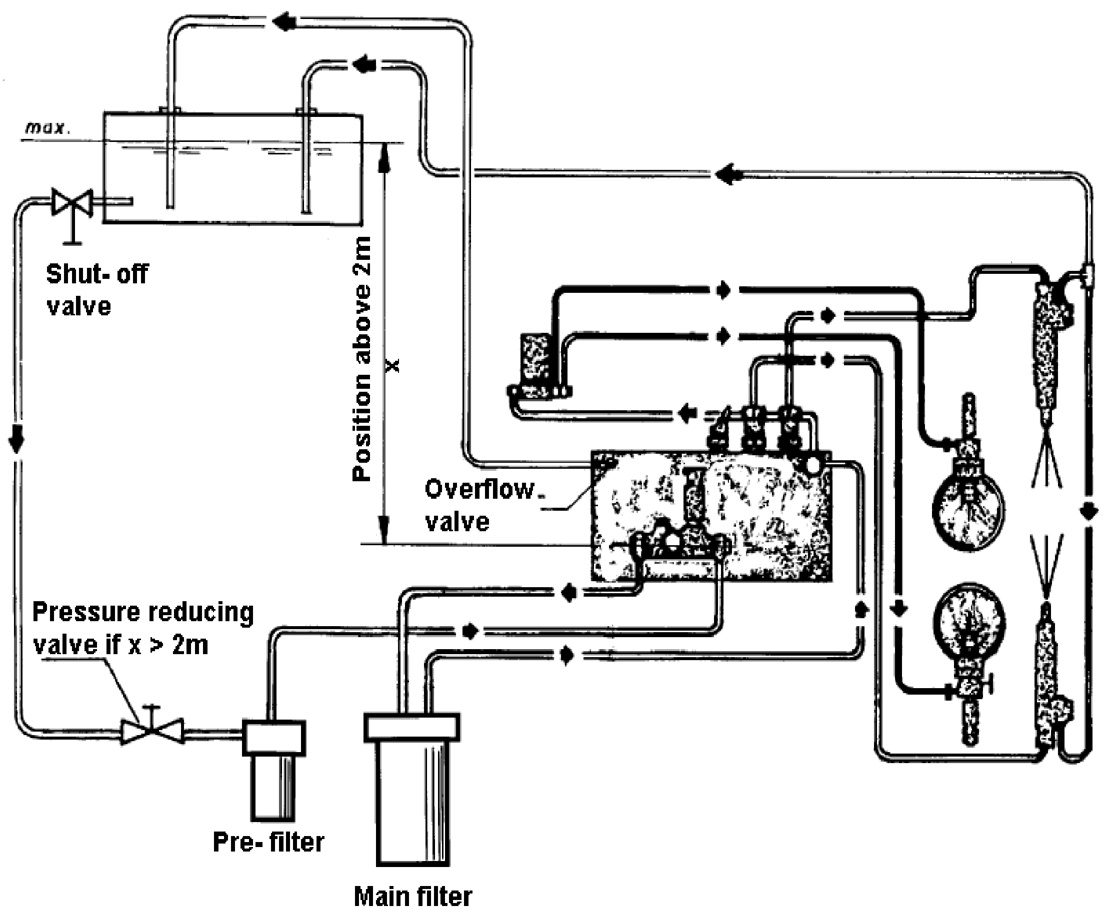


**High tank**

With high-level tanks, the upper edge of the tank must not be higher than 2 m above the fuel feed pump. If the tank must be placed higher, a pressure limiter must be installed (pressure limited to 0.2 bar before fuel feed pump of the engine at full-load operation).

Within the suction pipe leading to the engine, a shut-off valve must be provided near the tank, if the upper edge of the tank is located above the fuel feed pump (preventing leakages in case of filter change or service work).

**Fig. 4-4**




## 4.3 Routing and dimensioning of fuel pipes

The fuel pipes of copper or scale-free steel tubes not pertaining to the engine scope of supply are to be carefully cleaned before the installation. Best suited as connecting elements are screw unions with sealing cones and cap nuts. Flexible hoses are to be used for connecting to the engine fuel pipes. Parts possibly provided for installation, e.g. shut-off elements, must be sufficiently dimensioned. Manual pumps arranged remote from the engine must be attached such that they are easily accessible.

Plastic fuel pipes can also be used and, due to their very flexibility, offer a number of advantages for installation (see e.g. Tecalan pipes of the Deutsche Tecalemit Co.).

In view of the limited temperature resistance (abt. 100 °C permanent temperature can be withstood), the pipes must be laid with care.

Other well-known manufacturers are:

| | |
|---|---|
| Mecano Bundy, Heidelberg | (Mecanyl) |
| Continental, Hanover | (Polyamik 11) |
| VDEM, Frankfurt | (Aeternamik RF) |

The following must be observed when laying fuel pipes with low fuel tank:

For the suction pipe from the tank to the fuel feed pump a pipe 10 x 1, i.e. with a clear width of 8 mm, must be chosen for a line length up to 3 m. A clear width of 10 mm is required for lines from 3 to 5 m. For lengths above 5 m the clear pipe diameter “di” can be determined according to the following formula:

$$\mathbf{D_i = 0.6 \times \sqrt{P}} \quad \text{(mm)} \qquad P = \text{rated engine power (kW)}$$

This formula is based on a flow velocity of 0.8 m/sec and the volume of three times the fuel full load consumption.

If values smaller than $D_i$ = 8 mm are determined, the diameter $D_i$ = 8 mm must be laid regardless.

Example:

Engine FL 413 F; P = 101 kW at 1,800/min

$D_i = 0.6 \times \sqrt{101} = 6.02$ mm

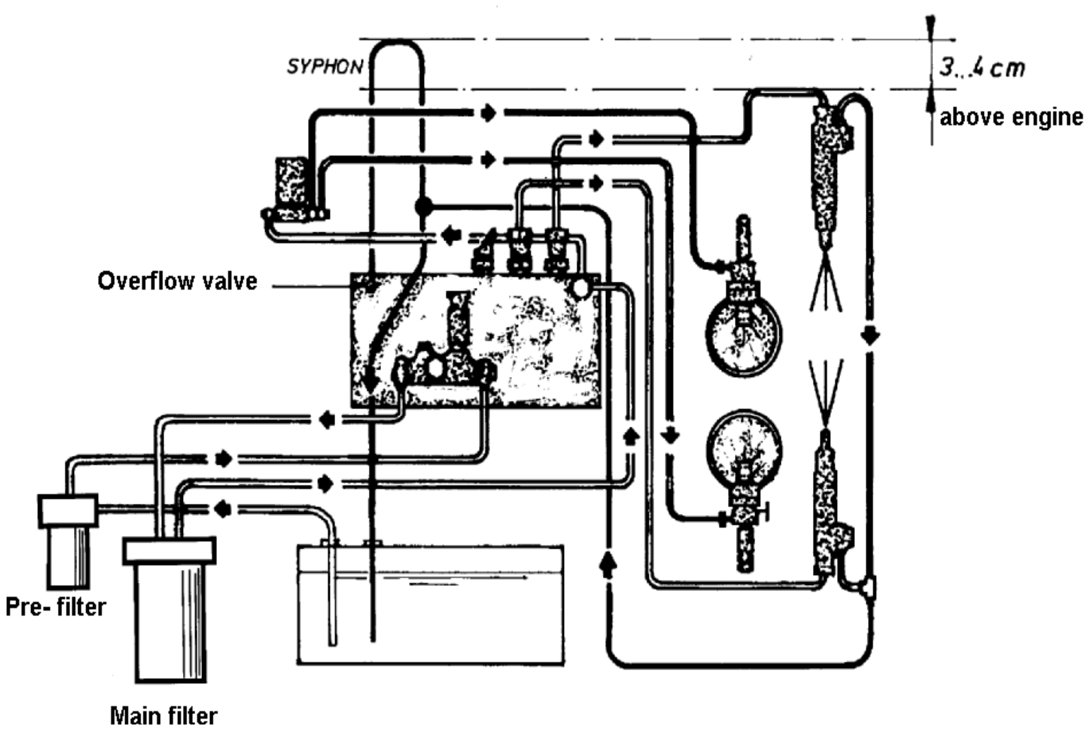
The line of $D_i$ = 8 mm is laid.

The suction pipe shall be laid as straight as possible without sharp bend. The suction opening in the fuel tank must have a distance to the tank bottom of abt. 40 mm to avoid that residues of water or sludge are also sucked in.

The fuel return pipe through which surplus fuel and leak fuel from the injection valves is discharged, may not end at the top base of the fuel tank but must be laid just as low as the suction pipe, i.e. up to below the minimum permissible fuel level when the lowest possible fuel level in the tank is below the top edge of the injection pump (see figure). This avoids air penetrating the suction system through this line during engine standstill and causing starting problems and loss of performance. Feeding in the return fuel below the fuel level also prevents additional foaming of the fuel.
However, this does not apply for series 1011 F/2011, see TPI No. 0199-99-0222. In the aforementioned engines, the fuel return must end above the fuel level in the tank.

It is not admissible to connect the fuel return pipe to the suction pipe. The return pipe must always be directed into the fuel tank. The connections for the fuel return pipe on the engine must be fed singly back to the fuel tank unless a siphon has been interconnected which allows only one return pipe to be laid.

**FIG. 4 -5**




The fuel return pipes must be dimensioned such that the pipe cross section corresponds to about half of the suction pipe cross section.

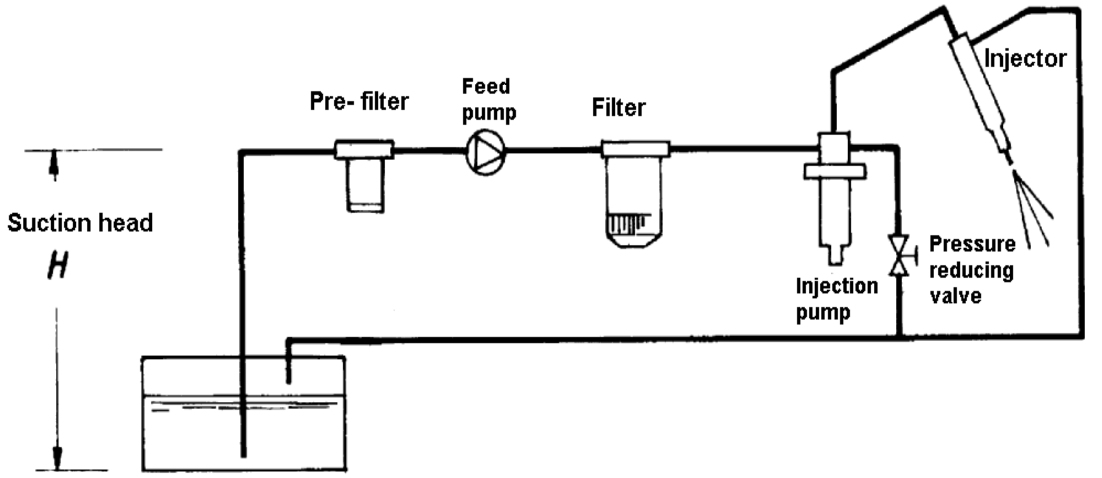
All connections must be air-tight.
Simplified routing of pipes must be approved by the head office.

**Engine series B/F L/M 1011F / 2011:**

For the fuel pipe laying of the feed and return pipes for engine series B/F L/M 1011F/2011, separate return of the nozzle and injection pump leak oil line to the bottom of the tank should be avoided because of the different injection system. This injection system has such a fast self breathing that the engine can be started easily despite the empty suction pipe. On the other hand this avoids the injection pumps sucking unfiltered fuel from the tank through the return pipe when the filter is blocked and enables engine operation. As an alternative to the return pipe laying to the upper fuel level, it is recommended to lay the pipe to half the tank level, or when laying the return pipe close to the bottom of the tank, to drill a 2-3 mm hole in the return pipe just after its inlet into the tank. This prevents self-running when the filter is blocked.

The necessary inside diameter of the 2011 fuel return pipe increases to 7,5 – 8mm.
A suitable adapter piece will be supplied with the engine.

**FIG. 4 -6 Fuel schematic 1011F/2011**




∗ **Note:** In 1011 F engines with diaphragm pump a suction height up to 3 m (depending on the line resistance) is acceptable.

## 4.4 Fuel heating

Where fuel is heated up beyond 30 °C (measured at inlet to injection pump), this will lead to a power reduction of abt 1 to 3 % per 10 °C and at higher temperatures to formation of steam bubbles and misfires.

The absolute maximum permissible fuel temperature is 60 °C, safe engine operation is no longer guaranteed above this.

## 4.5 Fuel tanks

Fuel tanks must be sufficiently ventilated. The tanks should neither be galvanized nor made of metal containing zinc, as fuels – depending on their composition – may form zinc soap which could damage the injection system.

Where equipment is partly operated at considerable inclinations, the ventilation system must be designed such that proper ventilation will be ensured in any position.

Residue of water and other dirt collects in the fuel tank. A sludge drain plug must therefore be provided at the lowest point on the fuel tank.

## 4.6 Fuel filtration

The fuel is filtered by a fine filter mounted on the engine. The additional use of a fuel pre-filter or pre-cleaner is recommended because this reduces wear on the pump and can prolong the life of the fine filter. In the series engines the fuel pre-cleaner is usually mounted on the fuel feed pump. If arranged remotely from the engine it must be installed like the fuel pre-filter in the suction pipe as close to the engine as possible. In the case of manual pumps installed remote from the engine it is advisable to mount it on these. The size of the pre-filter must be matched to the fuel flow volume (three times the volume of the full load consumption at rated speed) to avoid throttling in the fuel supply.

Installation of pre-filter (line filter) in the suction pipe system of the fuel system in FL 1011F engines is recommended to protect the feed pump diaphragm if the penetration of contaminants in the tank or fuel cannot be ruled out.
In engines of the 2011 series a fuel filter is absolutely essential to protect the piston feed pump, see TPI 0138-21-0292.

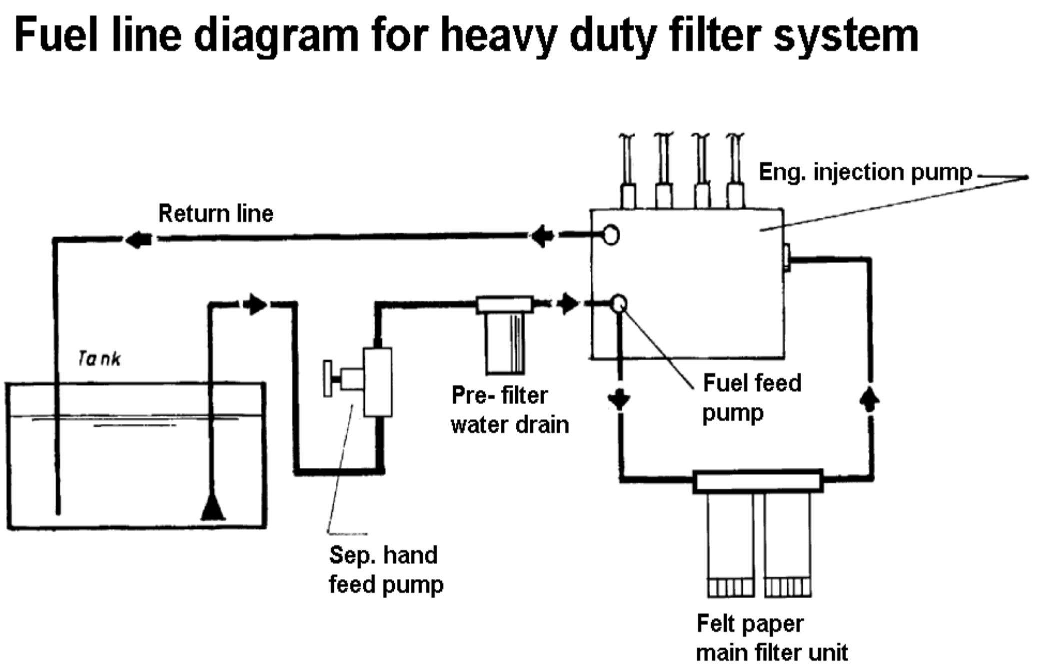
A water trap is required when using fuels with a high water content or in case of condensation due to temperature fluctuations.

## 4.7 Fuel filtration upon extreme applications

For engine and equipment applications under extreme conditions (e.g. poor fuel quality, high water content, poor spare parts supply) a combination of fabric filters as pre-filters and a felt-paper filter combination is recommended.

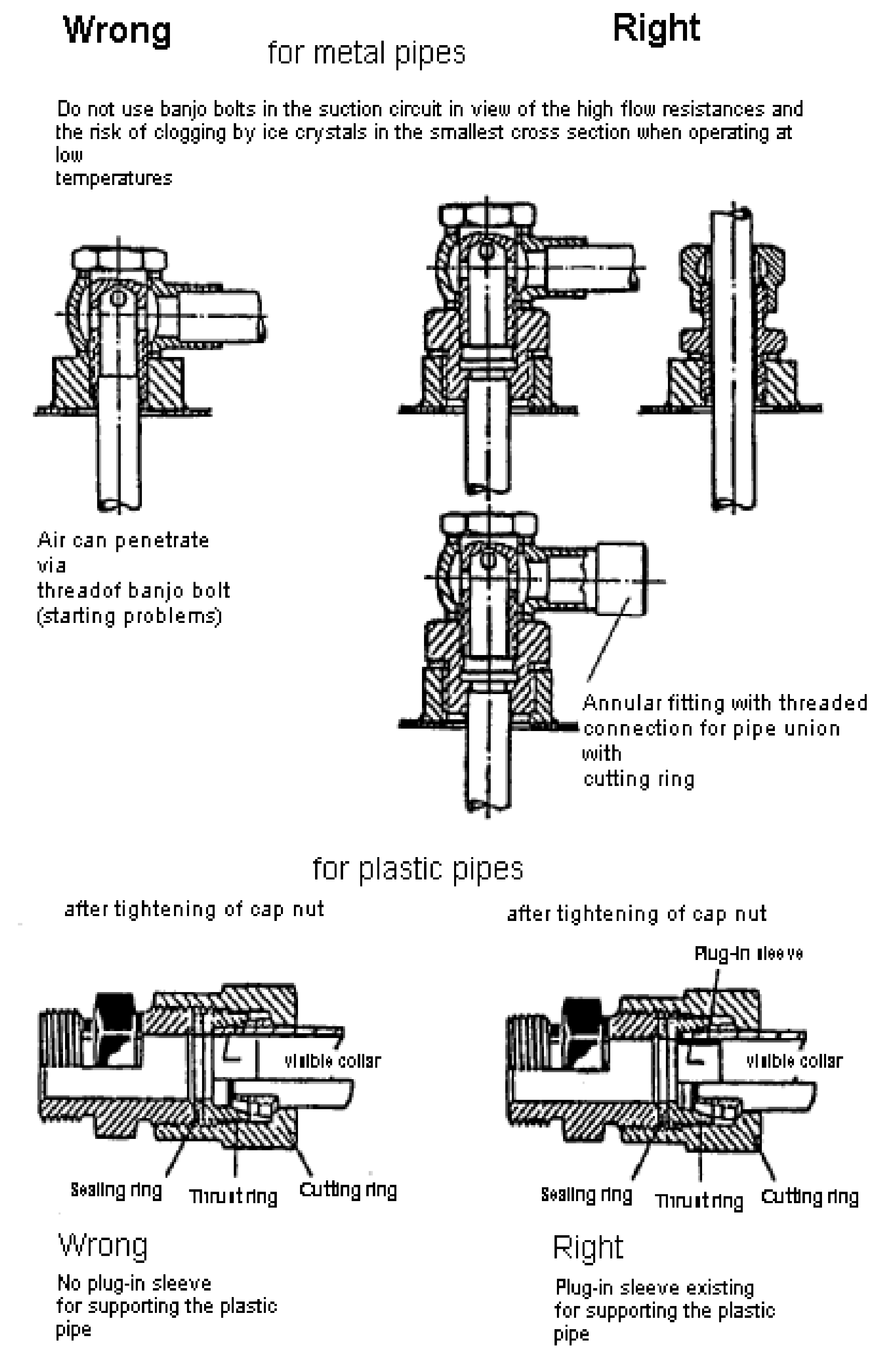
The fabric filter as a pre-filter serves as a water trap and is washable.

**FIG. 4 -7**



## 4.8 Representation of fuel connections

**FIG. 4 -8**



## 4.9 Engine operation at low temperatures

For engines operated in very cold regions, special measures to ensure the fuel supply are to be taken, which partly must be considered in the equipment design.

This particularly applies to:

- Dimensioning and routing of the pipes
- The configuration of the connections and the pipe elbows
- The filter system and its arrangement
- The fuel tank arrangement and possibly heating

We recommend you to talk to the installation consultants under these operating conditions.

# 5. LUBE OIL SYSTEM

DEUTZ engines are laid out for a forced-feed oil lubrication. Oil pressure and oil volume flow rate ensure lubrication of the engine and also, to a considerable extent, cooling of the engine. In the B/FL/M 1011F/2011 (oil-cooled diesel engine) series, the lube oil also doubles as the “cooling fluid” – see chapter 1..

Any modifications to the lube oil and cooling oil system require the previous approval of the DEUTZ head office. In this connection, the following reference values must be observed.

## 5.1 External lube oil systems in the main flow

If engine-integrated elements such as lube oil filters in the main flow are mounted remote to the engine, for servicing or installation reasons, the additional resistance from pipes, filter brackets and filters must not restrict the engine lubrication.

The admissible resistance values of the components used are determined on the basis of oil volume flow rate and selected pipe diameter. If the admissible system resistance is exceeded, the calculation should be carried out once again using a larger pipe diameter.

### 5.1.1 Lube oil flow rate

With the engine warmed up to service temperature, the oil volume flow rate "$Q_G$" is at rated speed:

$$Q_G = \{\varphi_P \times \varphi_B \times n_n\} \ / \ 1000 \qquad \text{(l/min)}$$

with $n_n$ = Rated speed of the engine
$\varphi_P$ = Pump factor
$\varphi_B$ = Operating factor

The factors $\varphi_P$ and $\varphi_B$ are dependent on the engine and given in table 1.

## FIG. 5 - 1

**Table 1:** Factors for oil volume flow rate

| Engine type | Factor $\varphi_B$ | Factor $\varphi_P$ |
|---|---|---|
| | | |
| D 909 L01 | 0.9 | |
| D 910 L02 | 0.9 | |
| D 910 L03 | 0.9 | |
| | | |
| F2L/M 1011 | 0.95* | 16.7 |
| F3L/M 1011 F | 0.90** | 21.1 |
| F4L/M 1011 F | 0.90** | 24.0 |
| BF4L/M 1011 F | 0.90** | 22.5 |
| | | |
| F2L/M 2011 | 0.9* | 16.7 |
| F3L/M 2011 F | 0.9* | 21.1 |
| BF3L/M 2011 F | 0.9* | 21.1 |
| F4L/M 2011 F | 0.9* | 24.0 |
| BF4L/M 2011 F | 0.9* | 22.5 |
| | | |
| F2L 912 / W | 0.8 | 7.0 |
| F3L 912 / W | 0.8 | 15.0 |
| F4L 912 / W 912 F | 0.8 | 21.0 |
| F5/6L 912 / W 912 F | 0.8 | 21.0 |
| F6L 912 | 0.8 | 35.0 |
| | | |
| F3L 913 | 0.8 | 15.0 |
| F4L 913 F3L 913 G | 0.8 | 21.0 |
| B/F4L 913 | 0.8 | 26.0 |
| B/F6L 913 / T / C | 0.8 | 30.0 |
| B/F6L 913 / T / C | 0.8 | 35.0 |
| BF6L 913 | 0.8 | 35.0 |
| | | |
| F3L 914 | 0.85 | 15.0 |
| BF3L 914 | 0.85 | 21.0 |
| F4L 914 | 0.85 | 15.0 |
| BF4L 914 | 0.85 | 21.0 |
| F5L 914 | 0.85 | 21.0 |
| F6L 914 | 0.85 | 21.0 |
| BF6L 914 | 0.85 | 35.0 |
| BF6L 914 C | 0.85 | 35.0 |
| | | |
| F6L 413 F / FW F6L 513 | 0.9 | 49.0 |
| F8L 413 F / FW / F8L 513 | 0.9 | 62.0 |
| BF8L 513 /LC | 0.9 | 71.0 |
| F10L 413 F/ FW / F/BF10L 513 | 0.9 | 71.0 |
| F12L 413 F / FW F/BF12L 513 / C | 0.9 | 83.0 |
| | | |

**Note:** Missing values were not available at the time of going to print; these will be added successively.

* of which 0.15 for filter and lubrication or 0.85 for cooling / heating
* of which 0.3 for filter and lubrication or 0.6 for cooling / heating

### 5.1.2 Layout of the pipe diameter

When considering the reference value of approx. 5 m/s for the maximum volume flow rate in the system elements (piping, banjo bolts etc.), the theoretical design diameter will be:

$$D_A = 2 \times \sqrt{Q_G} \quad \text{(mm)}$$

If possible, the actually existing diameters “$D_R$" or “$D_D$" or “$D_N$" of the system elements (see table 2) should be equal or larger than “$D_A$".

### 5.1.3 Determining the system resistance

For each individual element of the external lube oil filter system, the resistance $\Delta p_{total}$ (sum of individual resistances) of

| | | | |
|---|---|---|---|
| $\Delta p_{total}$ | $\leq 1$ | (bar) | for engines D909/910/ B/FL 1011/2011/912/913/914 |
| $\Delta p_{total}$ | $\leq 1{,}5$ | (bar) | for all other engines |

may not to be exceeded.

Considering the total resistance, we generally recommend for all engines that the limit value

$\Delta p_{total} \leq$ 1 bar should be observed.

**FIG. 5 - 2**

**Table 2 Element - resistances**

| Element | Resistance $\Delta p_{Element}$ [bar] |
|---|---|
| Lines (piping or hose) | $\Delta p_R = \frac{L_R}{300 \times D_R} \times \left(\frac{D_A}{D_R}\right)^4$ |
| Lines (corrugated hose pipe with internal wire reinforcement) | $\Delta p_R = \frac{L_R}{180 \times D_R} \times \left(\frac{D_A}{D_R}\right)^4$ |
| Lines (corrugated hose pipe without internal wire reinforcement) | $\Delta p_R = \frac{L_R}{100 \times D_R} \times \left(\frac{D_A}{D_R}\right)^4$ |
| Pipe bend 90° ; $r > D_R$ | $\Delta p_B = 0.01 \times \left(\frac{D_A}{D_R}\right)^4$ |
| Pipe elbow 90° ; $r \approx D_R$ | $\Delta p_K = 0.03 \times \left(\frac{D_A}{D_R}\right)^4$ |
| Local restriction | $\Delta p_D = 0.07 \times \left(\frac{D_A}{D_D}\right)^4$ |
| Pipe angle | $\Delta p_W = 0.12 \times \left(\frac{D_A}{D_N}\right)^4$ |
| Banjo bolt | $\Delta p_H = 0.16 \times \left(\frac{D_A}{D_N}\right)^4$ |
| Lube oil filter bracket, other device or element | $\Delta p_G = \Delta p_N \times \left(\frac{Q_G}{Q_N}\right)^2$ |

**Wherein:**

- $D_A$ = Calculated design diameter (mm)
- $D_D$ = Restrictor diameter (local restriction) (mm)
- $D_N$ = Nominal diameter (e.g. pipe angle, banjo bolt) (mm)
- $D_R$ = Internal width of the selected line (mm)
- $L_R$ = Pipe length (mm)
- $Q_G$ = Oil throughput through the machine (l/min)
- $Q_N$ = Rated throughput through the element (e.g. filter, switch, heat exchanger, etc.) (l/min)
- r = r = radius (mean value) of the bend or elbow (mm)
- $\Delta_{pN}$ = rated resistance of the element at $Q_N$ (bar)

## FIG 5-3

**<u>Example:</u>**

**System resistance of external filter assembly**

| | |
|---|---|
| Engine | BF 4 M 1012 at $n_n$ = 2300 $min^{-1}$ |
| Equipment | Lube oil filter bracket: $Q_N$ = 33.3 ltr/min<br>Distance: LR = 700 mm ;$\Delta p_N$ = 0.09 bar |
| Oil volume flow rate | $Q_G = 0, \times 22 \times \frac{2300}{1000} = 45.5$ |
| Design diameter | $D_A = 2 \times \sqrt{45.5} = 13.5$ mm |
| Selected | $D_R$ = 14 mm diameter for the system |
| 2 pipes | $\square p_R = 2 \times \frac{700}{300 \times 14} \times \left(\frac{13.5}{14}\right)^4$ = 0.29 bar |
| 2 bends | $\square p_K = 2 \times 0{,}03 \times \left(\frac{13.5}{14}\right)^4$ = 0.05 bar |
| 4 banjo bolts | $\square p_H = 4 \times 0{,}16 \times \left(\frac{13.5}{14}\right)^4$ = 0.55 bar |
| Filter bracket | $\square p_G = 0{,}09 \times \left(\frac{45.5}{33.3}\right)^2$ = 0.17 bar |
| Sum | $\Delta p_{total}$ = 1.06 bar |

### 5.1.4 Installation instructions

All pipes of the external lubrication system must be laid our for a minimum pressure of 45 bar (burst pressure). The pipes are to be carefully cleaned prior to installation.

The rubber tubes installed must be resistant to a permanent temperature ranging from -40 °C to +125 °C (temporarily up to +140 °C).

## 5.2 Lube oil microfilter in bypass flow

If lube oil microfilters in bypass flow are relocated remote from the engine, e.g. due to servicing reason, the lube oil lines are to be designed with an actual diameter that amounts to at least 2/3 of the design diameter $D_A$ as per section 5.1.2.

It is absolutely necessary to consult the head office, if a microfilter must be subsequently fitted to the engine. As the lubrication system is precisely matched in respect of oil volume flow rates and pressures, retrofitting of a bypass microfilter may affect the piston spray cooling. The engine warranty can only be maintained, if such retrofittings are carried out in consultation with the head office.

## 5.3 External lube oil tank

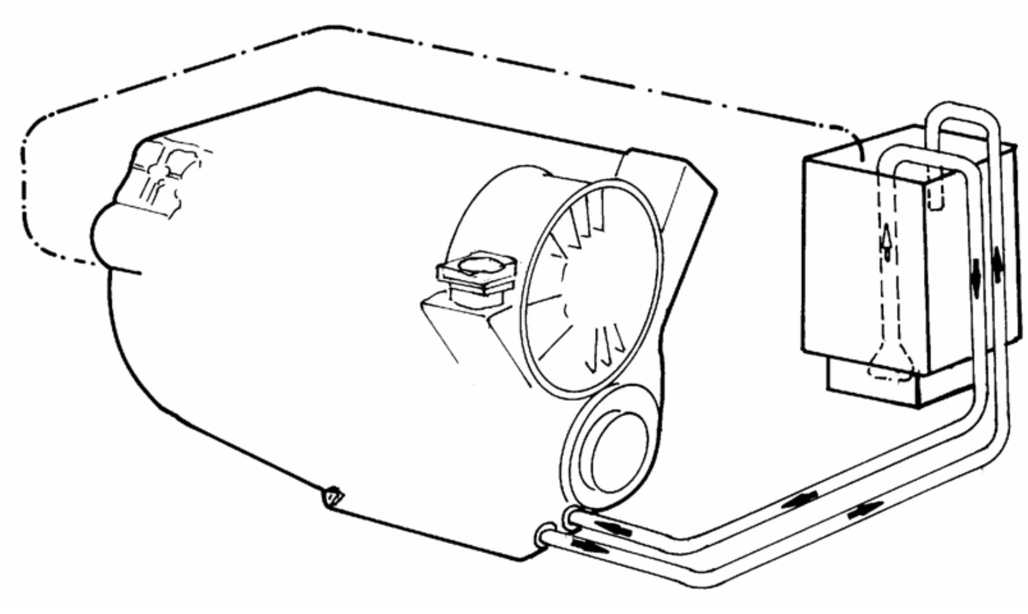
Engines with extremely flat oil trays (so-called dry sump oil tanks) are equipped with separate oil tanks which take up the necessary volume of oil. These oil tanks are arranged outside the engine in the engine room and are connected to the engine by flexible pipes. The actual engine lube oil pump draws in the oil from the oil tank through a pipe (suction oil pipe), while a second oil pump delivers the oil accumulated from the engine through a pressure oil pipe back to the tank.

Engine crankcase and oil tank interior are connected with each other via another pipe for gas balancing (breathing).

The following instructions must be followed for pipe dimensioning and installation of such a system:

**Schematic display of the lube oil circuit with separate oil tank** (dry sump lubrication)

**FIG. 5 - 4**



### 5.3.1 Oil volume flow rate

The oil volume flow rate through the oil pump (suction oil pump) when the engine is warm and running at rated speed is:

$$Q_G = (\varphi_P \times \varphi_B \times n_n) / 1000 \quad \text{(l/min)}$$

The same values apply for pump and operating factors according to table 1 of the chapter “External lube oil filter mounting” - section 5.1.1.

### 5.3.2 Suction oil pipe diameter

Under consideration of a speed of $W_A$ = 5 m/sec for the maximum volume flow speed in the pipes and elements, the resulting calculated design diameter is:

$$D_A = 2 \times \sqrt{Q_G} \quad \text{[mm] with } Q_G \text{ [l/min]}$$

The actually available diameter of suction pipes, however,
must be 20 % greater:

$$D_R \cong 1.2 \times D_A$$

All other actual diameters of those elements used in the suction oil area should be chosen greater than “$D_A$“ if possible.

Examples of machine elements, see table 2 under section 5.1.3.

### 5.3.3 Determining the admissible suction oil line resistance

The resistance in the suction pipe (pipe from the oil tank to the engine) and all other resistances in the suction oil system act directly pressure reducing on the oil pressure household of the engine. Therefore, compliance of the total resistance of the sum of the individual resistances on the suction oil side of

$$\Delta p_{total} \leq 0.2 \text{ [bar]}$$

is absolutely essential.

The individual resistances $\Delta p_{element}$ are calculated according to table 2 under section 5.1.3.

The loss in pressure due to the geodetic pumping height also has an influence depending on the position of the oil tank. As a measure of the pumping height h, the difference in height between the point of separation between the engine oil tray/crankcase and the middle of the oil tank should be used as a sufficient approximation (oil tank beneath engine).

The corresponding loss in pressure is:

$$\Delta p_0 = 0.85 \times [h / 1000] \quad \text{(bar)}$$

with h = geodetic pumping height in (m)

**FIG. 5 - 5**

## Example:
**System resistance of external filter assembly**

| | | |
|---|---|---|
| **Engine:** | BF 12L 513 C, rated speed 2300rpm | |
| **Piece of equipment:** | Oil tank below engine, with height difference between intersection oil pan/ crankcase being of 500mm. Suspension pipe length 1500mm. Suction pipe installed with 2 bends and 1 elbow. | |
| **Oil volume flow rate:** | $Q_G = 0{,}9 \times 83 \times \frac{2300}{1000}$ | = 172 [ltr/min] |
| **Design diameter:** | $D_A = 2 \times \sqrt{172}$ | = 26,2 [mm] |
| **Bend** with diameter DR = 30mm | $\Delta p_B = 2 \times 0{,}01 \times \left(\frac{26{,}2}{30}\right)^4$ | = 0,01 [bar] |
| **Elbow** with diameter DR = 30mm | $\Delta p_K = 0{,}03 \times \left(\frac{26{,}2}{30}\right)^4$ | = 0,02 [bar] |
| **Suction pipe** LR = 1500mm with diameter DR = 31mm | $\Delta p_R = \frac{1500}{300 \times 31} \times \left(\frac{26{,}2}{31}\right)^4$ | = 0,08 [bar] |
| **Delivery head** | $\Delta p_D = \frac{500}{10000} \times 0{,}85$ | = 0,04 [bar] |
| **Suction pipe resistance:** | $\Delta p_{gesamt} =$ | **= 0,15 [bar]** |

### 5.3.4 Pressure oil line diameter

The second oil pump in the engine for transporting the oil from the engine to the oil tank has an approx. 20 % greater pumping volume to reliably rule out accumulation of oil in the engine.

The same pipe diameter as for the suction oil pipe can be used for the oil pipe from the engine to the oil tank (pressure oil line). If smaller diameters are used, the pressure oil line resistance of the individual elements must be determined analogously with table 2 in section 5.1.3.

### 5.3.5 Determining the admissible pressure oil line resistance

The resistance of the pressure oil line (pipe from the engine to the oil tank) and other component resistances in this line have no direct influence on the oil pressure household of the engine. It must be ensured that enough oil is fed back from the engine into the tank at all times.

If no other elements except the connections are installed in pressure oil line systems, a total pressure oil resistance of ≤ 1.5 bar should be kept. This restricts the performance of the suction pump.

In cases in which other elements are used on the oil pressure side, such as switches (for oil flow diversion) and heat exchangers (e.g. as in the case of the oil-water heater for buses), a total pressure oil resistance of less than 4 (bar) should be kept to keep the pump performance requirement low here, too.

A pressure protection should be connected parallel to the elements if necessary and must be decided by the element manufacturer from case to case – since pressure peaks up to 10 (bar) can occur due to sudden engine run-up when the engine oil is cold.

### 5.3.6 Oil tank breathing

The separate oil tank consists of a space for accommodating the constructionally defined maximum oil volume and a breathing or oil degassing space. The oil tank is connected to the internal crankcase chamber of the engine by a pipe to allow the air separated from the oil to escape. The oil tank is therefore connected to the engine crankcase breathing system.

The diameter of the breathing pipe should be approx. 25 mm.

The interaction of engine/oil tank in terms of the oil household and the inclination capability of the engine/oil tank requires careful agreements so that only oil tanks of the DEUTZ scope of supply should be applied.

Oil tanks from the customers' own production must be evaluated by DEUTZ engine technology otherwise no engine guarantee can be given.

## 5.3.7 Technical installation notes

### 5.3.7.1 Oil lines between the engine and oil tank

Between the flexible mounted engine and the rigidly mounted oil tank the connecting lines must also meet the quality requirements with respect to strength and temperature resistance in addition to movement being compensated.

The following oil lines are recommended:

- Steel corrugated pipes with internal steel wire mesh to reduce the flow resistance due to pipe friction with internal diameter 31 mm; SAE flange connection 1 1/4 inch.
  Supplier: Gedack, 58259 Gevelsberg, Phone.: 02332/8960, Fax.: 02332/81950.

- Hydraulic pipes FC 194-20 with rated width 32 mm; crimp fitting or preferably SAE flange connection 1 1/4 inch, part no. 2 H 4775-20 or 2 H 4779-20.
  Supplier: Aeroquip, 76532 Baden-Baden; Phone.: 07221/682-1.

Necessary temperature resistance in
rubber pipes: -40 °C to +140 °C under the influence of lube oil

Pressure resistance in rubber pipes:
Continuous operation pressure resistance: 30.0 bar at +150 °C
Continuous vacuum pressure resistance: -0.3 bar at +140 °C

### 5.3.7.2 Breathing pipe between the oil tank and the engine crankcase

As a breathing pipe a rubber hose with a rated width of approx. 25 mm is recommended.

The hose must be temperature resistant from -40 °C to +140 °C.

When installing the breathing line make absolutely certain that the pipe is always laid ascending so that there is no oil accumulation which could block the pipe.
Obstructed degassing of oil endangers the engine lubrication.

### 5.3.7.3 Oil tank

When installing the oil tank, make sure that this is well lashed against the equipment frame by straps.

The straps must be fixed in the vicinity of the upper and lower base around the tank or below the “DEUTZ” label printed in the middle of the tank.

It is also possible to clamp the tank with four anchoring bolts between two auxiliary frames which hold the tank base at the top and bottom respectively.

Because of the high weight of the oil tank including oil filling, a stable tank mount is essential.

Later welding on the oil tank is strictly prohibited.

The installation level of the oil tank to the engine is given primarily by the suction pipe resistance. As a guideline, the tank center may be arranged about 300 mm above or below the center of the crankcase on a level with the center of the engine crankshaft.

## 5.4 External lube oil cooler

Air-cooled and oil-air-cooled engines have an engine-integrated lube oil cooler, the oil flow of which is partly controlled by a thermostat.

These integrated lube oil coolers are always mounted on the engine and in operation and are not described here.

Here, heat exchangers or other devices with which we want to use the engine oil heat as process heat – e.g. as heat for heating (see the chapter "Heating") – are dealt with.

See the descriptions in the previous chapters for the procedure for designing the oil lines and other connecting elements.

The limit values for the plant resistances (see 5.1.3) must be observed here.

When removing oil from the engine via the DEUTZ heating switches, maximum admissible flow resistances apply (see Heating chapter) due to appropriate oil pressure protection. In order to provide an optimum possible oil volume flow to a system for oil heat recycling, you are recommended to observe the resistance limits according to 5.1.3.

## 5.5 Changing the oil dipstick marks for inclined engine installations

The oil level must always be checked with the engine in horizontal position. Admissible deviation 2°.

If an engine is installed with a permanent inclination for stationary application, the oil dipstick must be matched to the relevant angle of inclination, i.e. maximum and minimum marks must be changed.

When determining the new marks, it is best to proceed as follows: Place the engine in a horizontal position prior to the inclined installation, top up with oil up to "minimum" mark and note the quantity filled in.

Now top up to "maximum" mark and record the difference in quantity.

Solder the marks on the oil dip stick.

Now, install engine in inclined position with the oil level at "maximum", introduce dry oil dipstick and mark wetting level with a groove.

Drain off differential oil volume, i.e. the *minimum volume measured* in the engine must be available.

Insert dry dipstick and mark wetting level with a groove.

For engine commissioning, proceed as specified in the operation manuals.

Note:
V-engines have dipsticks with line and point marks which both have to be changed.

# 6. ENGINE MOUNTING

## 6.1 General

Basically, a properly designed flexible mounting is preferable to other mounting configurations. A flexible mounting is optimally designed, if the natural frequency of the vibrating system comprising the engine mass and the elasticity of the mounting is at least 40% lower than the lowest exciting frequency of the engine.

A low natural frequency calls for soft flexible elements. These have the disadvantage of allowing considerable deflections under the action of external forces which may arise with inclined installations or under shock loads.

In many cases optimum flexible mounting cannot be shown because the aforementioned conditions can only be satisfied for 1 and 2 cylinder engines and sometimes also for 3 cylinder engines under great difficulty.
In such cases the mounting must be selected so that the number of resonance vibrations is kept as low as possible and the speed ranges of the resonant vibrations are outside the main operating speed range if possible.

Rigid mountings should only be used in exceptional cases.

On 4-cylinder engines, the configuration of a completely stiff connection between engine and foundation is practically impossible when taking into account the exciting inertia forces of 2nd order.

***Therefore, it is recommended to generally use a flexible mounting.***

or a mass compensation gear (MAG) – it is necessary to consult head office in this case.

## 6.2 Flexible mounting

A pre-condition for the proper execution of flexible mountings are foundations whose stiffness must be clearly higher than that of the flexible elements. Otherwise, the foundation acts as an additional spring. The elements must be arranged so that they can deflect under the influence of forces acting during operation.

| |
|---|
| Ensure a sufficiently free movement between engine and chassis:<br>Recommendation abt. 15 ... 25 mm |

Flexible mounting systems matched to our engines are part of the scope of supply of the individual engines. They are space-saving and can absorb thrust within certain limits, which is very useful for marine installations by taking up the propeller protection.

Therefore, we recommend to make use of the flexible mountings offered in the respective scope of supply.

To compensate the vibrations occurring on flexibly mounted engines, all the pipes leading to the engine must be flexible.

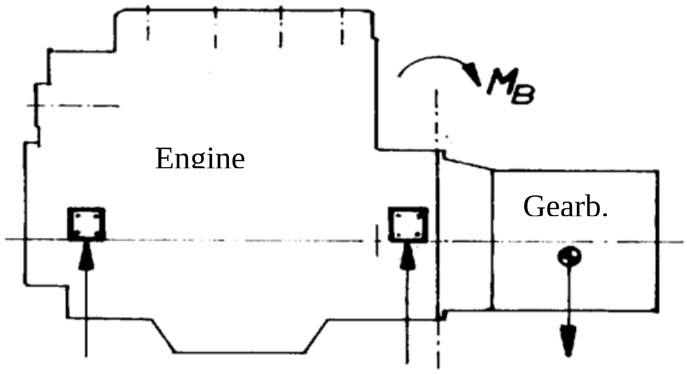
The same applies for air intake and discharge ducts.

Rigid connections to the foundation or the side panels will deteriorate the flexible mounting by increasing the natural frequency and may cause damage due to insufficient resilience.

When flexible elements are properly dimensioned, coupling, torque converter, transmission etc. can be flanged to the engine.

These fittings can be hung freely on the engine if the following limit values for the bending moment in the flywheel housing are not exceeded:

**FIG. 6 - 1**




## 6.3 Maximum admissible bending moment on the SAE housing

### On the side of the SAE housing

No values available.
If the engine mounting is provided by the customer, the distance from the center of the mounting to the SAE housing or engine block must correspond at maximum to that of the Deutz engine series, i.e. the Deutz track width must be complied with also when the customer provides his own engine mounting.

If this is not possible in individual cases, please consult head office.
Release of an engine mounting arrangement with a greater track width generally requires longer field trials.

**Max. admissible bending moment (Nm) between crankcase and SAE housing:**

*Table1:*

| **Engine series** | **max. admissible bending moment (Nm) between** *crankcase and SAE housing (*)* |
|---|---|
| F2L 1011F / 2011<br>B/F3L 1011F / 2011<br>B/F4L 1011F / 2011 | 450<br>650<br>900 |
| F2M 1011F / 2011<br>B/F3M 1011F / 2011<br>B/F4M 1011F / 2011 | 450<br>650<br>900 |
| B/FL 912 / 913 / 914 | 800 |
| B/FL / 413F / 513 | 1300 |

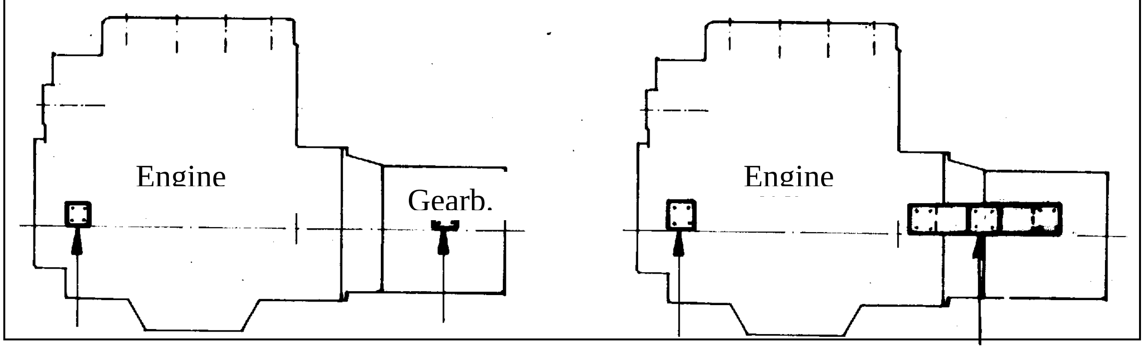
(∗) The values in this table refer to the static load. The admissible dynamic load is higher. The permissibility must be inquired after at head office for the individual case.

On exceeding the aforementioned bending moments with respect to the static calculation, the engine should be mounted not on the flywheel housing but on the gear housing. It is better to mount an auxiliary frame (beam) between the flywheel housing and the gear housing to which the mounting can be attached.

**Attention:**

In 6-cylinder V-90° engines the free gear mounting or hydraulic pump mounting is always very critical because of the free mass inertia around the transverse or vertical axis of the engine which lead to high fluctuating bending stresses on the engine/gear connection. High-strength SAE housings or the aforementioned auxiliary frames must be used in this case.

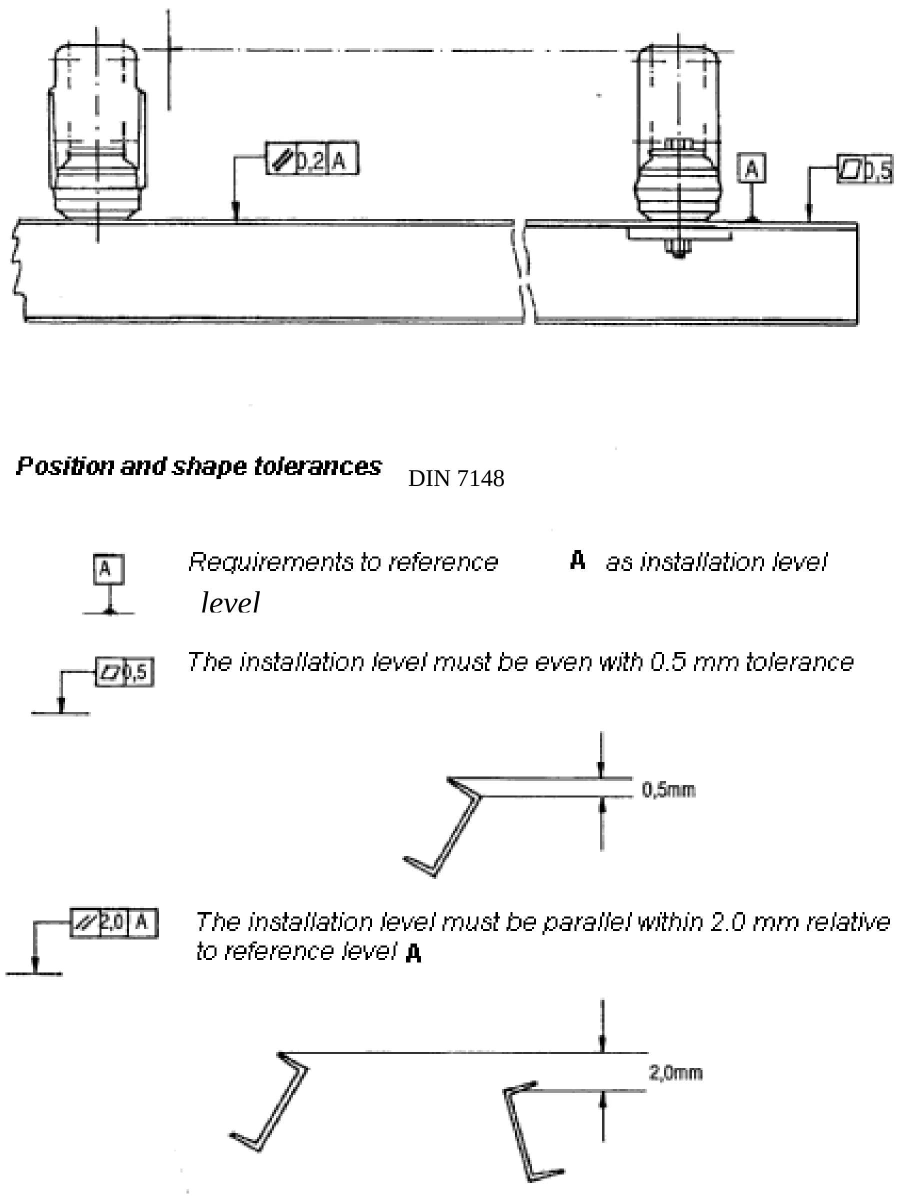
**FIG. 6 -2**




When installing the engine or the engine/transmission driveline with the fitted mounting elements, it must be ensured that the base is plane parallel and even.
The drilling template must be within the tolerance range, longitudinal ± 2 mm and transverse ± 1 mm. Through holes must be 4 mm bigger than the screw diameter.
The required washers must be made of grade St 60, at least 6 mm thick and with ∅26 mm at M12, ∅40 mm at M16.

Unequal stressloads or distortions of the mounting elements will be avoided in this way, as distorted rubber elements will affect the noise damping and vibration absorbing properties.

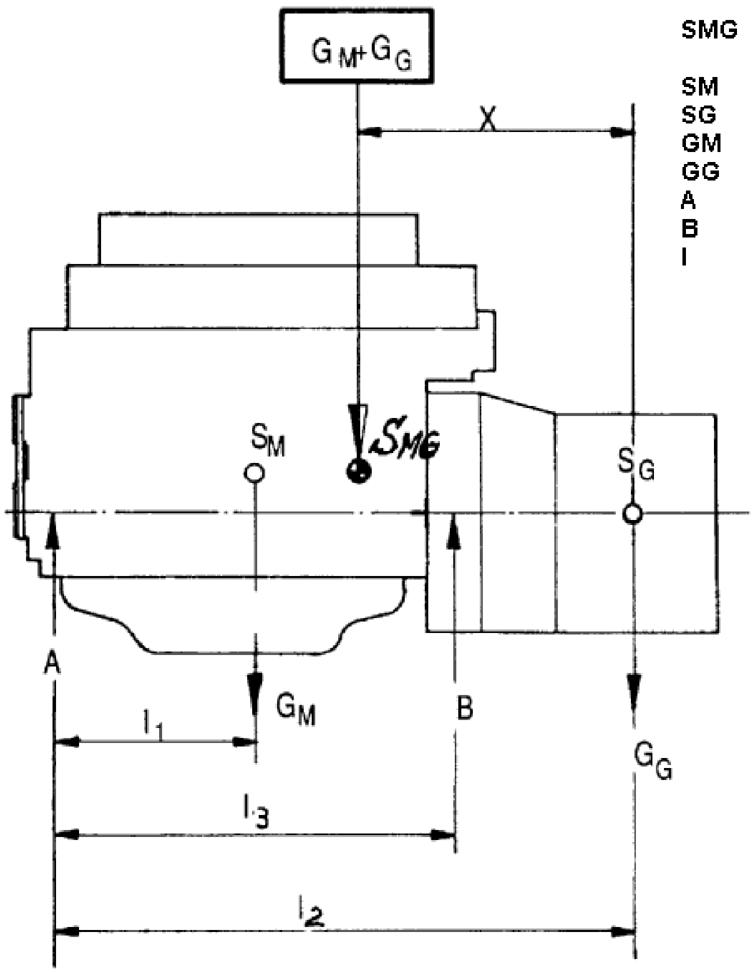
**FIG. 6 -3**




<u>Uniform loading of mounting elements:</u>
When arranging the mounting elements, ensure uniform loading. This can be achieved by balanced distribution of forces acting on the mounting elements, by changing the distances between the mounts or by changing the number of mounts. The variation in the number of mounts is in most cases the more appropriate approach.

When centers of gravity of engine and transmission and their weights proper are known, the forces acting on the mounts can be determined as follows:

**FIG. 6 -4**




| | |
|---|---|
| SMG | Center of gravity engine + transmission |
| SM | Center of gravity engine |
| SG | Center of gravity transmission |
| GM | Weight engine [N] |
| GG | Weight transmission [N] |
| A | Mount load at A [N] |
| B | Mount load at B [N] |
| l | Distances [m] |

$$A = \frac{G_M \times (l_3 - l_1) - G_G \times (l_2 - l_3)}{l_3} \ [N]$$

$$B = \frac{G_M \times l_1 + G_G \times l_2}{l_3} \ [N]$$

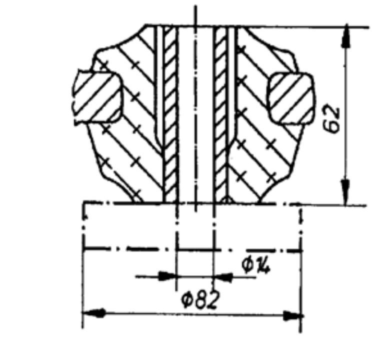
The position of the overall center of gravity (engine and transmission weight) relative to the transmission center of gravity can be determined with the following equation:

$$x = [\, l_2 - l_1 \,] \,/\, [\, 1 + G_G/G_M \,] \quad (m)$$

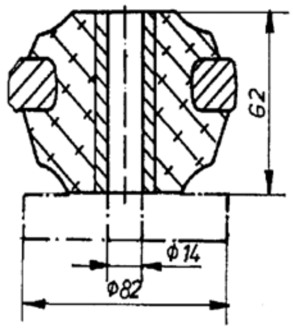
## Flexible mount configurations:

The DEUTZ scope of supply offers mounting elements which are adapted to the different engine versions and require only very little assembly works and space.

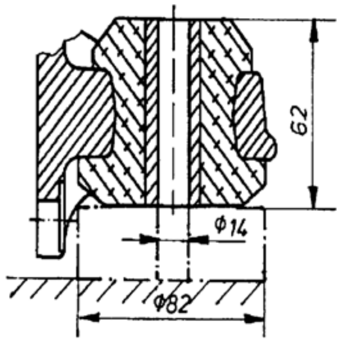
**Fig. 6 -5**



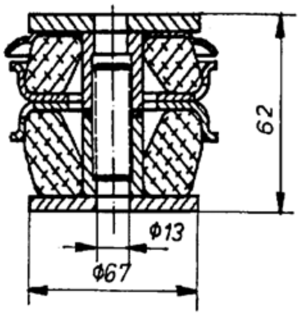

1. Bottleneck mounts



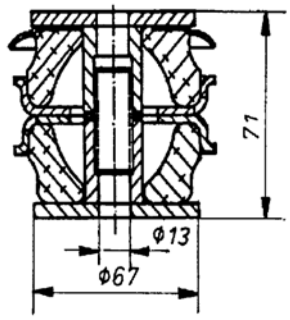

2. Soft cast mounts



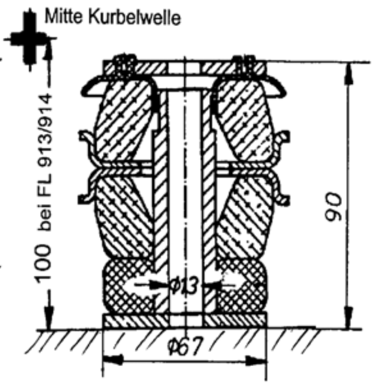

3. Hard cast mounts



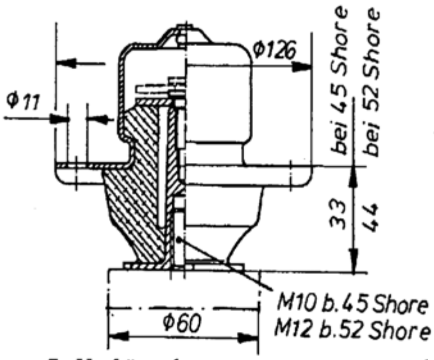

4. Sheet metal mounts, 62 mm high



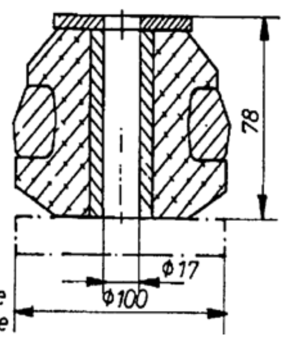

5. Sheet metal mounts, 71mm high



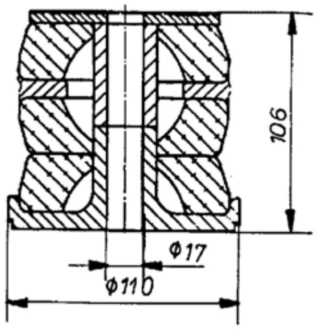

6. 6.Sheet metal mounts 90 mm high



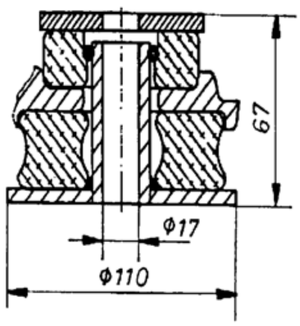

7. Displacement mounts



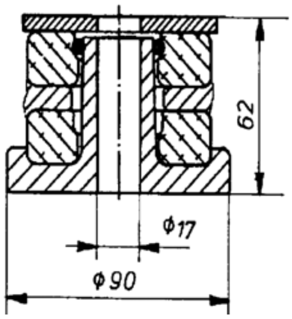

8. Cast mounts , high transv. load



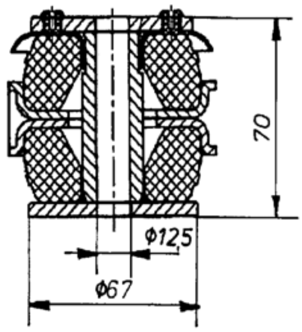

9. Cast mounts, big mac




10. Cast mounts, spec.des.




11. Cast mounts, underground operation




12. Sheet metal mounts

**FIG. 6 -6**

**Table 2:** **Admissible mount loads**

| *Fig.* | *Design* | *Material* | *Engine type* | *Load per mount foot (N)* | **Max. appl. temp. (C)** **incl. inner** *heating (*)* |
|---|---|---|---|---|---|
| **1** | *Bottleneck mount* | *Natural rubber 55 Shore* | *F2/3L 912/913/914* | 2200 | 90 |
| **2** | *Soft cast mount* | *Natural rubber 55 Shore* | *B/FL 912 / 913 / 914* | 2200 | 90 |
| **3** | *Hard cast mount* | *Natural rubber 55 Shore* | *B/FL 912 / 913 / 914* | 2200 | 90 |
| **4** | Sheet metal mount *62mm high* | *Natural rubber 68 Shore* | *F2/3L 912/913/914* | 3000 | 90 |
| **5** | Sheet metal mount *71mm high* | *Natural rubber 68 Shore* | *F2/3L 912/913/914* | 1000 | 90 |
| **6** | Sheet metal mount *90mm high* | a) EPDM with damping ring 20mm *50 Shore* | B/FL 1011F/2011 *B/FL 912 / 913 / 914* | 2000 | 130 |
| | | b) EPDM with damping ring 20mm *65 Shore* | B/FL 1011F/2011 *B/FL 912 / 913 / 914* | 3000 | 130 |
| | | c)Natural rubber with plastic disc 20mm *68 Shore* | *B/FL 912 / 913 / 914* | 3000 | 90 |
| **7** | *Displacement mount (special version)* | Natural rubber 45 Shore *52 Shore* | *F3L 912/913/914* | 600<br>1250 | 100<br>100 |
| **8** | Cast mount *(high transverse load)* | *Natural rubber 65 Shore* | B/FL 413/F/ *B/FL 513/C* | 3000 | 90 |
| **9** | Cast mount *(Big Mac, for vehicle installation* | EPDM *50 Shore* | B/FL 413/F/ *B/FL 513/C* | 3000 | 130 |
| **10** | Cast mount *(special version)* | Natural rubber *50 Shore* | B/FL 413/F/ *B/FL 513/C* | 4000 | 90 |
| **11** | Cast mount *Mining applications* | Natural rubber *70 Shore* | B/FL 413W/FW | 4000 | 90 |
| **12** | Sheet metal mount *70mm high* | a) EPDM 50 Shore *65 Shore* | B/FL 1011F/2011 | 2500<br>3000 | 130<br>130 |
| | | b) EPDM *50 Shore* | FL 511/208 | 2500 | 130 |

(∗) Attention: **The engine mount heats up due to internal friction in addition to heating up due to the engine compartment temperature. This must be taken into account in the design.**

**Notes to Table 2:**

- EPDM is a non-oil-resistant, temperature-resistant "synthetic rubber".
- The EPDM mounts with damping ring feature better noise damping properties than EPDM mounts without damping ring or cast mounting feet.
- All rubber qualities are resistant to low temperatures down to –40 °C.
- Especially sheet metal mounts and displacement mounts may be overloaded by transverse forces acting on them. To maintain proper functioning of the mounts, even when higher transverse forces are acting, stops should be provided in horizontal direction (5 mm max. deflection from neutral).
- Bottleneck mounts feature better sound damping properties than soft cast mounts.

**Note:**
Further technical details on flexible mounting elements are given in the detail drawings and can be obtained from head office.

For engine installations with open engine ventilation, make sure that the oil vapor escaping from the breathing system does not directly wet the rubber buffer of the flexible mount. The breathing pipes must be lengthened or re-laid if necessary.

## 6.4 Rigid mounting

The foundation for the rigid mounting system shall be stiff and heavy enough to prevent resonance-type vibrations from acting on the engine/foundation system. This means that the mount is to be designed as a subcritical system so that the maximum exciting frequency occurring will be sufficiently away from the natural frequency.

Where chassis frames are not absolutely resistant to bending and torsional stresses, four-point mount are particularly critical and may lead to engine damage.

It is therefore necessary to ensure a precise plane-parallel alignment of the rigid mounting points on the foundation or on the frame structure.

It is best when the engine with the rigid mount is placed on the frame. Then the gap below the mounting brackets is measured at several points using a feeler gauge.

Within the free bore gap, the suspension angles can be aligned by steps after having loosened the fastening bolts of a suspension angle.

**Attention:**
Use the specified moment when tightening the bolts.

Should this not result in proper, full-contact seating, insert spacer plates.

In the case of a rigid mounting, the drive configuration can be freely chosen as it is not subject to any restrictions as a consequence of the mounting system, e.g. setting of the rubber pads.

# 7. POWER TRANSMISSION

- Torque-transmitting components must be centered as per DIN ISO 7648 – also see SAE J 617A and SAE J 1033.
- The dynamical (subject to time-dependant changes) loads of torque-transmitting components in shaft systems of machine units must be determined via a torsional vibration calculation and compared with the admissible values.
  Here, not only the influence of the dynamical forces developed by the diesel engine, but also the influence of the dynamical forces developed by the working machine must be considered.
  If necessary, the manufacturer of the working machine must make available the data required for the calculation. For details, see VDI-regulation 3840.
  The engine-related data for a torsional vibration calculation can be made available by DEUTZ – please contact the acquisition staff or the technical support of the head office.

## 7.1 Clutches/couplings

The design of the clutch/coupling for transmitting the engine power to a drive element, e.g. generator or transmission, is mostly dependent on the drive element involved. Among others, it depends on the following:

- the arrangement (flanged or detached),
- the design of the drive element, e.g. single-bearing or two-bearing generator,
- the mounting of the engine and the drive element on the base,
- the design of the base,
- the requirements regarding torsional vibrations

If a major center offset must be overcome, a cardan shaft has to be installed in addition to a flexible coupling.

As a suitable clutch/coupling has to be provided for each particular case of application, this issue cannot be dealt with here because of the great variety involved. We recommend you to choose the clutch necessary for your application from the clutch suggestions in our delivery programs. We have made installation drawings which contain the important data you need.

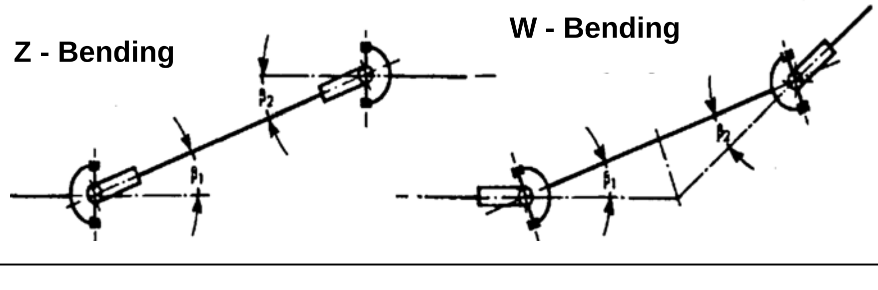
Torsional vibration analyses have already been made for the flexible couplings. If the data indicated in the drawings are not complied with, a specific torsional vibration analysis will be required, which we will carry out upon request and against reimbursement of the costs involved.

## 7.2 Installation of cardan shafts

The following pre-conditions must be met to avoid the transmission of different angular velocities:

- the two yokes of the cardan shaft must be located in the same plane,
- the bending angles $\beta_1$ and $\beta_2$ at the joints must also be in one plane and of equal size.

**FIG. 7 -1**



Due to the torque and bending angle of the joints, a bending moment depending on their size is transmitted to the engine and to the drive element.

The size of the bending moment is dependent on the torque induced and the bending angle of the joints. The bending moment deviates twice per revolution between zero and the maximum value.

$$M_{Bmax} = M_d \times \sin\beta \text{ (Nm)}$$

$M_d$ = applied torque (Nm)

$\beta$ = bending angle of the joint (°)

On the input and output side of the cardan shaft, radially rotating forces are generated by this bending moment. Vibrations are resulting which have the size of twice the engine speed and can lead to resonance phenomena depending on the mounting of the engine or the drive element.

With rigid mounting, the foundation should be as sturdy as possible and the bending angle $\beta$ kept as small as possible. To avoid damage to the needle bearings of the cardan joint, this angle $\beta$ should at least be 1°.

## 7.3 Power take-offs

The value of the admissible axial and radial power take-offs at the ends of the crank shaft and the auxiliary power take-offs of the engine are described in this chapter with excerpts from the “Technical Pocket Books” of the individual engines series. If you have any queries please contact the acquisition support or the technical support at DEUTZ head office.

### 7.3.1 Axial power take-off at crankshaft

#### Axial power take-off, flywheel side

At the flywheel end of the crankshaft, a maximum of 100% of the maximally possible engine power or the maximally possible torque are permitted to be taken.

The necessity of the installation of flexible couplings between the flywheel and the following power take-off unit must be decided from case to case. The design of the flexible coupling must be checked with the aid of a torsional vibration analysis. The respective technical data are made available by DEUTZ. Please contact the acquisition staff or the technical support of the DEUTZ head office.

#### Axial power take-off, vibration damper side (opposite to coupling)

In the axial power take-off on the opposite side to the coupling of the crank shaft, the power take-off is restricted according to the following tables as excerpts from the technical pocket books of the individual series.

The respective admissible power can then be determined with the specifications of the maximum admissible torque according to the following relation:

According to relationship T [Nm] = 9550 x P [kW] / n [min$^{-1}$]

the max. perm. power follows can be determined as a function of the speed:

P [kW] = T [Nm] x n [min$^{-1}$] / 9550

## 7.3.2 Radial power take-off at crankshaft

### Radial power take-off, flywheel side and damper side

Radial power take-offs result in a bending stress to the crankshaft as well as additional stress to the crankshaft support by the cross-acting force.

By the use of an external flange bearing, in these cases, the bending stress to the crankshaft can be drastically reduced.

For assessment of the permissibility of such take-offs / constructions, consult technical support at head office if necessary if no clear assessment is possible with the data in the following diagrams and tables.

## 7.3.3 Auxiliary power take-offs at the engine

For the Deutz diesel engines, beyond the normal power take-offs such as

- axial and radial power take-offs at the flywheel
- axial and radial power take-offs at the front crankshaft end,

the following auxiliary power take-off points for hydraulic pumps and compressors for example are existing:

The admissible powers tapped at the auxiliary power take-offs are explained in the following diagrams:

## 7.3.4 Power take-off tables and diagrams

Only the tables and diagrams for assessing the power take-offs for the following engines series are shown in this chapter:

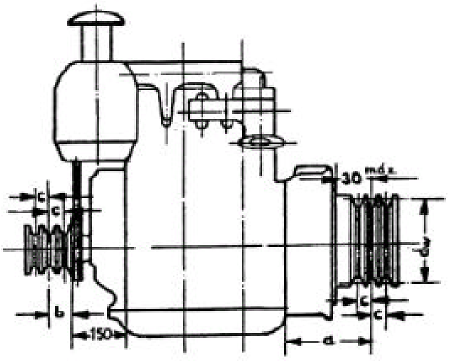
- series 909/910
- series 2011
- series 914
- series 413
- series 513

If you require additional data or the corresponding data of other older series, please contact the technical support at head office.

## 7.3.4.1 Series 909/910 FIG. 7 –2

| | Power take off | D910 L02<br>D910 L03 | Ausgabe<br>Issue<br>21.02.2002<br>1.Bearbeitung<br>Edition | Seite<br>Page<br>2.502E |
|---|---|---|---|---|

**POWER TAKE OFF** **ENGINE D 303-2/3**




**PTO´s with V-belts**

Max. distance of the pulleys:
a= 170 mm. b= 30 mm. c= 15 mm.

In the case of 2 V-belts, the max. allowed "a" and "b" dimensions is for the external v-belt.

The max. allowed quantity of type C v-belts (22 x 17) is 3.

The PTO without radial power take off (external bearing) is allowed if

flywheel side $\frac{P \times 10^5}{d_w \times n} \leq 3{,}7$

In case of higher values please use PTO (external bearing) QZ 01.

gearcover side on the crankshaft $\frac{P \times 10^5}{d_w \times n} \leq 3$

The pretension of the v-belts should not be higher than 1,5 to 2 times the periferical force on the v-belt.

Pretension $T_p = \frac{381 \times P \times 10^5}{d_w \times n}$ [N]

where P= Power to transmit [kW]
n = Engine apeed [rpm]
$d_w$ = Effectiv diameter of the pulley [mm]

**PTO with flat belts**

Max. distance to the center of the flat belt:
a= 170 mm., b= 30 mm.
To calculate the necessary width "B" of the belt to avoid slip and in relation to the contact angle use the formular

$B = \frac{F_t \times 7500}{d_1 \times ß}$ [cm] where $F_t$ = Tangential force [N]
$d_1$ = Ø of the small pulley [mm]
ß = Angle of contact [Degree]

We don´t recommend PTO´s with flat belts with a bigger width than 5,5 cm and without radial power take off (external bearing) and only should be used for low outputs to transmit. For higher outputs please use radial power take offs QZ 01(external bearing).

| | | |
|---|---|---|
| VV-TD<br>König | File: 2502_3E.XLS | Änderungsindex 00<br>21.02.2002 |

| DEUTZ | Power take off | D910 L02<br>D910 L03 | Ausgabe<br>Issue<br>21.02.2002<br>1.Bearbeitung<br>Edition | Seite<br>Page<br>2.503E |
|---|---|---|---|---|

## Auxiliary PTO on the gear cover

On the gear cover is available an auxiliary PTO to drive f. e. hydraulic pumps. The direction of rotation is the same as the engine and the speed is 1,142 times the engines speed, this means:

rpm engine = 1,142 rpm hydraulic pump

Max. allowed outputs on the auxiliary PTO.

| Engine speed | 1.000 | 1.200 | 1.400 | 1.500 | 1.800 | 2.000 | 2.200 | 2.400 | 2.600 | 2.800 | 3.000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Output [ kW] | 3 | 3,5 | 4 | 4,5 | 5 | 5,5 | 6 | 6,6 | 7 | 7,6 | 8,1 |

## Output reduction for natural aspirated engines

For each 100 m above the standard heigth acc. DIN-conditions: -1%
For each degree above the standard temperature acc. DIN-conditions: -0,5%

## Increase of the fuel consumption

For each 100 m above standard heigth acc. DIN.conditions: +0,5%
For each degree above the standard temperature acc. DIN-conditions: +0,5%

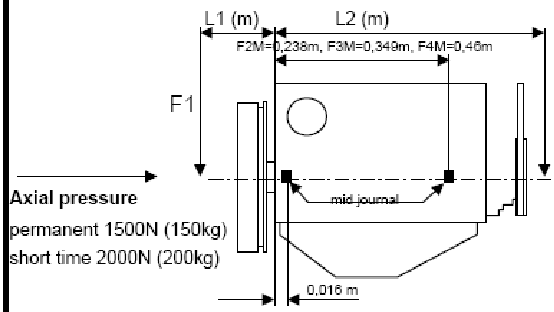
The DIN-standard is

| | |
|---|---|
| Atmosferical pressure: | 736 mm Hg |
| Ambient temperature: | 20° C |
| Relativ humidity: | 60 % |

| VV-TD<br>König | File: 2502_3E.XLS | Änderungsindex 00<br>21.02.2002 |
|---|---|---|

## 7.3.4.2 Series B/FL/FM 2011 FIG. 7 – 4

| DEUTZ | Power take-off | B/FM 2011<br>B/FL 2011 | Ausgabe<br>Issue<br>01.05.2001 | Seite<br>Page<br>2.61E |
|---|---|---|---|---|
| | | | 1.Bearbeitung<br>Edition | |

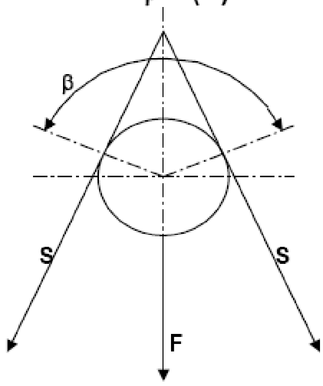



**Formular to calculate transmitted power**

$$P = M \times n / 9549{,}3 \text{ (kW)}$$

**Calculation of force "F" at v-belt drive**

$$F = 2 S \times \sin \beta/2 \text{ (N)}$$



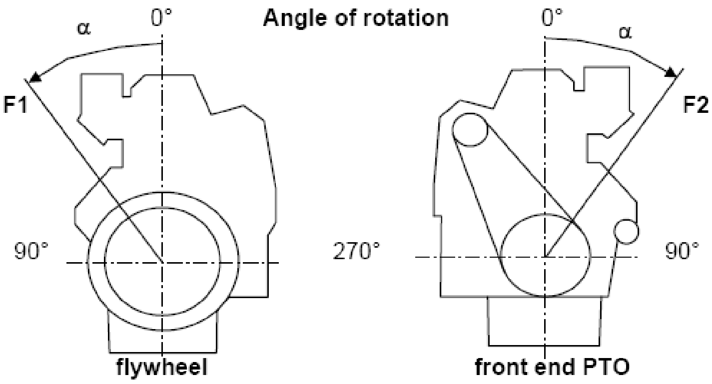
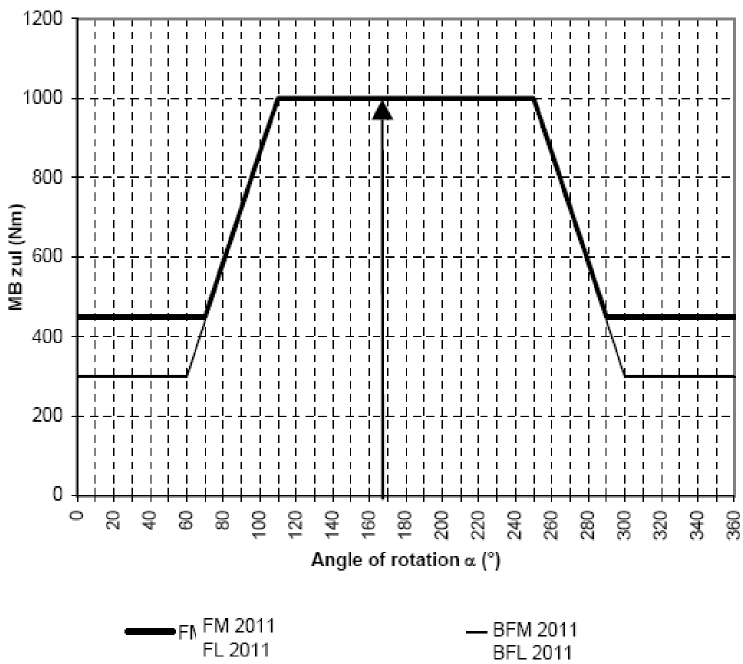




**Diagram1** (perm. bending moment in case of radial power take-off and of v-belt pulley or flywheel in overhung position)




Note regarding diagram 1
In diagram 1, the perm. bending moments are plotted against angles of rotation α. Only bending moments belows the representative borderlines are permitted.

When more than one v-belt drive is fitted, the result. bending moment and ist angle of rotation shall apply.

For example:
F4M2011 at front end PTO
Angle of rotation α = 170°,
MB perm. = 1000 Nm

| | | |
|---|---|---|
| R. Rechberg | File: 261_62e.XLS | Anderungsindex 03<br>22.02.2002 |

**FIG. 7 – 5**

| DEUTZ | Power take-off | B/FM 2011<br>B/FL 2011 | Ausgabe<br>Issue<br>01.05.2001<br>1.Bearbeitung<br>Edition | Seite<br>Page<br>**2.62E** |
|---|---|---|---|---|

**Table 1**

| power take off on: | flywheel | | | crankshaft, front | | |
|---|---|---|---|---|---|---|
| number of cylinders | 2 | 3 | 4 | 2 | 3 | 4 |
| axial power take off | 100 % of max. engine torque | | | see table 2, column 3 | | |
| radial power take off | without flange-type PTO<br>MB perm. (see Diagram 1)<br>otherwise flange-type PTO necessary | | | MB perm. (see diagram 1)<br>and I perm. (see table 2) | | |
| max.perm. I (kgm) | permisssible for all flywheels and couplings shown in LU torsional vibration calculation is necessary for rigid drive | | | see table 2 | | |
| max. perm. radial force F1 and F2 (N) | 3700 | | | 3700 | | |
| formula to calculate MB | F1(L1+0,016) | | | F2(L2-0,238) | F2(L2-0,349) | F2(L2-0,46) |
| perm radial PTO MB (Nm) | see diagram 1 | | | see diagram 1 | | |

**Table 2**

axial and radial power take-off at crankshaft, front

max. perm moment of inertia I (kgm) of rigid coupled components at V-belt pulley (standard)

rigid coupled components are: shaft journals, primary parts of flexible coupling, v-belt pulleys (except for standard v-belt pulley)

| engine | vibration damper | torque taken off (Nm) | engine speed (rpm) 2000 | 2300 | 2500 | 2600 | 2800 |
|---|---|---|---|---|---|---|---|
| F2M/L2011 | without | <= 22 | 0,3500 | 0,2500 | 0,1850 | 0,1700 | 0,1350 |
| | | <= 44 | 0,3500 | 0,2500 | 0,1850 | 0,1700 | 0,1350 |
| | | <= 66 | 0,3500 | 0,2500 | 0,1850 | 0,1700 | 0,1350 |
| | | <= 88 | 0,3500 | 0,2500 | 0,1850 | 0,1700 | 0,1350 |
| | | <= 93 | 0,3500 | 0,2500 | 0,1850 | 0,1700 | 0,1350 |
| F3M/L2011 | without | <= 33 | 0,0930 | 0,0600 | 0,0460 | 0,0400 | 0,0300 |
| | | <= 66 | 0,0930 | 0,0600 | 0,0460 | 0,0400 | 0,0300 |
| | | <= 99 | 0,0930 | 0,0600 | 0,0460 | 0,0400 | 0,0300 |
| | | <= 132 | 0,0800 | 0,0600 | 0,0460 | 0,0400 | 0,0300 |
| | | <= 140 | 0,0770 | 0,0600 | 0,0460 | 0,0400 | 0,0300 |
| BF3M/L2011 | without | <= 45 | 0,0700 | 0,0480 | 0,0350 | 0,0300 | 0,0250 |
| | | <= 90 | 0,0650 | 0,0450 | 0,0325 | 0,0275 | 0,0225 |
| | | <= 135 | 0,0600 | 0,0400 | 0,0300 | 0,0250 | 0,0200 |
| | | <= 180 | 0,0500 | 0,0300 | 0,0200 | 0,0200 | 0,0180 |
| | | <= 190 | 0,0480 | 0,0280 | 0,0180 | 0,0180 | 0,0175 |
| F4M/L2011 | without | <= 44 | 0,0550 | 0,0375 | 0,0280 | 0,0240 | 0,0160 |
| | | <= 88 | 0,0500 | 0,0375 | 0,0280 | 0,0240 | 0,0160 |
| | | <= 132 | 0,0250 | 0,0240 | 0,0240 | 0,0210 | 0,0160 |
| | | <= 176 | 0,0230 | 0,0180 | 0,0180 | 0,0180 | 0,0140 |
| | | <= 195 | 0,0220 | 0,0154 | 0,0154 | 0,0154 | 0,0130 |
| BF4M/L2011 | without | <= 60 | 0,0500 | 0,0375 | 0,0250 | 0,0180 | 0,0125 |
| | | <= 120 | 0,0225 | 0,0190 | 0,0190 | 0,0180 | 0,0125 |
| | | <= 180 | 0,0225 | 0,0125 | 0,0125 | 0,0125 | 0,0100 |
| | | <= 240 | 0,0225 | 0,0100 | 0,0070 | 0,0070 | 0,0070 |
| | | <= 270 | 0,0225 | 0,0088 | 0,0043 | 0,0043 | 0,0043 |

| W. Lemme<br>G. Saegert | File: 261_62e.XLS | Änderungsindex 02<br>05.10.2001 |
|---|---|---|

| DEUTZ | **Technische Erläuterungen**<br>*Technical explanations* | **B/FL 2011**<br>**B/FM 2011** | Ausgabe / Issue: **19.07.2001** | Seite / Page: **3.001 / E** |
|---|---|---|---|---|
| | | | **1.** Bearbeitung / Edition | |

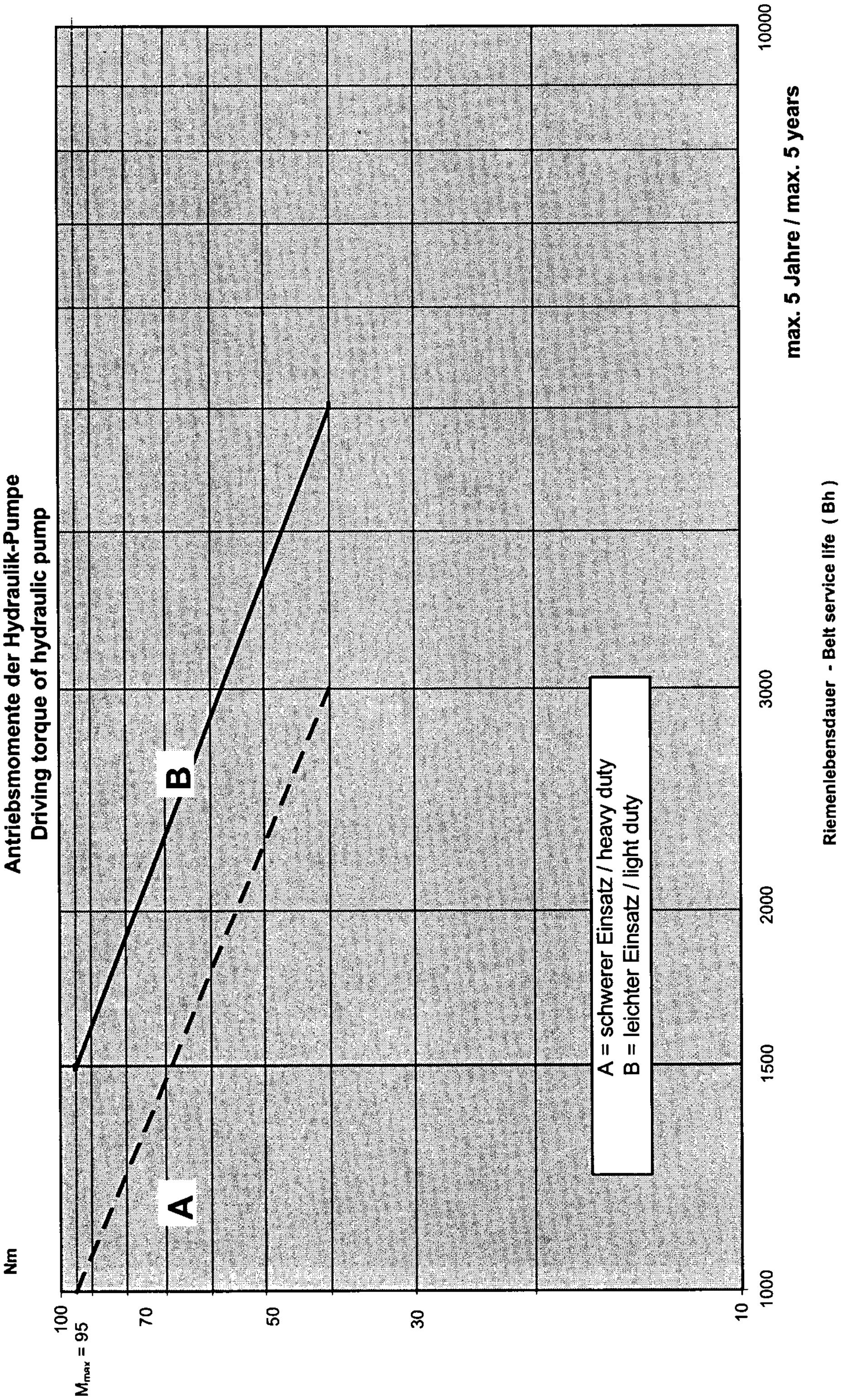
| Deutsch | English |
|---|---|
| **Hydraulikpumpen (Bosch)** | **Hydraulic pumps (Bosch)** |
| Allgemein :<br>Bei Auswahl und Betrieb von Hydr. Pumpen ist darauf zu achten, daß die zul. Temperatur des Hydrauliköls nicht überschritten wird.<br>Bei Beaufschlagung eines hydr. Lenksystems muss die Hydraulikpumpe ( Lenkhilfspumpe ) bezüglich Öldruck und Ölmenge darauf abgestimmt sein.<br>Bei voller Beaufschlagung leistungsstarker Hydraulikpumpen im Motorleerlauf, zulässige Drehmomentabnahme bei Motordrehzahlen zwischen 900-1500 1/min beachten. | General :<br>For the choice and operation of hydraulic pumps, note that the permissible hydr. oil temperature may not be exceeded.<br>It is essential that hydr. steering system of a vehicle is turned in with characteristics of a servo-pump, such as oil pressure and oil volume.<br>For high power consumption of servo-pump at engine idling speed, note permissible torque take-off at engine speed between 900 - 1500 1/min. |
| **Umgebungstemperaturbereich**<br>-15°C bis + 60°C | **Ambient temperature range**<br>-15°C to + 60°C |
| **Pumpeneingangsdruck**<br>min. 0,7 bar ( absolut )<br>max. 2,0 bar ( Überdruck ) | **Pump in-feed pressure**<br>min. 0.7 bar (abs.)<br>max. 2.0 bar ( over-pressure ) |
| **Hydrauliköle**<br>Legierte Hydraulik- oder Motoröle<br>SAE 10 - SAE 30 | **Hydraulic oil**<br>Alloyed hydraulic or engine oil<br>SAE 10 - SAE 30 |
| **Temperatur des Hydrauliköls**<br>SAE 10 max. 50°C<br>SAE 30 max. 80°C | **Temperature of hydraulic oil**<br>SAE 10 max. 50°C<br>SAE 30 max. 80°C |
| **Übersetzungsverhältnis**<br>$i = n_{Motor}:n_{Pumpe} = 1:1$ | **Transmission ratio**<br>$i = n_{Engine}:n_{Pump} = 1:1$ |
| Leistungsangaben der Hydraulikpumpen-Hersteller beachten.<br>**Wichtig: Die zur Zeit gültigen Sicherheits-forderungen der Gesamtanlage sind zu berücksichtigen !** | Note the rating data of hydraulic pump manufacturers.<br>**Important : Please note the latest valid security measures of entire plant.** |

| TK-NA | File: 3001_06.XLS | Änderungsindex 01<br>19.07.2001 |
|---|---|---|

| DEUTZ | **Technische Erläuterungen**<br>Technical explanations | **B / FL 2011**<br>**B / FM 2011** | Ausgabe / Issue: **01.02.01** | Seite / Page: **3.002 / E** |
|---|---|---|---|---|
| | | | **1.** Bearbeitung / Edition | |

Tabelle für Zahnriemenlebensdauer in Abhängigkeit vom Antriebsmoment der Hydraulik-Pumpe

Chart for the durability of toothed belt, depending on the driving torque of hydraulic pump.




Erläuterungen zur Auslastung des Antriebes, sowie Randbedingungen sind auf der nächsten Seite beschrieben.

The explanations for loading of drive as well as the marginal conditions are stated on next page.

| TK-NA | File: 3001_06.XLS | Änderungsindex 00<br>01.05.01 |
|---|---|---|

| DEUTZ | **Technische Erläuterungen** *Technical explanations* | **B/FL 2011 B/FM 2011** | Ausgabe / Issue: 01.02.2001 | Seite / Page: **3.003 / E** |
|---|---|---|---|---|
| | | | **1.** Bearbeitung / Edition | |

**Randbedingungen:**

Die Aussagen im Diagramm stützen sich auf eine Bewertung von Prüfstandsläufen und Praxiserfahrungen.
Der konkrete Einsatzfall in der Praxisanwendung kann, was die Beurteilung der Lebensdauer anbelangt, durchaus davon abweichen.
Es handelt sich also um sogenannte "Richtwerte" zur Beurteilung der Zahnriemenlebensdauer.

1. Riemen- und Spannrollenwechsel entspr. den angegebenen Betriebsstunden, jedoch spätestens nach 5 Jahren.

**Erläuterungen zur Auslastung des Antriebes**

A: Schwerer Einsatz
Hohe Umgebungstemperatur, hohe Staubbelastung, z.B. Bagger, Skid-Steer-Loader, Landmaschinen

B: Leichter Einsatz

Mittlere Umgebungstemperatur, niedrige Staubbelastung, z.B. Hebebühnen, Kompressoren, Radlader

2. Der Hydraulikpumpenantrieb ist bei jedem zweiten Steuerriemen- und Spannrollenwechsel mit zu erneuern, jedoch spätestens nach 6000 Bh.

**Marginal conditions:**

The declarations in the diagramm depends on valuation of test bench runs and practical results.

Conditions in the practical application can be different regarding the assessment of the service life.
The diagram shows so called "Standard values" for assessment of the toothed belt service life.

1. Drive belt and tensioning pulley have to be exchanged according to the service life value as shown in the diagram, but latest after 5 years.

**Explanations for loading of drive**

A: Heavy duty
High ambient temperature, high dust load, e.g. excavators, skid-steer-loaders, agricultural machinery

B: Light duty

Medium ambient temperature, low dust load, e.g. lifting equipment, compressors, wheel loaders

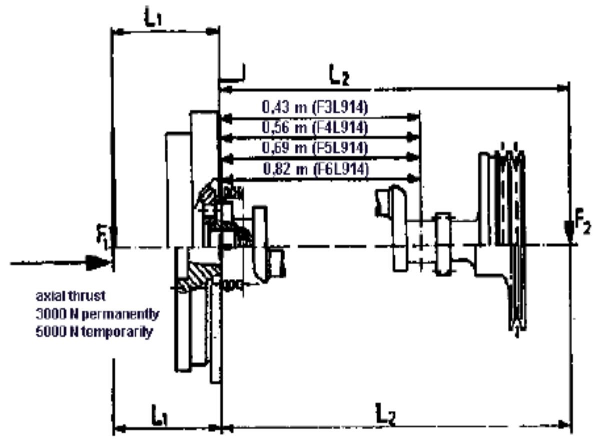
2. The hydraulic pump drive has to be exchanged at every second exchange of belt and tensioning pulley, but latest after 6000 working hours.

| TK-NA | File: 3001_06.XLS | Änderungsindex 00 01.05.2001 |
|---|---|---|

**Table 1**

| power take-off on: | flywheel | | | | crankshaft front | | | |
|---|---|---|---|---|---|---|---|---|
| no. of cylinders | 3 | 4 | 5 | 6 | 3 | 4 | 5 | 6 |
| axial power take-off | 100 % of max. engine torque | | | | see table 2, column 3 | | | |
| radial power take-off | determined by $M_{B,zul}$ (see diagram 1) | | | | determined by $M_{B,zul}$ (see diagram 1) and $J_{zul}$ (see table 2) | | | |
| max. perm. inertia moment $J$ [kg m²] | | | | | see table 2 | | | |
| max. perm. radial forces $F_1$, $F_2$ [N][1)] | 4000 | | | | determined by bend. moment and radial force dist. | | | |
| max. perm. radial force distances $L_1$, $L_2$ [m] | determined by bending moment and radial force | | | | 0,71 | 0,84 | 0,97 | 1,10 |
| formula for calculating bending moment $M_B$ | $F_1(L_1+0{,}04)$ | | | | $F_2(L_2-0{,}43)$ | $F_2(L_2-0{,}56)$ | $F_2(L_2-0{,}69)$ | $F_2(L_2-0{,}82)$ |
| max. perm. bending moment $M_{B,zul}$ [Nm] | see diagram 1 | | | | see diagram 1 | | | |

**Force initiation**




1) Calculation of Force $F_2$ at V - belt drive: $F_2 = 2S\sin\frac{\varphi}{2}$ [N]

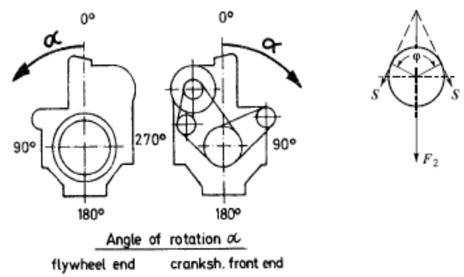
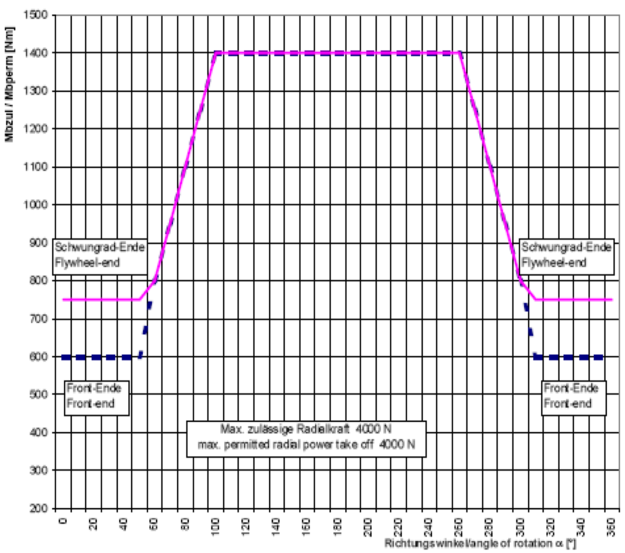



Table 2 with maximum permitted moment of inertia see next Page.

**Diagram 1** (max. perm. bending moment)




Notes regarding diagram 1

In diagram 1 the permitted bending moments are plotted against angles of rotation α. The shaded area represents the permitted bending moments for radial power take - off at flywheel end and crankshaft front end.
Where more than one belt drive is provided, the resultand bending moment and angle of rotation shall apply.

For example:
F 6 L 914 power take-off at crankshaft front end
Angle of rotation α = 170°
→ $M_{B,zul}$ = 1400 Nm

| DEUTZ | Power take-off | F L 914 | Issue: 22.04.2003 | Page: 2604E |
|---|---|---|---|---|
| | | | 1. Edition | |

| Axial and radial power take-off at crankshaft front end | | | Max. permitted inertia moment J [kgm²] of rigid coupled additional parts for V-belt pulley with two groves. Additional parts are, e.g. primer parts of flexible coupling, V-belt pulley (except for standard V-belt pulley and vibration damper) | | | | | |
|---|---|---|---|---|---|---|---|---|
| Engine | Vibration damper | Torque taken off [Nm] | $n_{Engine}$ [rpm] | | | | | |
| | | | **1500** | **1800** | **2000** | **2150** | **2300** | **2500** |
| | | | **Knurled gear wheel (tempered)** | | | | | |
| F3L 914 [2]) | without | ... 49 | 0,350 | 0,350 | 0,255 | 0,205 | 0,165 | 0,130 |
| | | ...195 | 0,350 | 0,350 | 0,255 | 0,205 | 0,165 | 0,130 |
| F4L 914 [2]) | without | ... 65 | 0,135 | 0,078 | 0,048 | 0,030 | 0,015 | 0 |
| | | ...260 | 0,135 | 0,078 | 0,048 | 0,030 | 0,015 | 0 |
| F4L 914 [2]) | with | ... 65 | 0,350 | 0,300 | 0,250 | 0,250 | 0,250 | 0,250 |
| | | ...260 | 0,350 | 0,300 | 0,220 | 0,220 | 0,220 | 0,220 |
| F5L 914 [1]) | with | ... 81 | 0,270 | 0,270 | 0,270 | 0,270 | 0,170 | 0,115 |
| | | ...325 | 0,250 | 0,250 | 0,250 | 0,250 | 0,150 | 0,095 |
| F6L 914 [1]) | with | ... 98 | 0,190 | 0,190 | 0,190 | 0,190 | 0,190 | 0,175 |
| | | ...390 | 0,175 | 0,175 | 0,175 | 0,175 | 0,175 | 0,175 |

[1]) Additional inertia moments for V-belt pulley with 3 groves (with integral damper) according 0223 1418 UA; for application of V-belt pulley with 2 groves according 0223 1415 UA the values as listed above can be increased by 0,010 kgm²

[2]) Additional inertia moments for V-belt pulley with 2 groves according 0415 8480 EB; for application of V-belt pulley with 2 groves according 0415 8478 EB the values as listed above can be increased by 0,005 kgm² and for V-belt pulley with 1 grove acc. 0415 8476 EB by 0,010 kgm².

| **Permitted power take-off for hydraulic pump drive** | |
|---|---|
| F 4 / 6 L 914 | See page: 2.607 |

| Först | 2604e.XLS | Index: 01 04.02.03 |
|---|---|---|

DEUTZ

# Power take - off

BFL 914 / C

| Ausgabe Issue | Seite Page |
| --- | --- |
| 03.05.02 | 2.605 E |
| 1. Bearbeitung Edition | |

**Table 1**

| Power take - off on: | Flywheel | | Crankshaft, front | |
| --- | --- | --- | --- | --- |
| Number of cylinders | 4 | 6 | 4 | 6 |
| Axial power take - off | 100 % of maximum engine torque | | see Table 2, Column 3 | |
| Radial power take - off | without flange-outboard bearing admissible radial force $M_{B\,zul}$ ( see Diagram 1) , otherwsise flange-outboard | | Max. adm. $M_{Bzul}$ ( see Diagram 1 ) and max. adm. $I_{zul}$ ( see Table 2 ) | |
| Maximum permissible I [ kg m²] | Permissible for all flywheels and couplings given in LU. Torsional vibration calculation is necessary for | | see Table 2 | |
| maximum permissible radial force $F_1$ und $F_2$ [ N ] 2) | 4000 | | 4000 | |
| Formula for calculating $M_B$ | $F_1$ ( $L_1$ + 0,04 ) | | $F_2$ ( $L_2$ - 0,82 ) | $F_2$ ( $L_2$ -- 0,56 ) |
| radial power take - off $M_{B\,zul}$ [ Nm ] | See Diagram 1 | | | |

Force initiation

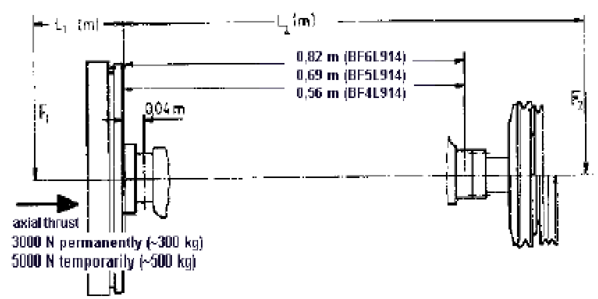
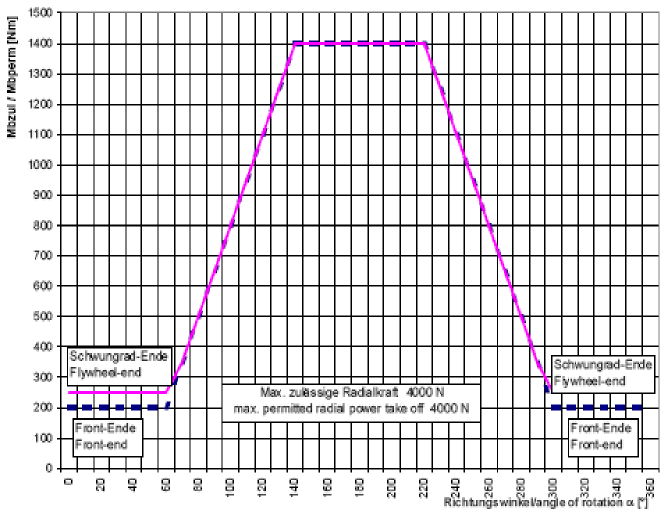


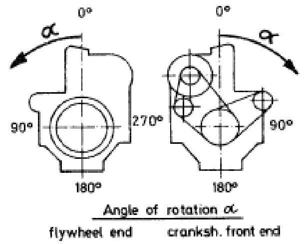

Diagram 1 (max. permissible bending moment




Notes regarding Diagram 1

In Diagram 1 the perm. bending moments are plotted against angles of rotation a. The shaded area represents the perm. bending moments for radial power take - off at flywheel end and crankshaft front end.
Where more than one belt drive is provided, the resultand bending moment and angle of rotation shall apply.

For example:
BF 6 L 914 / C power take-off at crankshaft front end
Angle of rotation a = 170 °, $M_{Bzul}$ 1400 Nm




1) Formula for calculating power which can be transmitted $P = \frac{M \cdot n}{9549}$ [kW]

2) Calculation of force "F" at V-belt drive $F = 2\,S \cdot \sin\frac{\alpha}{2}$ [N]

Table 2 with maximum perm. moment of inertia see next Page.

| DEUTZ | Power take-off | BF L 914 | Issue: 22.04.2003 | Page: 2.606E |
|---|---|---|---|---|
| | | | 1. Edition | |

| Axial and radial power Take-off at crankshaft front end | | | Max. permitted inertia moment J [kgm²] of rigid coupled additional parts for V-belt pulley with two groves. Additional parts are, e.g. primer parts of flexible coupling, V-belt pulley (except for standard V-belt pulley and vibration damper) | | | | | |
|---|---|---|---|---|---|---|---|---|
| Engine | Vibration damper | Torque taken off | $n_{Engine}$ [Upm] | | | | | |
| | | [Nm] | 1500 | 1800 | 2000 | 2150 | 2300 | 2500 |
| | | | **Knurled gear wheel (tempered)** | | | | | |
| BF4L914 [1]) | with | ...86 | 0,250 | 0,250 | 0,140 | 0,130 | 0,100 | 0,050 |
| | | ...343 | 0,250 | 0,220 | 0,120 | 0,110 | 0,100 | 0,050 |
| BF6L914 | with | ...129 | 0,060 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 |
| | | ...515 | 0,060 | 0,030 | 0,030 | 0,030 | 0,030 | 0,030 |
| BF6L914C | with | ...152 | 0,060 | 0,045 | 0,045 | 0,045 | 0,045 | 0,045 |
| | | ...608 | 0,060 | 0,030 | 0,030 | 0,030 | 0,030 | 0,030 |
| BF6L914C [2]) | with | ...195 | 0,050 | 0,030 | 0,030 | 0,030 | 0,030 | 0,030 |
| | | ...450 | 0,050 | 0,025 | 0,025 | 0,025 | 0,025 | 0,025 |
| | | | | | | | | |
| | | | | | | | | |

1) Additional inertia moments for V-belt pulley with 3 groves (with integral damper) according 0223 1418 UA; for application of V-belt pulley with 2 groves according 0223 1415 UA the values as listed above can be increased by 0,010 kgm².

2) for combine harvester engine 176 kW/2500 Upm; for other application please contact the head quarter

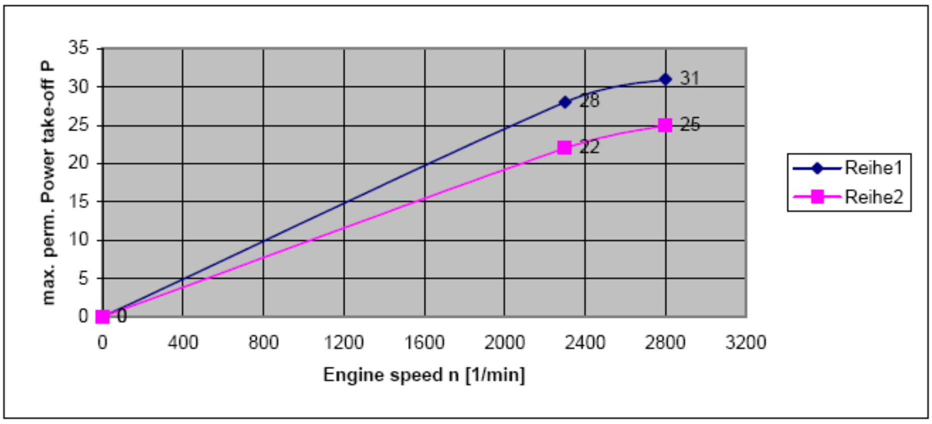
| **Permitted power take-off for hydraulic pump drive** | |
|---|---|
| BF 4 / 6 L 914 / C | s. page 2.607 |

| Först | 2606e.XLS | Änderungsindex: 01<br>04.02.03 |
|---|---|---|

| | Power take - off/Balancer shafts | FL 914<br>BFL 914/C | Issue: 16.06.2004 | Page: 2.607 E |
|---|---|---|---|---|
| DEUTZ | | | Edition: 1. | |

## ° Powertake - off

**Maximum permitted power take-off for hydraulic pump drive**




1. Gear bearing tempered and scraped (standard):
   curve 1: intermittend
   curve 2: permanently

2. Gear bearing tempered and grinded (noise suppression)
   Curve 1 represents all ranges of application, the improved gears with reinforced intermediate gear bearing

## ° Balancer shafts

without balancer shafts

It is not possible to retrofit balancer shafts.

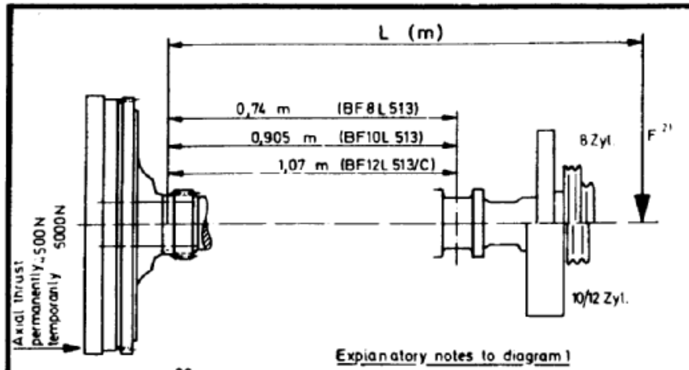
| Kallenbach | 2607e.XLS | Index: 02 |
|---|---|---|

KHD DEUTZ

# Power take-off

BFL 513

| Ausgabe / Issue | Seite / Page |
|---|---|
| 15.01.91 | 2.602E |
| 1. Bearbeitung / Edtion | |



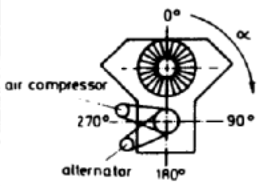




Table 1

| Power take-off on | Flywheel | | | Crankshaft, front | | |
|---|---|---|---|---|---|---|
| No of cylinders | 8 | 10 | 12 | 8 | 10 | 12 |
| Axial power take-of | 100% of max. engine torque | | | see Table 2, Column 4 | | |
| Radial power take-off | 100% of max. engine torque with flanged-on outer bearing | | | Max adm. $M_B$ and adm. J (see Diagram 1) (see Table 2) | | |
| Max. perm J | Permissible for all flywheels and coupling given in LU Tortional Vibration calculation is necessary for rigid drive. | | | See Table 2 | | |
| Formula for calculating $M_B$ [Nm] | — | | | $M_B$ = F(L-0,575) / $M_B$ = F(L-0,74) | $M_B$ = F(L-0,905) | $M_B$ = F(L-1,07) |
| Rad. power take-off perm. $M_B$ [Nm] | — | | | See Diagram 1 | | |
| max. perm. radial force F (N) | — | | | 5500 | | |

Table 2

Axial and radial power take-off at crankshaft front

max. permissible moment of inertia J [$kgm^2$] of rigid coupled additional parts

Additional parts are, for instance, stubshaft, primer parts of flexible coupling, V-belt pulleys (excluded, 4-grooved standard V-belt pulley and vibration damper)

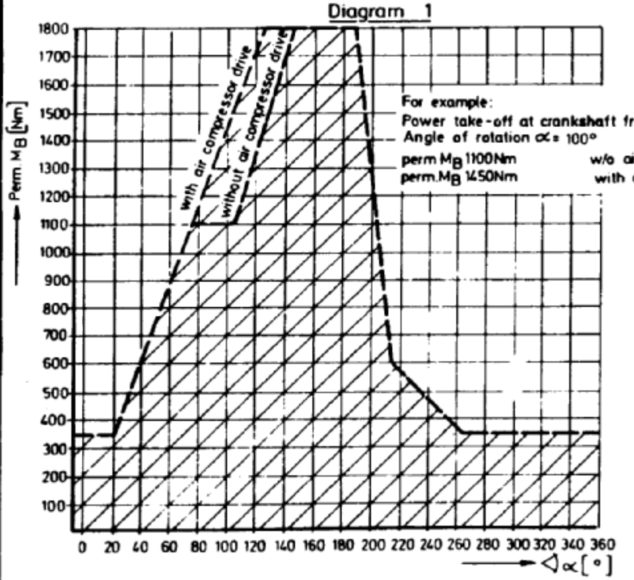
| Engine | Vibration damper | Quality of screws | Torque taken off 1) [Nm] | $n_{Motor}$ [1/min] 1500 | 1800 | 2000 | 2150 | 2300 |
|---|---|---|---|---|---|---|---|---|
| BF8L 513 | with | 12.9 | up to 950 | 0,4 | 0,4 | 0,4 | 0,4 | 0,25 |
| BF10L 513 | with | 12.9 | up to 297 | 0,2 | 0,2 | 0,2 | 0,2 | 0,2 |
| | | | up to 593,5 | 0,15 | 0,15 | 0,15 | 0,15 | 0,15 |
| | | | up to 890 | 0,1 | 0,1 | 0,1 | 0,1 | 0,1 |
| | | | up to 1187 | 0,35 | 0,05 | 0,05 | 0,05 | 0,05 |
| BF12L 513 | with | 12.9 | up to 1069 | 0,4 | 0,3 | 0,15 | 0,15 | 0,15 |
| BF12L513C | | | up to 1425 | 0,4 | 0,2 | 0,1 | 0,1 | 0,1 |

Explanatory notes to diagram 1

The hatched portion shows the perm. bending moments for rad. power take-off at front end with overhung V-belt pulley depending on the direction of pull (angle α)

Where more than one belt drive is provided, the resulting bending moment and angle of rotation shall apply

Diagram 1




1) Formula for calculating power which can be transmitted $P = \frac{M [Nm] \cdot n [1/min]}{9549}$ [kW]

2) Calculation of force „F" at V-belt drive $F = 2S \cdot \sin\frac{\alpha}{2}$ [N]

4) If "without flanged-on outer bearing" the fitting must be tested by Head office

| Klöckner-Humboldt-Deutz AG KHD | Benennung | Power take-off on BFL 513 / C |
|---|---|---|
| Abt AE-GB 2, AE-VI 2 | Number | 418 0904 UC 0148 - 99E |
| Dat 25.04.96 | Correction figure: | |

| KHD DEUTZ | Power take-off | FL 513 | Ausgabe / Issue: 15.01.91 | Seite / Page: 2.603E |
|---|---|---|---|---|
| | | | Bearbeitung / Edtion: 1. | |

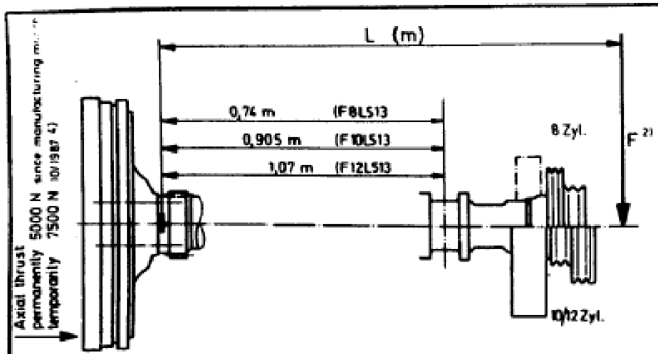



**Table 1**

| Power take-off on | Flywheel | | | | Crankshaft, front | | | |
|---|---|---|---|---|---|---|---|---|
| No. of cylinders | | 8 | 10 | 12 | | 8 | 10 | 12 |
| Axial power take-of | 100% of max. engine torque | | | | see Table 2, Column 4 | | | |
| Radial power take-off | 100% of max. engine torque with flanged- 3) on outer bearing | | | | Max. adm. MB and adm. J 4) | | (see Diagram 1) (see Table 2) | |
| Max. perm.J [kgm²] | Permissible for all flywheels and coupling given in L.U. Tortional Vibration calculation is necessary for rigid drive. | | | | See Table 2 | | | |
| Formula for calculating $M_B$ [Nm] | — | | | | | MB= F(L-0,74) | MB= F(L-0,905) | MB= F(L-1,07) |
| Rad.power take-off perm. $M_B$ [Nm] | — | | | | See Diagram 1 | | | |
| Max.perm. radial force$_F$ [N] | — | | | | 5500 | | | |

**Table 2**

Axial and radial power take-off at crankshaft front

max permissible moment of inertia J [kgm²] of rigid coupled additional parts.

Additional parts are, for instance, stubshaft, primer parts of flexible coupling, V-belt pulleys (excluded, 4-grooved standard V-belt pulley and vibration damper)

| Engine | Vibration damper | Quality of screws | Torque 1) [Nm] | n Engine [1/min] 1500 | 1800 | 2000 | 2150 | 2300 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| F8L 513 | with | 12.9 | up to 740 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | | | |
| F10L 513 | with | 12.9 | up to 231 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | | | |
| | | | up to 462,5 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 | | | |
| | | | up to 694 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 | | | |
| | | | up to 925 | 0,25 | 0,25 | 0,25 | 0,25 | 0,25 | | | |
| F12L 513 | with | 12.9 | up to 832,5 | 0,4 | 0,4 | 0,3 | 0,3 | 0,3 | | | |
| | | | up to 1110 | 0,4 | 0,3 | 0,25 | 0,25 | 0,25 | | | |

1) Formula for calculating power which can be transmitted $P = \frac{M[Nm] \cdot n[1/min]}{9549,3}$ [kW]

2) Calculation of force F at V-belt drive $F = 2 \cdot S \cdot \sin\frac{\beta}{2}$ [N]

3) If "without flanged-on outer bearing" the fitting must be tested by Head office

4) see TR 0148-01-420

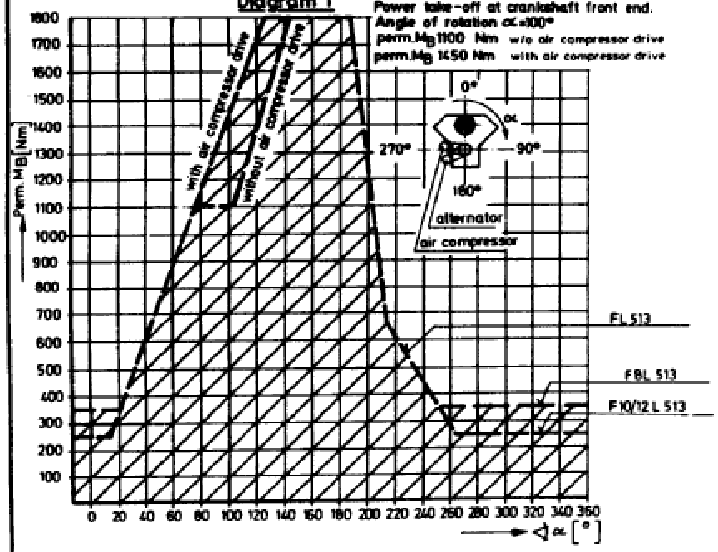
**Explanatory notes to diagram 1**

The hatched portion shows the perm. bending moments for rad. power take-off at front end with overhung V-belt pulley depending on the direction of pull (angle α)

Where more than one belt drive is provided, the resulting bending moment and angle of rotation shall apply.

**For example:**
Power take-off at crankshaft front end.
Angle of rotation α = 100°
perm. $M_B$ 1100 Nm w/o air compressor drive
perm. $M_B$ 1450 Nm with air compressor drive

**Diagram 1**




| KHD Klöckner-Humboldt-Deutz AG | Benennung: Power take-off on FL513 |
|---|---|
| Abt. AE-VBI / AEGB1 | Number: 240 1947 UC 0148-99E |
| Dat 26.11.90 | Correction figure |

| KHD DEUTZ | Auxiliary PTOs | B/FL513<br>B/F L513 L/C | Ausgabe / Issue: 01.12.95 | Seite / Page: 2.604E |
|---|---|---|---|---|
| | | | Bearbeitung / Edition: 1. | |

Approach for determining the max. permissible torque for the sum of auxiliary PTOs 1, 2, and 3:

1. Regarding the defined engine design, determine:
   - engine speed
   - cooling blower ratio
   - fuel injection pump drive with/without advance/retard unit

2. Based on these factors, determine from diagrams II, III, and the table (page 2):
   - fuel injection pump torque $M_E$
   - camshaft torque $M_N$ (at varying speed always $M_N$max)
   - blower torque $M_G$

3. Obtain sum from $M_E + M_N + M_G$, which plot on the vertical line in diagram I and draw a horizontal line intersecting the boundary line.

4. The perpendicular from the point of intersection to the $M_{Ne}$ line gives the maximum permissible auxiliary PTO torque.

The max.permissible aux. PTO torque can either be devided among the PTOs 1 ( for 8 cylinder ) 2 and 3 ( for 8,10,12 cylinder ) or taken off at one point.

**Restriction:**

For aux. PTOs 2 and 3, the max. permissible torque is 120 Nm each.

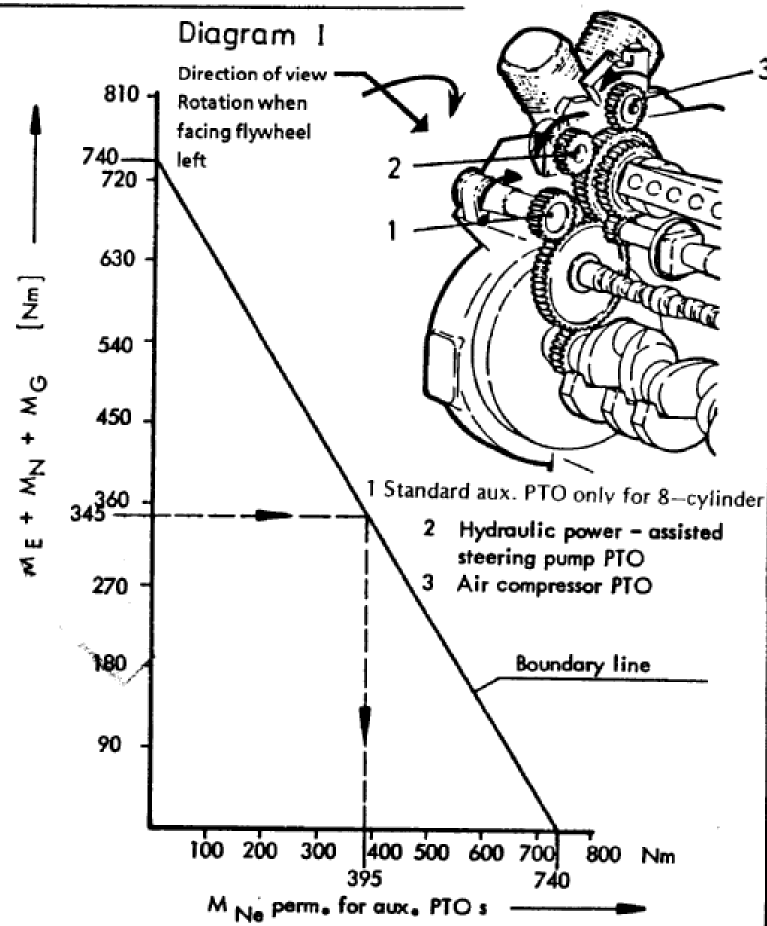
**Example:**

BF10L513 engine, n = 2,100/min, varying speed
blower ratio i = 2.0
fuel injection pump drive with
advance/retard unit

$M_E$ = 180 Nm (diagram II)
$M_N$ = 65 Nm (diagram III)
$M_G$ = $\frac{100 \text{ Nm}}{345 \text{ Nm}}$ (table)

max. permissible torque = 395 Nm

## Determination of the max. drive torque for the auxiliary PTO s




| Abteilung: AF-ED1 | Name: Humberg | Datum: 09.11.90 | Blatt Nummer: 240 1946 UE 0148-99 | Blatt 1 von Blättern 2 |
|---|---|---|---|---|
| | | | Änderungsziffer .01 vom 05.08.93 | |

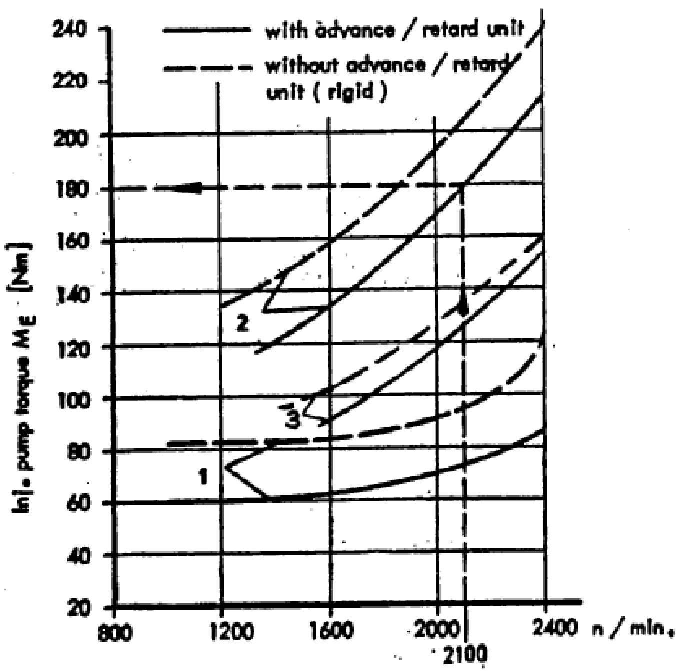
KHD DEUTZ

**Auxiliary PTOs**

B/FL513
B/F L 513 L/C

| Ausgabe Issue | Seite Page |
|---|---|
| 01.12.95 | 2.605E |
| 1. Bearbeitung Edition | |

## Diagram II

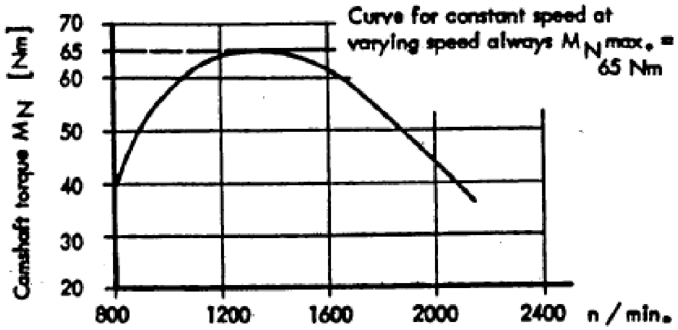



Curves 1 for engines B/F 8L 513 (MW-Pump)

Curves 2 for engines B/F 10L 513, B/F 12L 513/C (P-Pump)

Curves 3 for engines B/F 8 L 513 LC (P-Pump)

## Diagram III




| Blower torques $M_G$ [Nm] | | | | | | | |
|---|---|---|---|---|---|---|---|
| Blower torques I | | | | | | | Blower |
| 1,62 | 1,74 | 1,86 | 2,00 | 2,16 | 2,33 | 2,53 | Ø |
| 44 | 69 | 81 | 100 | 123 | 148 | 161 | 358/388 |

| | | | | |
|---|---|---|---|---|
| Abteilung : AF-ED 1 | Name : Humberg | Datum : 09.11.90 | Blatt Nummer : 240 1946 UE 0148-99 | Blatt 2 von Blättern 2 |
| | | | Änderungsziffer : AZ 01 vom 05.08.93 | |

| KHD DEUTZ | Power take-off | FL413 F/FW | Ausgabe Issue: 15.03.89 | Seite Page: 2.049E |
|---|---|---|---|---|
| | | | 4. Bearbeitung Edtion | |

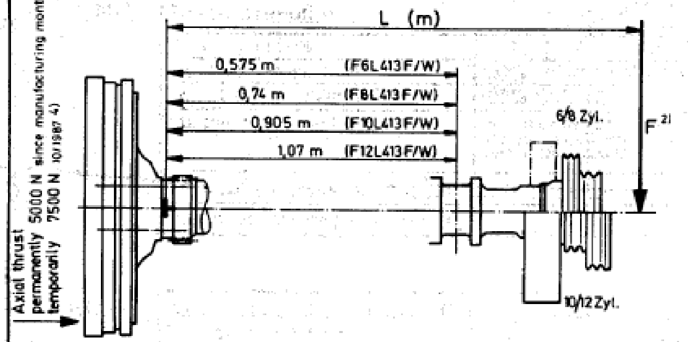



Table 1

| Power take-off on | Flywheel | | | | Crankshaft, front | | | |
|---|---|---|---|---|---|---|---|---|
| No. of cylinders | 6 | 8 | 10 | 12 | 6 | 8 | 10 | 12 |
| Axial power take-of | 100% of max. engine torque | | | | see Table 2, Column 4 | | | |
| Radial power take-off | 100% of max. engine torque with flanged- 3) on outer bearing | | | | Max. adm. $M_B$ and adm. 3 4) (see Diagram 1) (see Table 2) | | | |
| Max. perm.J [kgm²] | Permissible for all flywheels and coupling given in L.U. Tortional Vibration calculation is necessary for rigid drive. | | | | See Table 2 | | | |
| Formula for calculating $M_B$[Nm] | — | | | | $M_B$= F(L-0,575) | $M_B$= F(L-0,74) | $M_B$= F(L-0,905) | $M_B$= F(L-1,07) |
| Rad. power take-off perm. $M_B$[Nm] | — | | | | See Diagram 1 | | | |

Table 2

| Axial and radial power take-off at crankshaft front | | | | max. permissible moment of inertia J [kgm²] of rigid coupled additional parts. Additional parts are, for instance, stubshaft, primer parts of flexible coupling, V-belt pulleys (excluded, 4-grooved standard V-belt pulley and vibration damper) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Engine | Vibration damper | Quality of screws | Torque 1) [Nm] | n Engine [1/min] 1500 | 1800 | 2000 | 2150 | 2300 | 2500 | 2650 |
| F6L 413F/W | w/o | 12.9 | up to 555 | 0,4 | 0,4 | 0,3 | 0,25 | 0,2 | 0,1 | 0,06 |
| F8L 413F/W | with | 12.9 | up to 740 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 |
| F10L 413F/W | with | 12.9 | up to 231 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 |
| | | | up to 462,5 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 |
| | | | up to 694 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 |
| | | | up to 925 | 0,25 | 0,25 | 0,25 | 0,25 | 0,25 | 0,25 | 0,25 |
| | | | up to 832,5 | 0,4 | 0,4 | 0,3 | 0,3 | 0,3 | 0,25 | 0,15 |
| F12L 413F/W | with | 12.9 | up to 1110 | 0,4 | 0,3 | 0,25 | 0,25 | 0,25 | 0,2 | 0,15 |

1) Formula for calculating power which can be transmitted $P = \frac{M[Nm] \cdot n[1/min]}{9549,3}$ [kW]

2) Calculation of force „F" at V-belt drive $F = 2S \cdot \sin\frac{\gamma}{2}$ [N]

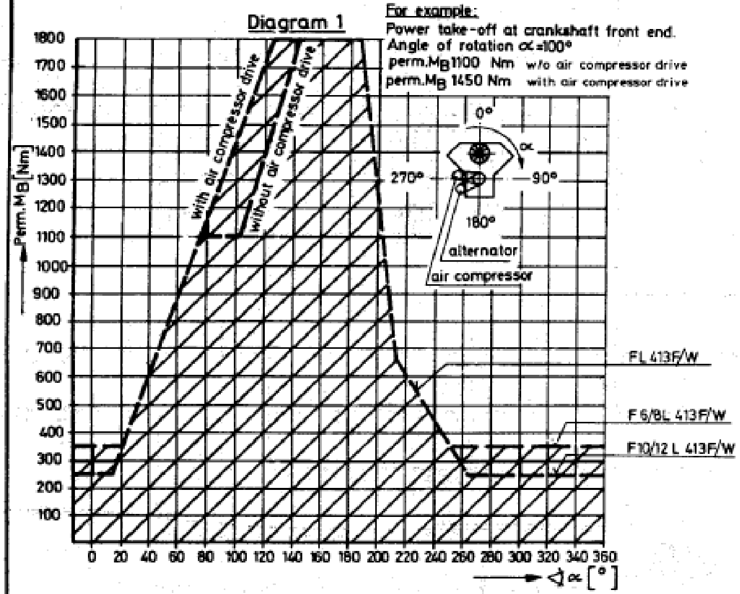
3) If "without flanged-on outer bearing" the fitting must be tested by Head office.

4) see TR 0148-01-420

**Explanatory notes to diagram 1**

The hatched portion shows the perm. bending moments for rad. power take-off at front end with overhung V-belt pulley depending on the direction of pull (angle α)

Where more than one belt drive is provided, the resulting bending moment and angle of rotation shall apply.




For example:
Power take-off at crankshaft front end.
Angle of rotation α=100°
perm. $M_B$ 1100 Nm w/o air compressor drive
perm. $M_B$ 1450 Nm with air compressor drive

| Klöckner-Humboldt-Deutz AG KHD | Benennung: Power take-off on FL413 F/W |
|---|---|
| Abt.: ABM, ASU, ASJ | Number: 214 9295 UC 0148-99E |
| Dat.: | Correction figure: 1 |

## 7.4 Assembly instructions / axial force load on the pass-fit bearing

If drive systems are flanged to the engine, the contact surfaces must ensure a correct fit; remove the preservation agent.

When tightening the fastening screws, make sure that no axial force is acting onto the pass-fit bearings of the crankshaft. Articulated shafts must permit easy displacement.

**By no means, the axial clearance of the crankshaft must be influenced by clutches or connection elements between engine and drive system.**
**Prior to first starting up, check the axial clearance of the crankshaft.**

Admissible axial force load for the pass-fit bearing:

**FL 909 :** **2600 N** pressure in flywheel direction
**1500 N** traction in flywheel direction
**FL 910 :** **3150 N** pressure in flywheel direction
**3150 N** traction in flywheel direction

| | | |
|---|---|---|
| **B/FL 1011 F / 2011:** | **1500 N permanently** | **2000 N short-term** |
| **B/FM 1011 F / 2011:** | **1500 N permanently** | **2000 N short-term** |
| **B/FL 912 / 913:** | **3000 N permanently** | **5000 N short-term** |
| **B/FL 914:** | **3000 N permanently** | **5000 N short-term** |
| **B/FL 413 / 513:** | **5000 N permanently** | **7500 N short-term** |

# 8. HYDRAULIC OIL COOLERS

## 8.1 General

DEUTZ diesel engines with direct air cooling are equipped upon request with hydraulic air coolers. These coolers are engine-integrated and supplied with cooling air from the engine blower. The blower is laid out so as to ensure an optimized cooling air supply to the cooler and satisfactory engine cooling is guaranteed at all times. Therefore, any arbitrary changes to the precisely matched components of the cooling system are not permissible.

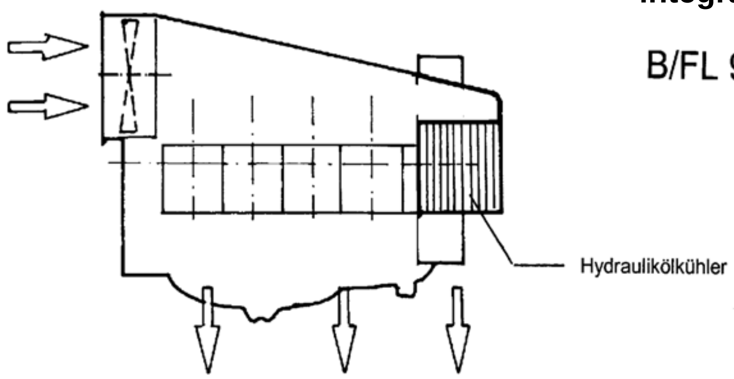
The air-cooled DEUTZ diesel engines with mounted hydraulic oil coolers offer major advantages as no specific cooling unit is required for dissipating the hot air.

**Fig. 8 – 1** **Engine-integrated hydraulic oil cooler**

**Hydraulik oil cooler configurations**
**"Air-cooling"**

**Direct air-cooling with integrated hydr. oil cooler**

B/FL 912/913/914

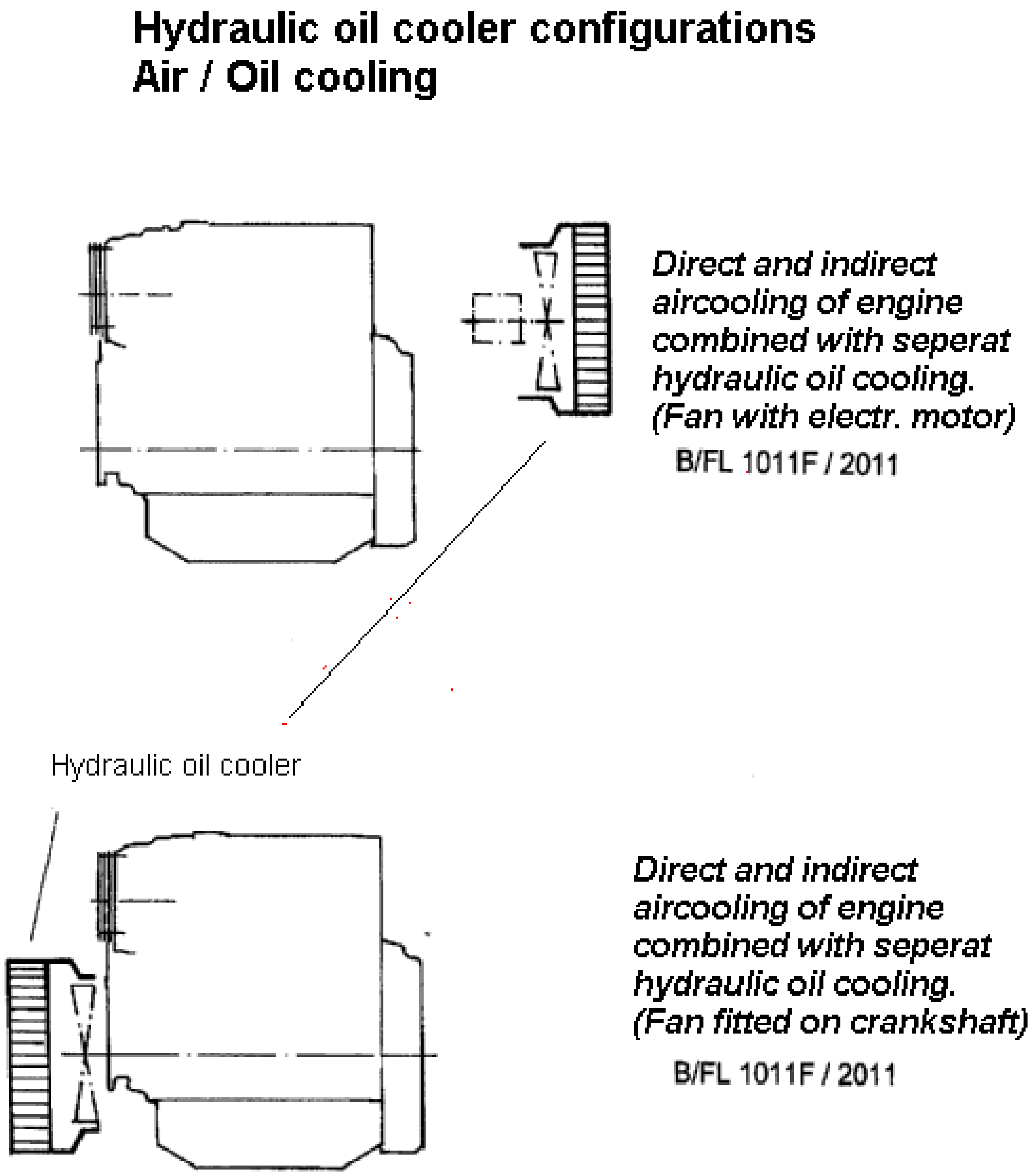



DEUTZ diesel engines featuring combined direct and indirect air cooling (series FL 1011F / 2011) or exclusively indirect air cooling (series FM 1011F / 2011) have no engine-integrated hydraulic oil coolers.

For these, re-cooling systems, consisting of heat exchanger and motor-driven fan, are necessary.

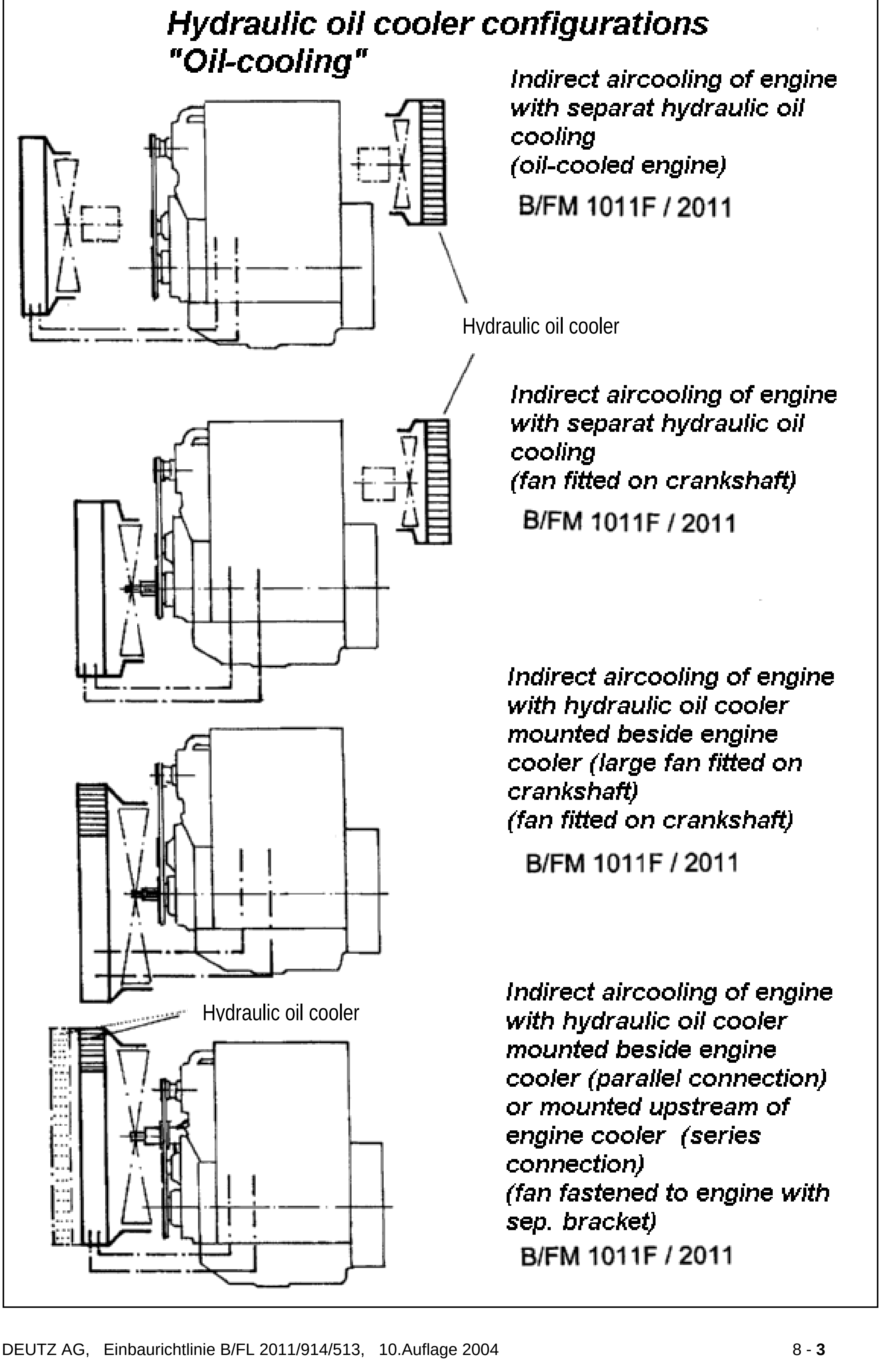
Alternatively, re-cooling systems can be used in which the fan is fitted at the front crankshaft and the oil cooler is mounted separately in front of the fan.

**Fig. 8 - 2** **Separate hydraulic oil cooler**



Alternatively, in engines featuring indirect air cooling (the so-called fully oil-cooled engines B/FM101/2011) the fan can also be mounted on a bracket at the blower end of the engine and driven by a V-belt. The engine oil cooler and hydraulic air cooler are then installed in front of the fan.

**Fig. 8 - 3** **Separate hydraulic oil cooler**



**Cooling performances of the hydraulic oil coolers:**

The cooling capacities which can be achieved by the hydraulic oil coolers can be seen in the diagrams in the technical pocket books.

Q[kW] can be cited as a reference value for the cooling capacity:

B/FM 1011F: Q approx. 31 % of the max. engine performance at ITD* 40 °K and 50 l oil throughput / min.
Pressure resistance of the hydraulic oil cooler 25 bar.

B/FM 2011: Q approx. 14 % of the max. engine performance at ITD* 40 °K and 50 l oil throughput / min.
Pressure resistance of the hydraulic oil cooler 25 bar.

B/FL 914: Q up to approx. 42 % of the engine performance (performance group BII)
at ITD 80 °K and 20 l oil throughput / min and cylinder
at max. rated engine speed depending on the cooler version

B/FL 513: Q up to approx. 44 % of the engine performance (performance group BII)
at ITD 80 °K and 120 l oil throughput / min
at max. rated engine speed depending on the cooler version

*****ITD is the input temperature difference between the oil inlet and the air inlet at the cooler network.

We recommend that you measure the hydraulic oil temperatures during typical working cycles of the equipment so as to verify a sufficient cooling capacity of the hydraulic oil coolers.

In case of deviating cooling air temperatures and cooling air volumes at the hydraulic oil cooler inlet the ITD will decrease and thus reduce the cooling capacity. It is very important to determine the ITD to be able to calculate the reduced cooling capacity.

## 8.2 Installation and connection proposals for hydraulic oil coolers for engines with direct air cooling

Examples of engine series: B/FL 912 / 913 / 914
B/FL 513/413

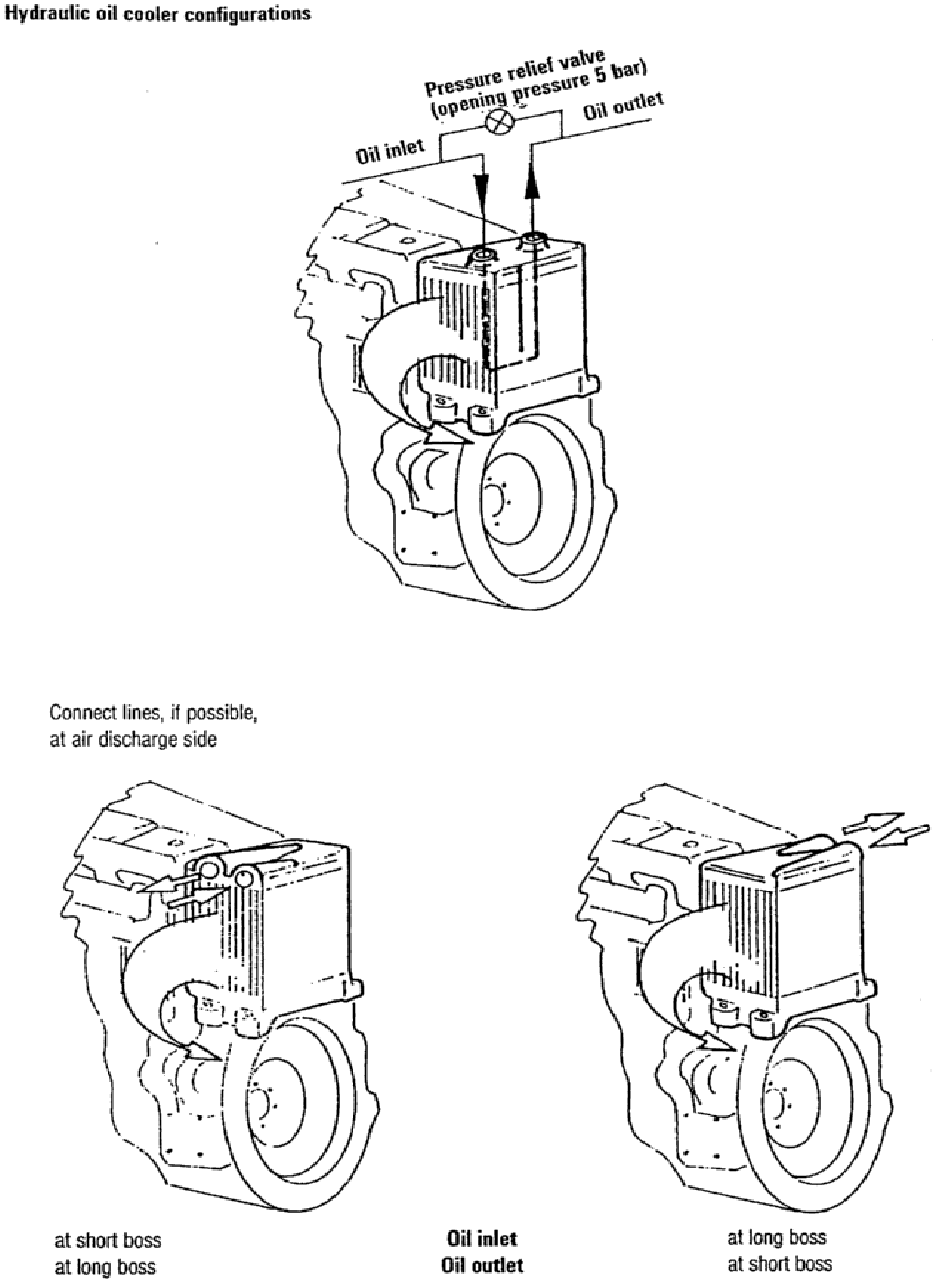
One hydraulic oil cooler will be provided for in-line engines and one or two coolers for V-engines. They will be arranged at the flywheel end or mounted on top of the engine.

In the hydraulic oil coolers mounted by DEUTZ, the oil flow is diverted once and is thus directed twice in the so-called cross-counterflow to the air flow.

The oil inlet is to be provided at the exhaust air side. This results in a more effective cross-counterflow, i.e. the maximum possible heat quantity is dissipated.

## Circuit diagram with one oil cooler on the engine

**Fig. 8 - 4 Engine-integrated hydraulic oil cooler**

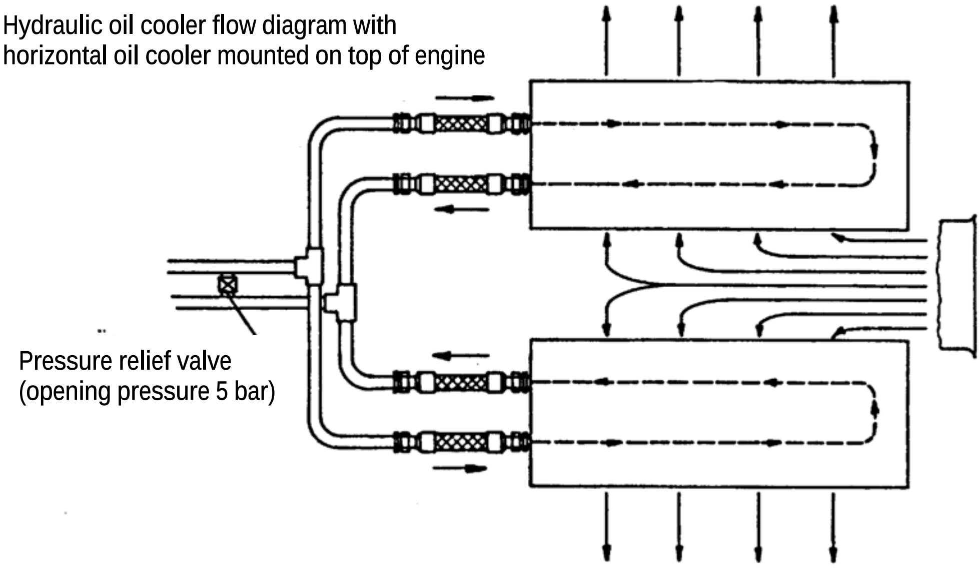



To make full use of the re-cooling capacity and also obtain effective protection against pressure pulses from the hydraulics, we recommend to circulate the hydraulic oil to be cooled in a separate circuit (oil tank – pump – cooler – filter – oil tank) with a separate pump.

## Circuit diagram for two oil coolers above the engine

Two hydraulic oil coolers, when used in V-engines, are best mounted parallel and in cross-counterflow on the oil side. Only with very small oil flow volumes it may sometimes be better to have a series circuit to get an optimum cooling capacity.

**Fig. 8 - 5** **Engine-integrated hydraulic oil cooler**




When the circulating oil flow volume is correctly metered, the flow resistance of a hydraulic oil cooler at service temperature is not more than 1.5 bar; when the hydrostatic system is started with cold oil and pressure increases in front of the hydraulic oil cooler above the maximum permissible operating pressure of 16 bar, it is necessary to install a sufficiently dimensioned short-cut line with a pressure relieve valve which is set to 5 bar.

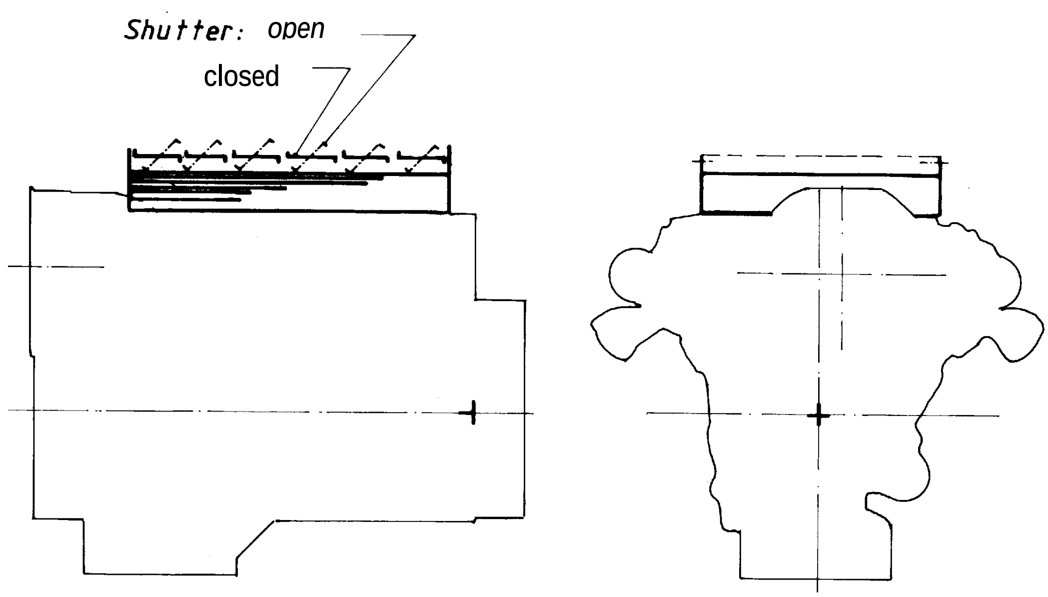
The back pressure in the return line must not exceed 5 bar with the oil being cold.

**Oil cooler for high re-cooling capacity using retarder / transformer** are equipped with a shutter on the air outlet side.

In case of the required cooling capacity the shutter opens 100 % and the assigned regulator of the blower provides full cooling air flow. The air side resistance of the cooler is designed so that most of the supplied air flows under the cooler and does not undercool the engine running at no load.

Further details can be taken from the Service Bulletin 9039/84 of 1984-07-31.

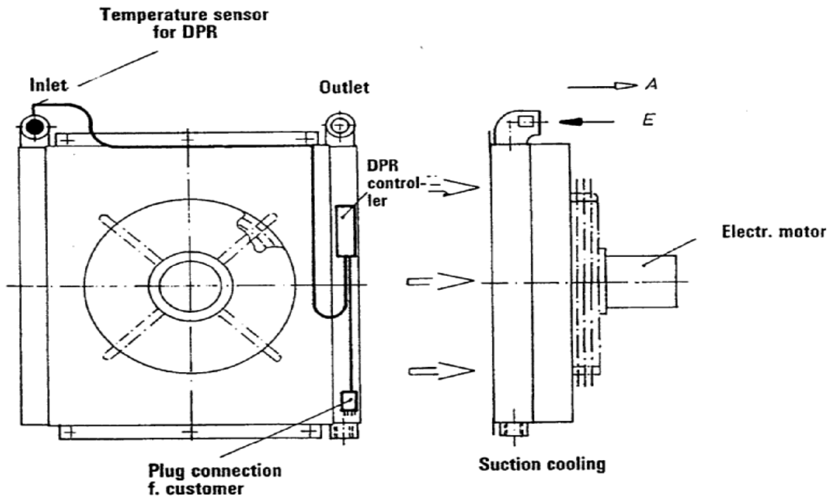
**Fig. 8 - 6**



## 8.3 Installation and connection proposals for hydraulic oil coolers for air cooled engines with combined direct/indirect cooling or with indirect cooling

### 8.3.1 Separate re-cooling systems with fan and electric fan drive

Fig. 8 - 7




This arrangement is available with different re-cooling sizes and motor drives for 12 and 24 V.

**Installation notes:**

- The air inlets and outlets should not be obstructed in any way during installation in order to maintain the nominal cooling capacity.
- The coolers should always be mounted upright as the motor may only be operated in a horizontal position. The drain holes on the motor housing should always point vertically downwards.
- The vertical cooler position is also specified by an integrated temperature controller. For functional reasons said controller must always be installed in a vertical position (cable outlet downwards) – admissible variations from the vertical ± 15°.
- The oil connections of the cooler must be on top so as to ensure automatic breathing. If the cooler installation position must be changed by 90° so that one oil connection is on top only, the temperature controller must be turned by 90° as well.
- When installing extended pipes or lines at the oil-end cooler connections, the screw unions must be tightened with utmost care. It is absolutely necessary to counterhold at the cooler bosses using appropriate wrenches.
- If the temperature controller has no failsafe circuit, an additional oil temperature monitor must be installed.
- Cleaning the fan and electric motors with high pressure cleaners is not allowed.
- The motors should be resistant to steady-state ambient temperatures of up to 90°C.

- The coolers should be flexibly mounted – however depending on the installation position in relation to the diesel engine and frame stiffness as well as design layout of the flexible engine mounting the hydraulic oil cooler may also be rigidly mounted.

- The oil pressure resistance of the coolers must be observed (operating pressure / bursting pressure).

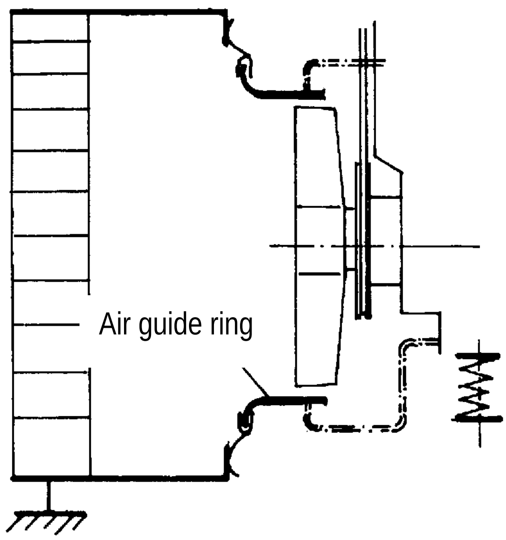
### 8.3.2 Separate recooling systems with fan on the engine crankshaft

The heat exchangers described under 8.3.1 are also used in this case – they, too, serve as engine oil coolers of the fully oil-cooled engines B/FM 1011 F and B/FM 2011.

As the fan is mounted to the crankshaft, the cooling capacity is no longer constant due to varying engine speeds.

To increase the air volume flow rate, the fans can operate in so-called fan rings. Such rings are rigidly mounted to the engine so as to allow a minimum radial gap between fan and ring.
If necessary, extending edges may have sealing contact with the fan ring and its inlet.

**Fig. 8 - 8**




For further information about the cooler / fan arrangement, see the chapter “B/FM 1011F / 2011- Engine cooling“.

# 9. AIR COMPRESSOR

## 9.1 Drive / installation position

The air compressors attached to air-cooled DEUTZ diesel engines for supplying the compressed air systems are driven either via the gearwheel drive or by a V-belt drive.

Please see the Technical Pocket Book (**El**ectronic**TA**schen**B**uch [Pocket Book]) for possible mounting variations of the individual series – please contact head office if you have any questions.

## 9.2 Compressor / sizes

The compressors are used as

| | |
|---|---|
| Single-cylinder compressor | (110.150.293.300 cm³ stroke) |
| Two-cylinder compressor | (600 cm³ stroke) |

## 9.3 Pipe connections / pipe design

All pipes connected to the compressor must be connected in a permanently sealing and air-tight manner; they must be laid torsion-free and must internally be absolutely clean (free from foreign bodies rust, scale or similar).

**Intake line** (connection 0 at cylinder head -. see circuit diagram compressor)

- The intake air for the compressor must always be taken from the combustion air line (if, possible, always vertically from the top) between combustion air filter and engine intake pipe or exhaust gas turbocharger. This guarantees good air filtering for the compressor.
- This point must always be arranged in front of the connection for crankcase breathing (as distant as possible) (seen in the direction of flow of the combustion air) to avoid that oil is sucked in by the compressor. The distance to the exhaust gas turbocharger is then enlarged to keep the influence of the compressor intake air pulsation on the exhaust gas turbocharger as small as possible.
- It should also be noted that compressor air removal comes to a stop before a spark plug or before the ether injection (start pilot system).
- A straight or curved length of pipe (minimum bending radius 40 mm) is recommended as a suction nozzle on the compressor cylinder head.
- Because of the relative movement between the connection at the engine and the compressor, a flexible link in the suction pipe is required. Appropriate suction intake pipes with connection to the combustion air system are part of the DEUTZ scope of supply.

If intake lines are provided by the OEM, the following marginal conditions apply:

**Table 1:**

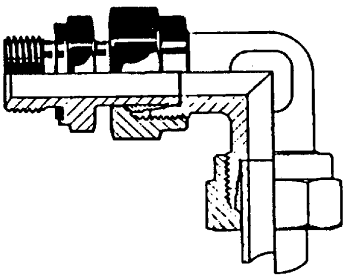
| **Intake pipe length** [m] | **Diameter** [mm] |
|---|---|
| up to 0.3 | ≥ 15 |
| more than 0.3 up to 1.0* | ≥ 22 |
| * Lengths exceeding 1 m are not permitted and require consultation of the compressor manufacturer | |

**Max. admissible intake vacuum pressure: 50 [mbar]**
**Max. admissible intake overpressure: 200 [mbar]**

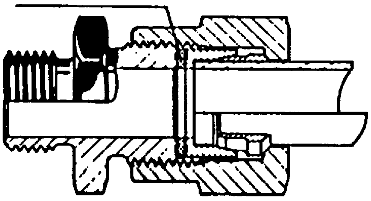
**<u>Pressure pipe</u>** ( connection 2 at cylinder head – see circuit diagram compressor )

- The connection of the pressure pipe to the cylinder head of the compressor shall be made by the customer via a straight pipe screw union as per DIN with metallic sealing ring.
- In its first section, the further pressure line should be laid as straight as possible or, at least, without sharp bends as, otherwise, coke deposits can form in the bends.

**FIG. 9 -1**



**WRONG** (90° bend)




**RIGHT** (straight connection)

- To keep vibrations of the compressor (also due to its attachment to the flexibly mounted engine) off the compressed air system arranged behind, part of the pressure line must be flexibly executed – as pipe helix (which can at the same time serve as cooler for the compressed air) or via pressure hose.

**Table 2: Sizes pressure pipe**

| Pipe length between compressor and following system (pressure governor) | Diameter [ mm ] | Compressor size/kind of cooling [ cm³ ] |
|---|---|---|
| Recommendation:<br><br>maximally up to 4 [m]<br><br>however, see note below | ≥ 15<br>(pipe 18 x 1.5)<br>≥ 15<br>(pipe 18 x 1.5)<br><br>≥ 22<br>(pipe 25 x 1.5) | up to 300 + 600<br>water-cooled<br>up to 300<br>air-cooled<br><br>600<br>air-/oil-cooled |
| NOTE:<br>Pipe lengths exceeding 4m are admissible, but require the assessment of the compressor manufacturer regarding the observation of temperature Successor equipment with respect to their function for summer/winter operation. | For compressors with ESS, the pressure pipe can be reduced to NW 8 mm, if the admissible air intake temperature at the following system is observed (pressure governor/air drier).<br>pressure regulator, max. inlet temperature: ≤ 150 °C<br>air dryer, max. inlet temperature: ≤ 60 °C | |

**Admissible air temperatures in the pressure line:**

If pressure hoses are directly connected to the compressor outlet, their compressive strength must be ensured even at a compressed air temperature of 250 °C.

The max. admissible permanent temperature of the air flow in the pressure socket of the compressor is 220 °C; this temperature is permitted to be exceeded only for a very short time during the filling phase (arrangement of pickup points as directed by the manufacturer). The temperature of the pressure socket is strongly influenced by the counter-pressure, the kind of cooling of the compressor, the intake air temperature and, in particular, the connection time (ED) of the compressor.

A suitable pipe routing must make sure that no condensed water can flow to the compressor or remains in the pipe – therefore, lay pipes with an inclination.

## 9.4 Pressure regulation

When laying out the pressure regulating system, it must be made sure that the pressure governor with its regulating system is matched to the compressor. Pressure governor and the air drier always connected behind are mostly forming one unit. The use of air dryers is always recommended to keep the water off the overall compressed air system.

Observe the installation instructions of the manufacturer.

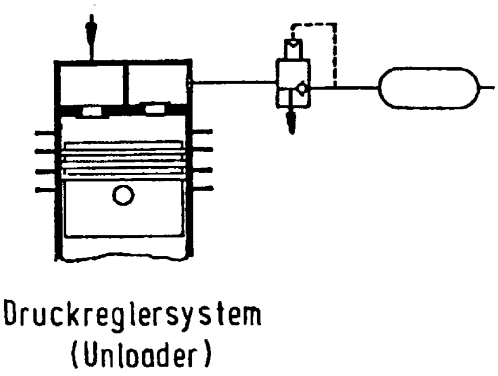
To keep the thermal load on the cylinder heads small, the impact pressure in the pressure line between compressor and pressure governor must not exceed 0.7 bar during the shutting down phase of the compressor.

The following regulating systems are used:

### 9.4.1 System with Unloader (pressure governor)

This regulating system is frequently used in nearly all of the Central European countries including Eastern Europe. As this system relates to compressors without intake valve control (and without ESS), no further details are given here.

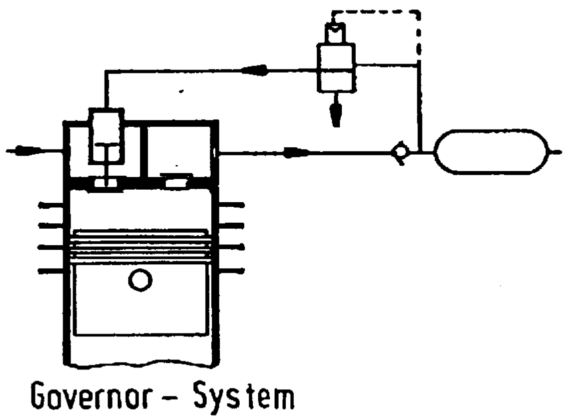
**FIG. 9 -2**




### 9.4.2 System with Governor

This regulating system is predominantly used in the USA, in Sweden, Norway, partly also in England and South-Africa. In the case of this governor regulating system, in the idling phase of the compressor (compressor shutdown), the intake valve of the compressor is opened so that the power consumption of the compressor in the idling phase is distinctly lower than with blowing via pressure regulating valve.

**FIG. 9 -3**



### 9.4.3 Energy saving system ( ESS )

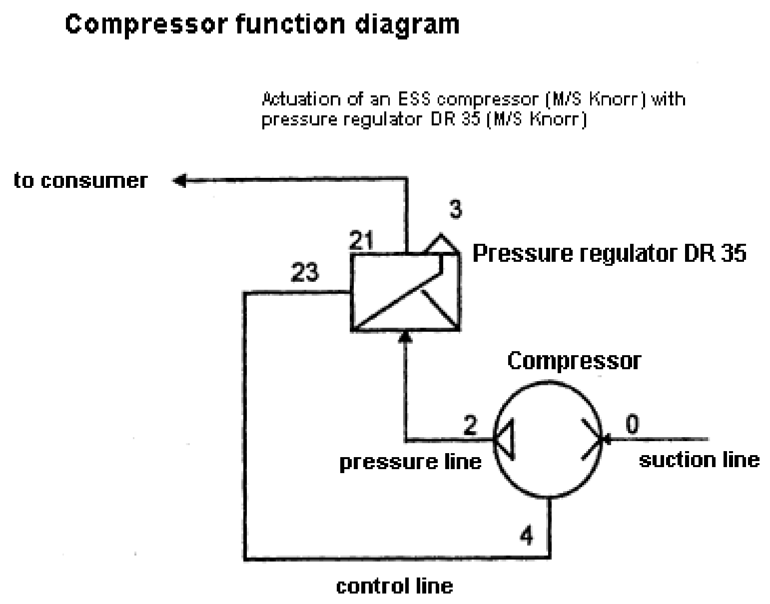
Similar to the governor, in the case of the ESS, regulation takes place on the suction side; however, by a movable disc (plate) and the non-return valve in the inlet compartment, the drawn in air is no more reciprocated in the suction system from one side to the other, but remains in the compression compartment without pressure reversal. In addition, compression work is saved.

Via a unilaterally spring-loaded control piston, the intake disc is moved. In the idling phase, coming from the pressure governor, the pressure of the compressed air system acts as control pressure onto the control piston and displaces it against the spring force, until the limit position (zero delivery) is reached.

If the command "delivery" is given by the pressure governor, the control line is breathed and the control piston is pushed back by the spring and moves the intake discs into position "delivery".

Compressors with ESS and pressure governor must be matched to each other so that the selection of the pressure governor must be assessed by the compressor manufacturer.

**FIG. 9-4**




**<u>Control line</u>** (connection 4 at cylinder head – see circuit diagram compressor)
The control line for the compressor with **ESS** (energy saving system) must laid by the customer with a continuous inclination between the cylinder of the compressor and the pressure governor or the air drier (connection 4).

**Dimensioning of the control line:**
Line length: ≤ 6 [ m ]
Line diameter: NW 4 [ mm ]

If the line length or the nominal width of the control line is increased, trouble-free functioning of the ESS is not ensured.

If the customer renounces the ESS, the connection of the control line at the compressor must be closed with a bore of 2 to 4 mm using a locking screw M 22 x 1.5.

This breathing bore ensures that the control piston clearly remains in its position and the full compressor delivery is always guaranteed.

**Max. total pressure:**
The maximally admissible counter-pressure of the compressors depends on its type and is mostly defined by the OEM via the disconnection pressure in the system. Normally, the disconnection pressure is 8 bar, the compressed air being blown into the open air (compressor without ESS) via separate exhaust air silencers. Such silencers are part of the scope of supply of the compressor manufacturer and are carefully matched.
With ESS-compressors, the air is circularly delivered (recirculation), when the disconnection pressure is reached.
For ESS compressors, a minimal disconnection pressure of 8 bar must be considered.

The max. admissible total pressure values vary between 8 and 19 bar depending on the compressor size and can be requested from the manufacturer.

## 9.5 Cooling/lubrication of the compressor

The compressors integrally attached to the engine are connected to the engine lube oil circuit for lubrication. The hydraulic oil lines are laid on the engine.

The choice of cooling depends on the installation conditions. This can be provided by wind, by blowing from the cooling air store of the engine or by oil cooling.

### 9.5.1 Cooling by wind

The cooling depends on free access of the cooling air to the compressor.

The necessary average cooling air velocity near to the cylinder head
(range approx. 100 mm from the external contours of the cooling fins):

| | |
|---|---|
| for $V \leq 150\ cm^3$ | 4 m/sec at $p \leq 8$ bar<br>6 m/sec at $p > 8$ bar |
| for $V > 150\ cm^3$ | 6 m/sec |

### 9.5.2 Cooling by engine cooling air

#### 9.5.2.1 Air-cooled engines

If the engine is not sufficiently cooled by wind the cooling air store can be tapped through a 10 to 15 mm bore to tap air to blow into the compressor directly through a pipe. The distance of the pipe opening from the compressor (at head height) is abt. 40 to 60 mm.

Please bear in mind that the cooling air from the engine store is not always available in engines with a regulated blower.

### 9.5.2.2 Engines with external cooling systems

In engines such as the BFM2011 with a fan on the crankshaft which operates either as a suction or push-type fan, the compressor is in the air stream of the fan as a result of the installation situation.

### 9.5.3 Oil cooling

The oil-cooled compressors are connected to the lube oil circuit of the engine for cooling. Separate oil circuits are available for cooling and lubrication.

We recommend oil-cooled compressors for encapsulated engine installations.

## 9.6 Compressor design

An air requirement calculation must clarify the required compressor size. Here, it must be clarified, which air requirement is existing for which period of time.

Bear in mind that the compressor connection time (ED) – i.e. compressed air feed – should be abt. 30 to max. 50 % of the total compressor operating time.

Connection time values exceeding 60% are too high and can lead to premature compressor failures. If necessary, values for permanent connection times must be determined by measurements of the delivery- and idling times or extended operating periods (days).

## 9.7 Compressor power take-off for auxiliary steering pump

Optionally, individual compressors are equipped with a power take-off for connecting e.g. auxiliary steering pumps to the compressor crankshaft.
Generally, the power take-off is suitable for a take-off of 10 [kW].

Auxiliary steering pump as per Deutz scope of supply:

Vane cell pumps of ZF
21 [l/min] delivery up to 150 [bar] pressure (without pressure limiting valve)

with intake pipe connection M26x1.5 (12 mm deep) for pipe 19x22
pressure pipe connection M18x1.5 (16 mm deep) for pipe 12x15

# 10 ELECTRICAL EQUIPMENT

## 10.1 Batteries

Electrically started engines draw heavy currents from the battery upon starting. The batteries must be capable of supplying these currents.

In addition to an adequate capacity of the battery, the cold starting behavior of the engine is essentially determined by the cold-start test current (for further details, see DIN 43539, Part 2). You will find the respective values on the battery nameplates.

If a battery with a larger cold-start test current than recommended is used, the starter can become mechanically and thermally overloaded.
If the cold-start test currents are too small, the cold starting behavior deteriorates; the starting function is no more ensured.

**Observe the following when installing the battery:**

- The ambient temperature of the batteries must not exceed 60 °C at a max.
- The acceptability of the battery installation in the engine compartment must be confirmed by temperature measurements.
- Install batteries in an easily accessible position considering possible servicing works, unless "maintenance free" batteries are used.
- Batteries must be fastened such that no natural movements are possible.
- The battery installation space must be well ventilated. Do not install electric switches near the battery in view of the generation of sparks and the risk of explosions.

Servicing instructions and further references may be taken from the documentation of the battery manufacturers.

**Note:**
Standard lead batteries for motor vehicles are not allowed to be used as starter batteries for generating sets within the scope of application of VDE 0108. Nickel-cadmium accumulators or similar batteries are required here, for example.

## 10.2 Starter and battery capacities<br>Battery switch / master controller / starter switch

In view of its short-term high current consumption, the starter is decisive for dimensioning the battery. The starter converts the electrical energy stored in the battery into mechanical energy. It can develop its capacity only, if a battery of sufficient capacity is available.

Maximally admissible maximum cold-start test currents are assigned to the starters; therefore, when assigning starters and batteries, make sure that the data given in table "Assignments starters/batteries" are observed.

Starters can be executed with and without insulated return cable.

The starters must be protected against splash water, road dirt, fuel, oil and excessively high temperatures. If necessary, install a screening plate.

+100 °C as admissible permanent temperature of the starter housing (pole housing) must not be exceeded.

Short-term temperature peaks of up to +120 °C are admissible at the two pickup points "pole housing" and "housing starter solenoid", short-term being defined with a time of 15 min. at a max. and the sum of the events must only be abt. 5 % of the entire operating time.

The maximally admissible housing temperature of the starter solenoid is also +100 °C.

## Notes:

- During welding works, it is best, if the battery remains connected with both poles and also the generator remains connected wit the battery. *This only refers to generators **without** Zener diodes.*

  Generators of today are normally equipped with Zener diodes; therefore, during welding works, both poles of the battery must be isolated to protect further electronic components.

- The so-called external starting (via an additional, external battery) is dangerous without connected battery. When withdrawing the cables from the poles, high inductive phenomena can occur (electric arcs, voltage peaks) and destroy the installed electronic components – unless these are protected against voltage peaks by suitable protection circuits (e.g. recovery diodes).

- Starters are permitted to turn without interruption for a maximum of 1 minute. Then, a waiting time of 3 minutes (cooling down) is necessary prior to the next turning operation. After two starting cycles, a waiting time of 30 minutes is required.

- By a suitable software in the control unit or a start lock relay (see chapter 10.6), the starter is protected against reeling in in the running or slowing down engine. A locking time of at least 6 seconds is recommended.

- Starters must not be cleaned with high-pressure steam cleaners.

- The contacts of the starter terminals 30, 50 must be protected against unintended short-circuiting (jump protection)

- The admissible tightening torques for nuts and screws at starter terminals 30, 50 may be taken form the starter drawings.

- When replacing a starter, check the girth gear on the engine flywheel for damage and check the number of teeth – if necessary replace the girth gear.

- The strength of the cable insulation must stand the max. current at an ambient temperature of +100 °C without being damaged.

- Prior to performing assembly works at the engine in the starter area or at the starter proper, the battery must be isolated.

- Unless otherwise expressly indicated in the individual case, starters are not suitable for being used in an environment with explosion risk.

## Battery switch / master controller / starter switch

- The switches must be protected against dust and water.
- The switches must stand currents (inductive loads) as indicated in the following table:

**Table 1:**

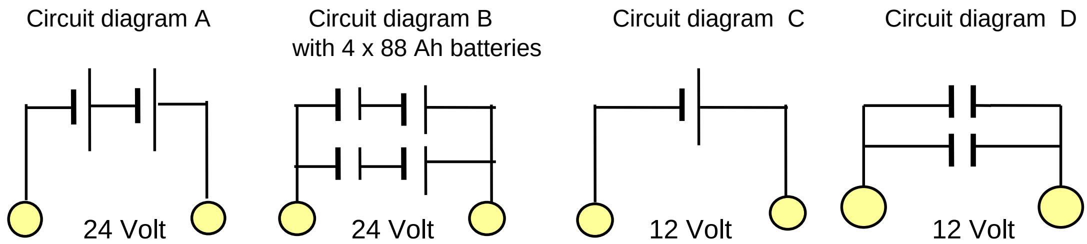
| | 12 Volt system | 12 Volt system | 24 Volt system | 24 Volt system |
|---|---|---|---|---|
| | short-term | permanently | short-term | permanently |
| EV / IF Starter | 60 A | 12 A | 24 A | 7 A |
| KB / QB starter | - - - | 25 A | - - - | 12 A |

- For electrical systems in busses, tramcars, fuelling vehicles etc., battery main switches are specified, with which the board mains can be isolated from the battery.

  In the case of systems with three-phase alternator, an electro-magnetic battery main switch is required. It avoids that the alternator can be isolated from the battery with running engine.

## Table 2: Assignment starter / batteries

Battery cold-start test current and starter motor short-circuit current as a function of the battery and starter motor size at the following temperatures and at 0 % battery discharge.




| Starter power<br>[kW] | Rated voltage<br>[Volt] | Admissible battery capacity<br>[Ah] (27 °C)** | Battery cold test current DIN<br>$I_{kp}$ [A](-18 °C) | Starter short-circuit current $I_k$ [A] +20 °C)* at supply cable resistance 1 [ mΩ ] | Circuit diagram of the batteries | Minimum / maximum admissible total resistance $R_{batt}$ + $R_{supply}$ [ mΩ ] |
|---|---|---|---|---|---|---|
| 1.9 | 12 | 66 | 300 | 890 | C | |
| | | 88 | 395 | 980 | C | |
| | | 110 | 450 | 1030 | C | |
| 2.0 | 12 | 66 | 300 | 890 | C | |
| ISKRA | | 88 | 395 | 980 | C | |
| | | 110 | 450 | 1030 | C | |
| 2.2 | 12 | 66 | 300 | 950 | C | |
| | | 88 | 395 | 990 | C | |
| IF | | 110 | 450 | 1030 | C | |
| | | 143 | 570 | 1110 | C | |
| 2.2 | 12 | 66 | 300 | 1100 | C | 5.20 / 6.50 |
| | | 88 | 395 | 1285 | C | 5.20 / 6.50 |
| EV | | 110*** | 450 | 1325 | C | 5.20 / 6.50 |
| 2.3 | 12 | 66 | 300 | 1100 | C | 4.67 / 6.50 |
| | | 88 | 395 | 1285 | C | 4.67 / 6.50 |
| EV | | 110*** | 450 | 1325 | C | 4.67 / 6.50 |
| | | 143 | 570 | 1325 | C | 4.67 / 6.50 |
| 3.0 | 12 | 88 | 395 | 1420 | C | 3.09 / 4.67 |
| | | 110 | 450 | 1420 | C | 3.09 / 4.67 |
| EV | | 143 | 570 | 1560 | C | 3.09 / 4.67 |
| | | 210 | 700 | --- | C | 3.09 / 4.67 |
| | | 176 = 2x88 | 790 | 1750 | D | 3.09 / 4.67 |
| | | 225 | 680 | --- | C | 3.09 / 4.67 |
| 3.0 | 12 | 88 | 395 | 1150 | C | 3.09 / 4.67 |
| | | 110 | 450 | 1150 | C | 3.09 / 4.67 |
| IF | | 143*** | 570 | 1250 | C | 3.09 / 4.67 |
| | | 210 | 700 | 1325 | C | 3.09 / 4.67 |
| | | 176 | 790 | 1480 | C | 3.09 / 4.67 |
| | | 225 | 680 | 1325 | C | 3.09 / 4.67 |
| 3.1 | 12 | 88 | 395 | 1380 | C | 3.09 / 4.67 |
| | | 110 | 450 | 1445 | C | 3.09 / 4.67 |
| IF | | 143 | 570 | 1600 | D | 3.09 / 4.67 |
| | | 176 | 790 | 1790 | D | 3.09 / 4.67 |
| 3.2 | 24 | 55 | 255 | 780 | A | 12.00 / 18.00 |
| IF | | 66 | 300 | 835 | A | 12.00 / 18.00 |
| 4.0 | 24 | 66 | 300 | 1200 | A | 8.40 / 12.00 |
| | | 88 | 395 | 1300 | A | 8.40 / 12.00 |
| EV | | 110*** | 450 | 1400 | A | 8.40 / 12.00 |
| | | 170 | 600 | 1400 | A | 8.40 / 12.00 |
| | | 210 | 700 | 1400 | A | 8.40 / 12.00 |
| | | 225 | 680 | 1400 | A | 8.40 / 12.00 |
| 4.0 | 24 | 66 | 300 | 940 | A | 8.40 / 12.00 |
| | | 88 | 395 | 1050 | A | 8.40 / 12.00 |
| IF | | 110*** | 450 | 1100 | A | 8.40 / 12.00 |
| | | 170 | 600 | 1100 | A | 8.40 / 12.00 |
| | | 210 | 700 | 1100 | A | 8.40 / 12.00 |
| | | 225 | 680 | 1100 | A | 8.40 / 12.00 |

| **Starter** power [kW] | **Rated** voltage [Volt] | **Admissible battery capacity** [Ah] (27°C)** | **Battery cold test current** DIN $I_{kp}$ [A](-18°C) | **Starter short-circuit current** $I_k$ [A] (+20°C)* at supply cable resistance 1 [ mΩ ] | **Circuit diagram of the batteries** | **Minimum / maximum admissible total resistance** $R_{batt}$ + $R_{supply}$ [ mΩ ] |
|---|---|---|---|---|---|---|
| 4.8 | 24 | 66 | 300 | 1090 | A | 8.40 / 11.50 |
| | | 88 | 395 | 1170 | A | 8.40 / 11.50 |
| IF | | 110*** | 450 | 1270 | A | 8.40 / 11.50 |
| | | 170 | 600 | 1270 | A | 8.40 / 11.50 |
| | | 210 | 700 | 1270 | A | 8.40 / 11.50 |
| | | 225 | 680 | 1270 | A | 8.40 / 11.50 |
| 5.4 | 24 | 88 | 395 | 1520 | A | 6.80 / 9.00 |
| | | 110 | 450 | 1620 | A | 6.80 / 9.00 |
| KB | | 143*** | 570 | 1760 | A | 6.80 / 9.00 |
| 6.6 | 24 | 110 | 450 | 1600 | A | 5.20 / 8.40 |
| | | 143 | 570 | 1750 | A | 5.20 / 8.40 |
| KB | | 176*** | 790 | 2000 | B | 5.20 / 8.40 |
| 9.0 | 24 | 143 | 570 | 2080 | A | 4.70 / 7.00 |
| | | 176 | 790 | 2260 | B | 4.70 / 7.00 |
| QB | | 220*** | 900 | 2580 | B with 4x110Ah | 4.70 / 7.00 |

**Note:** Missing values were not available at the time of going to print; these will be added successively.

The greatest cold test current specified in every line gives the maximum admissible battery for the corresponding starter.

***** The short-circuit current at a temperature of the battery acid of +20 °C is taken as a basis for the maximal starter current; this results in the largest cable cross sections.
The short-circuit current of a starter is a function of the size (cold-start test current), the temperature and the charging condition of the used battery.

****** Larger battery capacities should not be used in connection with the individual starter sizes as, otherwise, the starter can become thermally and mechanically overloaded.
Largest available and common individual battery capacity is 210 Ah/700 A.

**Note:**
If greater battery capacities with greater cold test currents than specified here are used, greater supply line resistances are required to comply with the minimum admissible total resistance of internal resistance of the battery and supply line resistance.
If necessary, contact application engineering or the starter manufacturer (Messrs. Bosch).

*** This battery capacity is absolutely essential if the max. cold-start limit temperature of the engine (assignment starter – engine type as per pocket book) must be reached. The minimal supply cable resistance of the starter main cable (advance/reverse) with 1 Milliohm must be observed.

**Starter 12V 3kW for engine family 2011 / 1011F:**

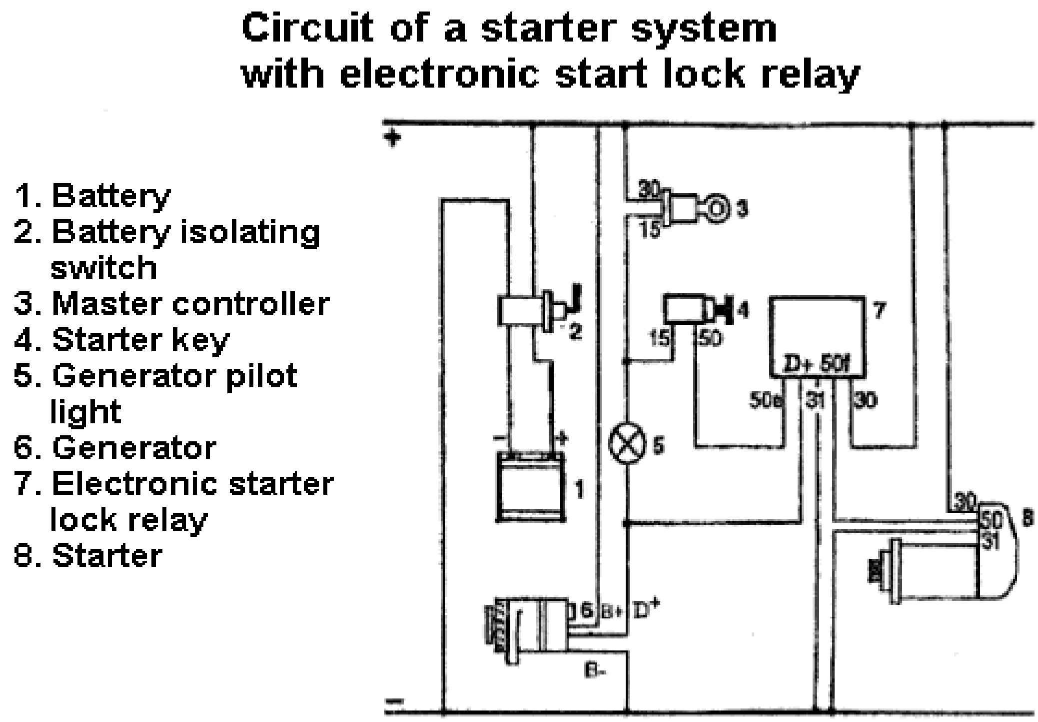
This starter has to be used always for following reasons:

- In the application larger battery size as suitable for the 2,3 kW starter are used
- Remote start kit designed for bigger starters is often used at this equipment, e.g. equipment on air ports
- Start happens often near could start limit or with high parasitic load or long starter run time (approx. 30sec).

## 10.3 Dimensioning of the starter main cable

(cable between terminals 30, 31 of starter and battery)

Bild 10-1




### 10.3.1 Required rated cross section considering heating up of the cable (minimum cross section)

We recommend to determine the required minimum cross section of the starter main cable (between starter and battery) with the maximal short circuit current $I_K$ occurring at the starter to exclude restrictions when selecting the battery.

**For classified on-board systems, the following calculation is not admissible. Here, only the specifications of the respective classification society must be observed.**

The determination of the minimum cross section by calculation is made considering heating up of the cable at a short-term admissible cable charge of 30 A/mm2 taking the following relation as a basis.

$$\mathbf{q} = \frac{I_K}{I_L} = \frac{\mathbf{I_K}}{\mathbf{30}} \ (mm^2) \text{ with}$$

$I_K$ = Short-circuit current of the starter at +20 °C [A]

$I_L$ = Admissible cable load [A/mm$^2$]

This minimum cross section **q** must not be fallen below.

## 10.3.2 Required rated cross section of the starter main cable

For laying out the starter main cable, the total resistance of the system – comprising the line resistances of the supply and return line, transition resistances and the internal battery resistance - must be considered

$$R_{total} = R_{admissible\ line\ supply} + R_{admissible\ line\ return} + R_{transition} + R_{intern.\ battery}$$

Depending on the starter size, an total resistance $R_{total}$ must be observed which is within the specified limits (see quotation drawing to the starter and basic specification of Bosch). Thus, the individual resistances and, consequently, cross sections, batteries and cable lengths can be selected such that the admissible range is observed.

If the minimal total resistance is fallen below, there is the risk of mechanical and thermal damage to the starter.
If the maximally admissible total resistance is exceeded, functional failures and power losses of the starter must be expected (caution in case of busses and ships in view of the long cables).

Power losses of the starter lead among other things to poor cold starting behavior of the diesel engine (e.g. failure to reach the cold starting limits due to low cranking speed). The starter reaches its maximum power at min. admissible total resistance.

**Calculation of the line resistance:**
With the minimum cross section (considering the line heating up) calculated before, the line resistances can be determined on the basis of table "copper line cross sections".

Frequently, parts of the body or the frame are used as return line. Here, the same resistance value must be assumed as for the supply line from battery to starter.

If ground return line is selected, it must be particularly made sure that the bridging resistances by ground leads are avoided. The cross section of the ground leads should at least maintain the cross section of the plus line.

**Make sure that the ground cable "from battery to ground at diesel engine” is clamped in the close vicinity of the starter (potential restriction).**

**Calculation transition resistance:**
The transition resistances are strongly differing and cannot be calculated on a common basis. Especially in applications with many transitions or when using a battery isolating switch, it is recommended to repeat the measurement.

**Calculation battery resistance:**
The battery resistance at +20 °C is not known, but can be calculated from the cold-start test current $I_{KP}$ indicated on the battery as per DIN 43539 (30 sec discharge time, 9 V minimal voltage).

| | | | |
|---|---|---|---|
| For 12 V systems: | $R_{iBatt\ +20\ °C}$ | = | 2400 x (0.687 / $I_{KP}$) |
| For 24 V systems: | $R_{iBatt\ +20\ °C}$ | = | 4800 x (0.687 / $I_{KP}$) |

Beyond DIN standard, the cold-start test current is often also indicated as per SAE, BCI or DIN EN (10sec discharge time, 7.5V minimum voltage).

According to SAE, BCI and DIN EN 60095-1 (will become DIN EN 50342), the value for the battery resistance is larger by the factor 1.66 than according to DIN 43539. This must be considered in the above equation.

In rare cases, IEC (60 sec. discharge time, 8.4 V minimum voltage) is applied. Here, the conversion factor to DIN 43539 is 1.15.

These data only apply to lead acid batteries.

## Example: Determination of the rated cross section of the starter main cable

**Installed lead acid battery** as per DIN 45539:
1x12 V, 143 Ah, $I_{KP}$ = 570 A, $I_K$ = 1560 A
(see table "Assignment starter/battery")

**Installed starter:**
3.0 kW, 12 V with admissible total resistance $R_{total}$ = 3.09... 4.67 [mΩ]
(see table "Assignment starter/battery")

| **Cable length** | | |
|---|---|---|
| | Battery for starter terminal: | 3.0 m |
| | Return cable starter to battery: | 3.0 m |
| | Total cable length: | 6.0 m |

Cable cross section = **? admissible** Line resistance = **? admissible**

### a) Determination minimum cross section:

Minimum cross section starter main cable: $q = I_K / I_L = I_K / 30 = 1560/30 = 52{,}0 \text{ mm}^2$

Selected: $q = 70 \text{ mm}^2$

### b) Determination rated cross section:

With 70 mm² as selected rated cross section, the line resistance results from table “copper line cross sections“

$R_{Line}$ = 0.259 x 6.0 [mΩ/m x m = mΩ] = 1.554 [mΩ]

Transition resistance: Measuring proof required, neglected here, however.

| | | | |
|---|---|---|---|
| Internal battery resistance: | $R_{iBatt +20°C}$ | = | 2400 x (0.687 / $I_{KP}$) |
| | | = | 2400 x (0.687:570) |
| | | = | 2.892 [ mΩ ] |
| Total resistance: | $R_{total}$. | = | $R_{iBatt +20°C} + R_{Line}$ |
| | | = | 2.892 + 1.554 = 4.446 [mΩ ] |

### c) Result:

**The total resistance is within the limits of the admissible total resistance of 3.09 ... 4.67 [mΩ], i.e. the selected rated cross section can be maintained for the above-mentioned line length.**

The required minimum cable length $L_{min}$ results from

$R_{total}$. - $R_{iBatt +20°C}$ = $R_{Line}$
3.09 - 2.892 = 0.259 x $L_{min}$
It follows that: $L_{min}$ = 0.76 [ m ]

This length $L_{min}$ must not be fallen below.

### d) Observation of the engine cold starting limit :

To observe the supply line resistance 1 mΩ as pre-condition for reaching the cold starting limit, the supply line cross section is increased from 70 to 95 mm².
The following results from table "copper line cross section"

$R_{Line}$ = 0.196 x 6.0 = 1.176 [mΩ] > 1 [mΩ]

Then, the total resistance for reaching the cold starting limit is:

$R_{total}$ = $R_{iBatt +20°C} + R_{Line}$
= 2.892 + 1.176 = 4.068 > 3.09 [mΩ].

---

To reach 1 [mΩ] more precisely, the supply line must additionally be shortened by 0.90 m.
The following results: $R_{Line}$ = 0.196 x 5,10 = 0.999 [mΩ]
Then, the total resistance for reaching the cold starting limit is:

$R_{total}$ = $R_{iBatt +20°C} + R_{Line}$
= 2.892 + 0.999 = 3.891 > 3.09 [mΩ].

---

Alternatively, the line could be used with 70mm², however, it would have to be shortened to a length of abt. 3.87 m $R_{Line}$ = 0.259 x 3.87 = 1.002 [mΩ]
Then, the total resistance for reaching the cold starting limit is:

$R_{total}$ = $R_{iBatt +20°C} + R_{Line}$
= 2.892 + 1.002 = 3.894 > 3.09 [mΩ].

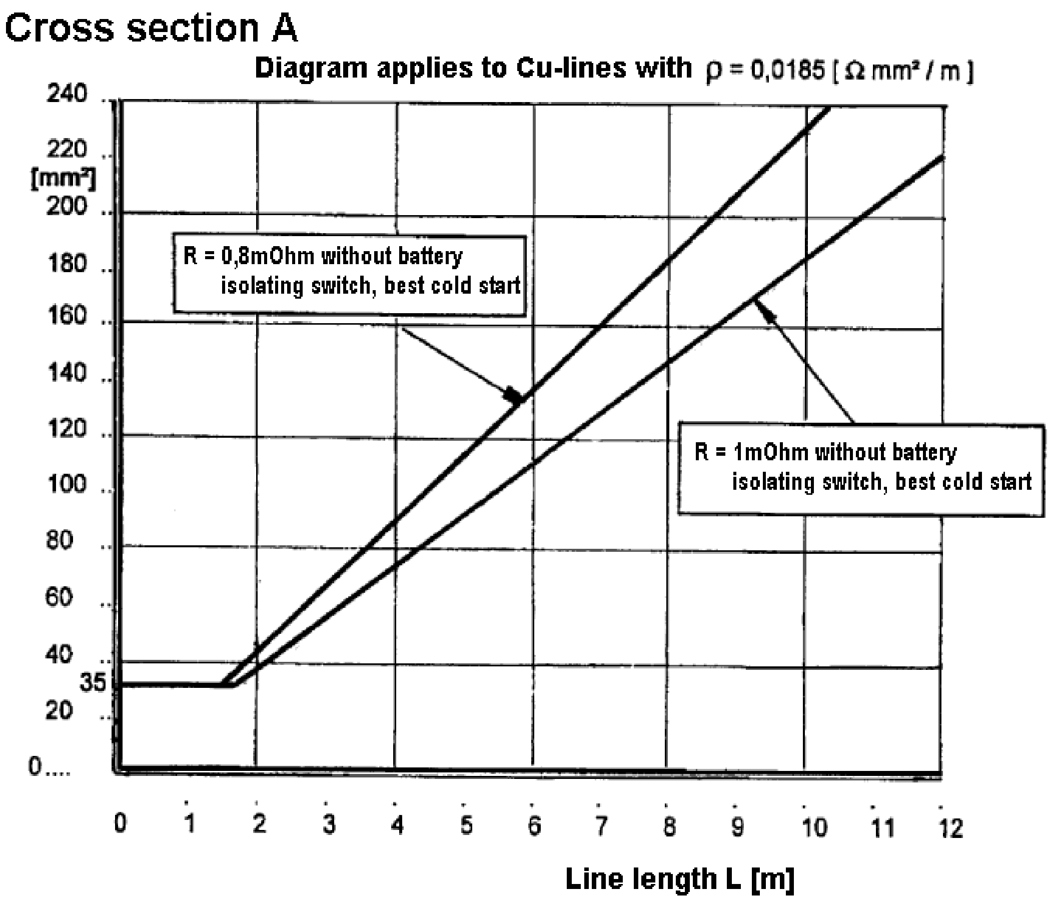
---

In this way, from the electrical side, the pre-conditions for reaching the maximally possible cold starting limit of the diesel engine are given with this starter and battery equipment.

### 10.3.3 Graphical determination of the cable cross section for the starter main and ground cable:

If the cable routing between battery plus pole and starter terminal 30 represents an individual and direct connection and does not comprise branches, then, and only then, the following diagram can be used for determining the cable cross section. The line resistance in this case is 1 mΩ (for supply and return line) - with the installation of a battery isolation switch, the line resistance is 0.8 mΩ.

**FIG. 10 -2**




| | | |
|---|---|---|
| Example: | Total length: | 6 m |
| | Required cross section: | 110 mm² |
| | Selected: | 120 mm² (1 mΩ - line as per table "copper line cross sections") |

The diagram lines result from:

$\mathbf{A} = [\,\mathbf{I} \times \rho \times \mathbf{L}\,] / \mathbf{U}$ with $\mathbf{U} = \mathbf{R} \times \mathbf{I}$ and $\rho$ **= 0,0185** ( Ωx mm² / m )

i.e.

$A = [\,\rho \times L\,] / R$ (mm²)

$A = [\,0.0185 \times L\,] / R$ (mm²) with R ( Ω ) and L ( m )

## 10.4 Dimensioning of the control cable to the starter (from battery via starter switch to terminal 50 at starter)

To secure starter functioning at maximally admissible ambient temperature, the effective supply line resistance Rmax – determined between battery plus pole and terminal 50 at starter – is permitted to be only within the range given by the manufacturer in his quotation drawing.

The data apply to any operation of the starter.

Dimensioning of the cables is made via recording of individual electrical resistances, contact resistances and individual currents of additional consumers.

The effective control cable resistance determined such must be checked by current and voltage measurements with defined resistances (instead of the picking up relay).

### 10.4.1 Required rated cross section of the control cable in engines without cable harness as per Deutz scope of supply:

The rated cross section of the control cable is determined by determining the supply line resistance of the control cable between battery plus pole via starter switch up to terminal 50 (switch relay starter).
The limit values to be observed for the line resistances $R_{max}$ of the control cables are a function of size and type of the starter and may be taken from the respective quotation drawing of the starter manufacturer.

As supply line resistances of the control line between terminal 50 and the battery plus pole it applies for the following starters for max. 120 °C temperature function limit:

**Table 3: Admissible resistances $R_{max}$ of the control line**

| Starter Type | Power [kW] | Rated voltage [V] | Max. admissible control line resistance $R_{max}$ in [ mOhm ] at 100 °C | at 120 °C |
|---|---|---|---|---|
| | 1.9 | 12 | | |
| | 2.0 | 12 | | |
| | | | | |
| | 3.2 | 24 | | |
| | | | | |
| EV | 2.2 | 12 | | |
| EV | 2.3 | 12 | | 32 |
| EV | 3.0 | 12 | | 32 |
| | | | | |
| EV | 4.0 | 24 | | 115 |
| | | | | |
| IF | 2.2 | 12 | | 37 |
| IF | 3.0 | 12 | | 10 |
| IF | 3.1 | 12 | | 32 |
| | | | | |
| IF | 4.0 | 24 | 10 | |
| IF | 4.8 | 24 | 10 | |
| | | | | |
| KB | 5.4 | 24 | | 185 |
| KB | 6.6 | 24 | | 92 |
| | | | | |
| QB | 9.0 | 24 | | 92 |

**∗ Missing values were not available at the time of going to print; these will be added successively.**

On the basis of the relation

| | | | | |
|---|---|---|---|---|
| $R = q_R \times L$ | mit | $L$ | = | line length [m] |
| | | $q_R$ | = | spec. Line resistance [mΩ/m] |

the maximum admissible resistance of the control cable per line length is determined by the resolution according to $q_R$ and with the $R = R_{max}$ – value (m ?) and the available control line length L (m):

$$q_{min} = R_{max} / L \quad \text{( m? / m)}$$

The corresponding **rated cross section A [mm²] for the control cable** is selected from the “copper line cross sections” table.

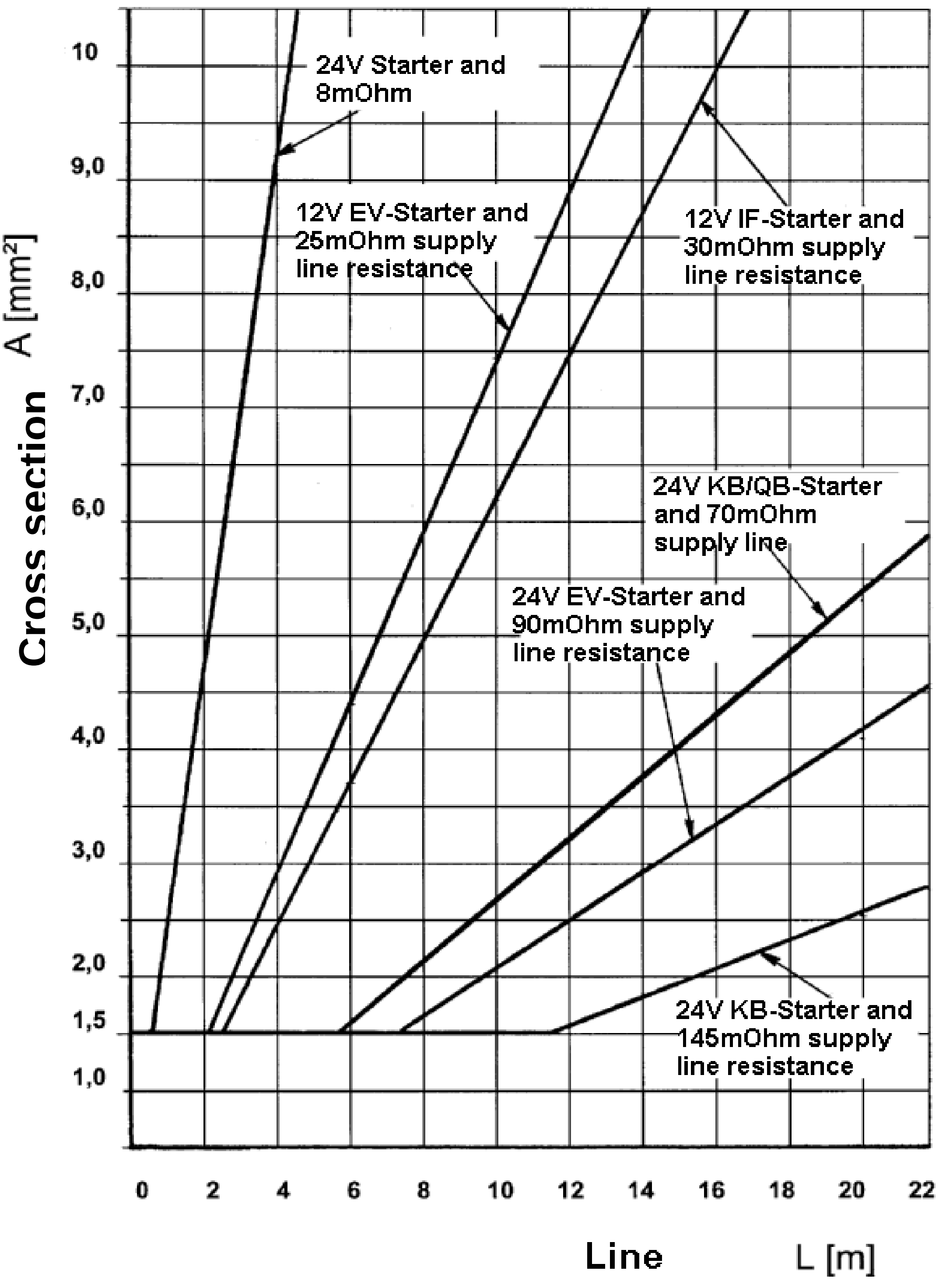
### 10.4.2 Graphical determination of the control cable cross section for engines without cable harness as per Deutz scope of supply:

Only if the control cable is laid as an individual, separate line between battery – starter switch –terminal 50 – **then and only then, the following diagram is permitted to be used for finding the cable cross section between battery plus pole, starter switch and terminal 50.**

The following resistance losses for terminal connections/contacts are already taken into account.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | mΩ | **24V / IF** | 4.0/4.8 | kW | i.e. | $R_{tot.\ control\ cable}$ | = 8 | mΩ |
| 7 | mΩ | **12V / IF** | 2.2 | kW | i.e. | $R_{tot.\ control\ cable}$ | = 30 | mΩ |
| 7 | mΩ | **12V / EV** | 2.3/3.0 | kW | i.e. | $R_{tot.\ control\ cable}$ | = 25 | mΩ |
| 22 | mΩ | **24V / KB** | 6.6 | kW | i.e. | $R_{tot.\ control\ cable}$ | = 70 | mΩ |
| 22 | mΩ | **24V / QB** | 9.0 | kW | i.e. | $R_{tot.\ control\ cable}$ | = 70 | mΩ |
| 25 | mΩ | **24V / EV** | 4.0 | kW | i.e. | $R_{tot.\ control\ cable}$ | = 90 | mΩ |
| 40 | mΩ | **24V / KB** | 5.4 | kW | i.e. | $R_{tot.\ control\ cable}$ | = 145 | mΩ |

**FIG. 10-3** Diagram only applies to Cu-lines with $\rho = 0.0185$ [Ω x mm²/m]




The diagram lines are given by A = [ 18.5 x L ] / R (mm²) with R (mΩ) and L ( m )

### 10.4.3 Required rated cross section of the control cable in engines <u>with cable harness</u> as per Deutz scope of supply:

The line resistance of the control cable in the cable harness of the engine must be taken into account in determining the cross section for the remaining length of the control cable which the customer wishes to lay.

That means that, from the specified resistance values for the entire control cable, the resistance value $R_{Part}$ of the control cable integrated in the engine cable harness must be deducted.

The result is the line resistance $R_{max,\ residue}$ for determining the cross section of the residual length of the control cable to be laid by the customer.

The line resistances of the control cables in the engine cable harness $R_{part\ control\ line}$ are obtainable from the acquisition staff.

With the limit values for the line resistance $R_{max}$ to be observed for the control cable – as a function of size and type of the starter – the following maximum resistance for the respective residual control cable between terminal 50 and the battery plus pole results:

$$R_{max,residue} = R_{max} - R_{Part\ control\ cable}$$

e.g.
$\mathbf{R_{max,residue} = 115 - 16.7 = 98.3\ [m\Omega]}$
for Bosch 24 V-EV-Starter 4.0 kW and a fictitious line resistance of the control cable in the engine cable harness

If contact resistances in the control cable still need to be considered, these values must be subtracted from $\mathbf{R_{max,rem}}$ before the rated cross section calculation continues.

Now, the rated cross section A for the control cable can be determined as follows:

## Method 1:

On the basis of the relation

$$\mathbf{R_{max,residue} = q_R \times L_{Part\ control\ cable}}$$ with $L$ = length [m] of residual control cable, $q_R$ = spec. line resistance [mΩ/m]

can be found via

$$\mathbf{q_R = R_{max,residue} / L_{Part\ control\ cable}} \quad [m\Omega / m]$$

using the determined value of $q_R$, the pertaining rated cross section A [mm$^2$] of the control cable can be found in table "Copper line cross sections".

## Method 2:

On the basis of the relation

$$\mathbf{R_{max,residue} = [\, L_{Part\ control\ pipe} \times \rho \,] / A}$$

with

$\rho$ = 18.5 (mΩ mm² / m) as spec. resistance for copper lines

the rated cross section A is determined as follows:

$$\mathbf{A = [\, L_{Part\ control\ line} \times \rho \,] / R_{max,residue}} \quad [mm^2]$$

| | | |
|---|---|---|
| with | $L$ | [m] |
| | $R_{max,residue}$ | [ mΩ ] |
| | 18.5 | [mΩ mm²/m] |

Result:

$$\text{Rated cross section } \mathbf{A = 18.5 \times L_{Part\ control\ cable} / R_{max,residue}} \quad [mm^2]$$

### 10.4.4 Checking by measurement of the effective supply line resistance with existing cable harnesses

Measuring the supply line resistance of the starter main cable and the control cable can only be determined with sufficient accuracy during the start process with the actual installation. All additional consumers which may be connected during the start process must be switched on. Measurements by equivalent resistances have proved too inaccurate. Bosch will perform such measurements with suitable measuring equipment where required and at extra cost. Further information obtainable from DEUTZ.

## 10.5 Triggering protection terminal 50

When triggering terminal 50, make sure that the reel-in relay of the starter represents an electro-magnetic component. Therefore, triggering must be protected against inductive disconnection voltage peaks by a suitable protective circuit.
This also applies to starters with additional pilot relay.

| |
|---|
| This means that between terminal 50 of the starter solenoid switch and the output of the starter key (terminal 50) no additional consumers are permitted to be connected as this can lead to starter defects due to a hindered reeling out – unless a start lock relay is connected. |

## 10.6 Power relay for activating the starter

The control cable to the starter solenoid switch can be connected via a power relay (e.g. Bosch article no. 0332 002 150 / 12 Volt and 24 Volt). This power relay is then triggered via the starter switch.
In this way, the voltage losses of the control cable do no more influence the solenoid switch of the starter and safe reeling in of the starter is made sure.

The relay should be installed near the starter, but not mounted to the engine.

## 10.7 Start lock relay - see TPI 0199-99-0217 supplement in the Annex

The start lock relay avoids reeling in of the starter pinion with running engine and, in this way, protects the starter pinion and the girth gear against destruction.

A start lock relay is always necessary, if upon starting the engine cannot be directly heard or watched or in case of twin engine systems. The relay should be installed in the close vicinity of the starter – but not fastened to the engines – to keep the voltage losses low with a normal cable expenditure.

Install the relay always such that the connections show downwards.

When selecting the time-lag relay, you should make sure that the start can only be repeated, when the engine is absolutely standing still.

**Upon a repeated start, a minimum waiting time of 6 sec. must be observed after the drop of the D+ signal (alternator)).**

| | |
|---|---|
| Admissible ambient temperature for the start lock relay: | -30 °C / +70 °C |

## 10.8 Dimensioning of various cable cross sections

### 10.8.1 Minimum cross section

| |
|---|
| For reasons of strength, the cross section of control cables, light cables or supply lines must be at least 1.5 mm². |

### 10.8.2 Dimensioning

When determining line cross sections, the voltage drop and heating up must be considered.

**a) Determining the current size I [A] :**
From the power requirement of the electrical consumer and the rated voltage, the current size results with

$$I\ [A] = P\ [Watt]\ /\ U\ [Volt]$$

**b) Determining the theoretical line cross section A [mm²] :**
With the admissible voltage drop UVL [V] -see table "admissible voltage drops" and the current size I [A] as well as the specific electrical resistance $\rho$ = 0.0185 [ $\Omega$ mm²/m ] and the line length L [m] the line cross section is determined as follows:

$$A\ [mm^2] = I \times \rho \times L\ /\ U_{VL}$$

**c) Actual line cross section $A_w$ [mm²] :**
The line cross section A determined by calculation must be rounded to the next higher value Aw according to table "copper line cross sections".
Cross sections below 1.5 mm² are not admissible!

**d) Actual voltage drop $U_{VList}$ [V] :**
From the relation under b) together with the actual line cross section:
the result is

$$U_{VList}\ [V] = I \times \rho \times L\ /\ A_w$$

**e) Checking the current density S [A/mm²] :**
To avoid inadmissible heating of the line
following current density S must be complied with

| | |
|---|---|
| $S < 30\ [A/mm^2]$ | Short-term consumers ( e.g. main starter cable ) |
| $S < 10\ [A/mm^2]$ | Permanent consumers ( e.g. B+ charge line alternator) |

Values for rated cross sections and admissible permanent current upon continuous operation may be taken from table "copper line cross sections".

### 10.8.3 Cable cross sections for selected consumers

The following line cross sections are only rough reference values; a re-calculation is obligatory.
The indicated line lengths comprise plus and minus line.

| | | | Rated cross section mm² |
|---|---|---|---|
| Heater plugs* | 12 V / 3.4 cyl. engines | Fuse 50 A | up to 5 m: 6 |
| | 12 V / 5.6 cyl. engines | Fuse 70 A | up to 5 m: 10 |
| | 24 V / 3.4 cyl. engines | Fuse 30 A | up to 5 m: 4 |
| | 24 V / 5.6 cyl. engines | Fuse 40 A | up to 5 m: 6 |
| | | | |
| Heating flange | 12 V-system | Fuse 125 A | up to 5 m: 25 |
| | 24 V-system | Fuse 100 A | up to 7 m: 16 |
| | | | |
| Monitoring systems (for cylinder head temperature, oil temperature, air filter etc.) | | | 1.5 |
| | | | |
| Lifting solenoids / solenoid valves | | | 2.5 |
| | | | |
| Start lock relay | 12 V | | up to 5 m: 4.0 |
| | 24 V | | up to 5 m: 2.5 |
| | | | |
| Spark plug (direct injection) Connecting cable from starter switch (or power relay for spark plug | 12 V<br>24 V | | up to 5 m: 6.0<br>up to 5 m: 4.0 |
| Regulator switch removed | | D-, D+, DF | up to 5 m: 1.5<br>above 5 m: 2.5 |

* Individually, short circuits may occur at individual heater plugs as a consequence of which the electrical line burns through, if it is not fused. As for engines installed in vehicles or equipment, these lines are combined with lines for the monitoring systems, e.g. in a cable harness, in the most unfavorable case, a cable fire can result.
Therefore, we urgently recommend to fuse the electrical lines to the heater plugs.

## 10.9 Admissible voltage drops:

| **Type of line** | **Adm. voltage drop on plus cable** | | **Adm. voltage drop in whole circuit** | | **Remarks** |
|---|---|---|---|---|---|
| Rated voltage | 24 V | 12 V | 24 V | 12 V | |
| Charging cable from three-phase current generator Terminal B + to battery | 0.65 V | 0.3 V | 0.8 V | -- | Current upon rated voltage and rated power |
| Control cable from three-phase current generator to regulator (terminals D+, D-, DF ) | 0,2 V | 0.1 V | -- | -- | At max. exciting current - **see remark 1** |
| Other control cables from switch to relay, horn etc. | 1.0 V | 0.5 V | 2.0 V | 1.5 V | Current upon rated voltage |

**Remark 1**: All of the three control cables, if possible, of the same length and resistance.

## 10.10 Copper cable cross sections: as per DIN ISO 6722, Part 3, Insulation of PVC

| **Rated cross section** [mm²] | **Resistance per meter cable length** [mΩ/m] at + 20 °C | **Diameter** [ mm ] | **Diameter with insulation** (see remark 5) [ mm ] | **Admiss. permanent current** (see remark 4) **at ambient temperature** **+ 30 °C** [A] | **+ 50 °C** [A] |
|---|---|---|---|---|---|
| 0.75 | 24.7 | 1.3 | 2.5 ( - ) | - | - |
| 1.0 | 18.5 | 1.5 | 2.7 (2.1) | 19 | 13.5 |
| 1.5 | 12.7 | 1.8 | 3.0 (2.4) | 24 | 17 |
| 2.5 | 7.6 | 2.2 | 3.6 (3.0) | 32 | 22.7 |
| 4 | 4.71 | 2.8 | 4.4 (3.7) | 42 | 29.8 |
| 6 | 3.14 | 3.4 | 5.0 (5.0) | 54 | 38.3 |
| 10 | 1.82 | 4.5 | 6.5 (6.4) | 73 | 51.8 |
| 16 | 1.16 | 6.3 | 8.3 (8.0) | 98 | 69.6 |
| 25 | 0.743 | 7.8 | 10.4 | 129 | 91.6 |
| 35 | 0.527 | 9.0 | 11.6 | 158 | 112 |
| 50 | 0.368 | 10.5 | 13.5 | 198 | 140 |
| 70 | 0.259 | 12.5 | 15.5 | 245 | 174 |
| 95 | 0.196 | 14.8 | 18 | 292 | 207 |
| 120 | 0.153 | 16.5 | 19.7 | 344 | 244 |

Remark 4: as per DIN VDE 0298, Part 4.
Remark 5: smaller outer diameters can be represented with other insulation material (values in brackets for material TPE-E, line 13Y as per DEUTZ works standard 823 600-2, temp.-resistant from -40 °C...+150 °C, e.g. for engine cable harness).

## 10.11 Generators and regulators

- Generators and regulators must be protected against heat radiation and splash water.
  - The admissible max. temperature of the generators depends on their design. Generally, for the generators offered within our scopes of supply, the following maximum values apply:

| | **Housing** | **Cooling air temperature** |
|---|---|---|
| Three-phase AC generator | max. + 90 °C | + 80 °C* |
| Regulator attached to three-phase AC generator (integrated) | max. + 130 °C** | - |
| Overvoltage protection systems | max. + 60 °C | - |

* Generators can be operated under any electrical condition up to max. 80 °C ambient and air temperature.
** Pick-up point at regulator letter "A" of the word GERMANY (for Bosch systems).

- In case of a high dust development or when the above-mentioned temperatures are exceeded, the cooling air can be sucked from a dust-free and cooler space via air intake sockets of the generators using a hose. However, this room must not be under vacuum pressure.

| Internal width of the hose line: | | |
|---|---|---|
| Upon suction from the free space | 60 mm ∅ | for 55.80 Amp. Gen.(Type K,N) |
| | 70 mm ∅ | for 120, 140, 180 Amp. Gen. (Type T) |

- The attached regulator and the connection terminal can be provided with a protective cap (e.g. against falling rocks).
- We recommend to attach dust-proof generators to avoid the premature wear of the carbon brushes.
- When installing the generator, ensure a good accessibility for resetting the belt tension and possibly required servicing works.
- In the case of **parallel connection of generators**, make sure that regulator types and regulator levels (V) - with temperature compensation – are identical. In case of differing generators or regulator temperatures, the intersection of the characteristic lines can lead to a differing utilization (service life) of the generators. Sucking in of fresh air avoids this and, moreover, entails a clear increase of the service life of the generator.
  The parallel connection of generators with additional diodes must be avoided.
- When cleaning the generator with water vapor or a high-pressure water cleaner, make sure that the vapor- or water jet is not directed onto or into the generator opening or ball bearing. After the cleaning procedure, the generator should be operated for 1-2 minutes to remove water residues, if any, from the generator.

## 10.12 Three-phase generators (charging balance)

The selection of the generator size depends on the energy requirement of all consumers permanently connected or intermittently connected consumers. Consider that, despite all consumers, always a reserve for charging the battery must be available.

For a 24 Volt system, the current requirement results from the determination of the total electrical power $P_{elec}$ [kW] required for all consumers.

$$I = P_{elec} / 24 \quad [A]$$

On the basis of this current value, with the aid of generator characteristic lines, it must be decided, which minimum speed a selected generator must have to cover the current requirement – for characteristic line, see pocket book.

It must be aimed at covering the current requirement of all systems connected permanently or over an extended period of time already upon engine idling operation. This must be made sure by determining the transmission ratio of n-engine / n-generator. It must also be made sure that, upon maximum engine speed, the limit speed value of the generator is not exceeded.

### Notes:

The 28 V generators are resistant to voltage peaks up to 300 V for max. 20 msec.

Voltage peaks from the generator are limited to max. 56 V by Zener diodes.

In the case of the voltage-resistant versions or those protected by Zener diodes, voltage peaks can occur in the mains without jeopardizing the generator or the governor, e.g. upon emergency operation without battery.

All generators with attached governors included in the DEUTZ scope of supply are protected against overvoltage from the on-board mains.

**Increasingly, however, electronic components are connected to the mains. These electronic components are very sensitive to voltage peaks generated by the generator or during switching operations in the mains. Therefore, it is necessary to protect inductive components such as coils, relays or solenoids with a recovery diode or a parallel resistor.**

When connecting e.g. the battery cables to the terminal of the three-phase generators, absolutely make sure that the polarities are correctly assigned (alternator B**+** to the plus-pole of the battery). Exchanging the polarity by mistakes means short-circuit and destruction of the rectifier elements – the generator is out of function.

In the case of 2-pole generators, generator B- is connected with the minus-pole of the battery.

## 10.13 Dimensioning of the B+ cable from the generator (charging line)

Dimensioning of the B**+** line (from generator B**+** to battery plus-pole) depends on the maximally admissible voltage loss.

| | | |
|---|---|---|
| Max. admiss. Voltage loss $\Delta U_{tot.}$ | = 0.65 V | for 24 V-systems with ground connection |
| | = 0.80 V | for 24 V-systems with 2-pole version for supply and return line (e.g. for marine applications) |
| | = 0.40 V | for 12 V-systems with ground connection |

With the determined max. current of the generator (see charging balance), with the aid of the specific line resistance $q_R$

$$\mathbf{q}_R = \mathbf{R}_{\text{charging line}} / \mathbf{L}_{\textbf{Line}} = \Delta\mathbf{U}_{\text{total}} / (\mathbf{I}_{\text{charging current}} \times \mathbf{L}_{\text{line}}) \quad [\text{m}\Omega / \text{m-line}]$$

from the table “copper line cross sections” the necessary rated cross section can be determined.

Or the following calculation is directly made:

$$A[\text{mm}^2] = \{ I_{\text{charging current}}[A] \times L_{\text{line}}[m] \times \rho[\text{mm}^2\Omega/\text{m}] \} / \Delta U[V]$$

with $\rho = 0.0185$

Then, the pertaining line diameter is searched for in table "copper line cross sections".

**Example:**

The cable between the line from generator B+ to plus-pole of battery is 6 m long.
A generator 28 V/120 A is used. The charging current at generator speed 6000 1/min in the cold state of the generator is 130 A.
Required cross section or cable diameter for the B+ line ?

With $q_R = \Delta U_{total} / (I_{charging\ current} \times L_{line})$ the following results

$q_R = 0.65 / (130 \times 6) = 0.8334$ [ mΩ / m line ]

Acc. to table "copper line cross section", this value is between the cross section values 25 ... 16 mm².

As 0.8334 [ mΩ / m line ] with 22.20 mm² rated cross section* is closer to cross section 25mm², for the B+ line, the cable diameter 7.8 mm is selected.

*as per A [mm²] $= I \times L \times \rho / \Delta U$

$= \rho / q_R$ = 0.0185 [mm²Ω/m] / 0.0008334 [Ω/m]

**Notes:**

- The admissible voltage drop of the line (e.g. additional ground line for a flexibly supported generator) from generator B**-** to ground connection of battery is permitted to be 0.1 V at a maximum.
- In the case of 2-pole insulated generators, the cables from battery plus-pole to B**+** at the generator and from B**-** at the generator to battery minus-pole are permitted to have a maximal voltage drop of 0.8 V.
- Maximally admissible length of the charging line at 12 Volt: ≤ 5 m
  24 Volt: ≤ 15 m

## 10.14 Solenoid for engine shutdown

The solenoids at diesel engines serve for the electrical engine shutdown, into which the engine monitoring (e.g. oil pressure, coolant temperature, oil temperature, speed and similar) can be integrated. The solenoid is attached to the engine and influences the control rod.

**The solenoids feature the following electric connection:**

**a) Energized shutdown:**

When starting the engine and during engine operation, the solenoid is idle. If during engine operation voltage is applied to the solenoid, it presses the lever at the injection pump into position "fuel zero delivery", the engine is shut down.

**b) De-energized shutdown:**

Upon engine start and during engine operation, voltage is applied to the solenoid. Under the permanent application of voltage, the solenoid develops heat. If the voltage applied to the solenoid is interrupted, a spring force is released, under which the lever at the injection pump moves into position "fuel zero delivery" – the engine is shut down.

The dimensioning of the electric line cross sections can be made as per item 10.8.3. The admissible voltage loss for the lines including terminals, switches and contacts is permitted to be max. 10 % of the rated voltage.

Due to the installation position close to the engine, these **solenoids** must stand high acceleration forces and ambient temperatures:

| | |
|---|---|
| Admissible permanent vibratory load: | 20 g |
| Admissible permanent ambient temperatures with moved air: | -40 °C to +90 °C |

**Note:**
When disconnecting the solenoid, voltage peaks occur which can destroy the non-protected electronic system. Therefore, suitable protective measures must be taken.

**Note on series 2011:** The polarity of the connections must be observed for the aforementioned components, see TPI 0138-48-0265.
PIN 1= Plus connection
PIN 2= Minus connection

## 10.15 Checklist for inspection of starter motor system

<u>Cable laying, cable dimensioning, cable connection:</u>

- Main cable (to terminal 30) and control cable (to terminal 50) have to be routed in that way that they do not come into contact (prevent short circuit)
- The cables have to be fixed approx. 300mm after starter motor connection for the first time.
- At terminal 50 only the control line to starter motor coming from a relay or from starter switch is allowed. Additional electrical consumer e.g. relays have to be connected at terminal 45.
- The permitted resistance of control cable (terminal 50) and battery main cable (terminal 30) can be rough calculated with cross section, cable length (incl. ground cable, if available) number of transitions (add per transition 0,05mOhm). For the starter motor the permitted total resistance is cable resistance plus battery internal resistance. Admissible values see starter drawing or installation guide line.

<u>Power relay for activating starter:</u>
This relay should be similar to Bosch relay 0 332 002 150, the following data should be checked:

- Switch-on voltage lower than 8Volt
- admissible electrical power 10% over value on starter motor drawing, e.g. HE starter 60Amps, relay min 66Amps.
- for short time (under 1 sec.) 250Amps must be permitted
- relay should be switched off when voltage is between 1,5 to 4,0V.

<u>Start blocking relay:</u>
A minimum waiting time of 5 (6) sec. must be observed

- after the drop of signal of terminal 50
- after drop of signals of "W", "D", "n"
- after starter has been switched off by speed signal
- start function must be blocked as long a speed signal occurs.

## 10.16 Electronic engine equipments

### 10.16.1 General

Proper functioning, reliability and permanent durability of electronic / electric components or systems depend to a considerable degree on their installation as well as on handling and care.

The service life of electronic/electrical components is also dependent on the ambient temperature; therefore, the admissible service temperature range is always specified. It should be noted in this connection that continuous operation of such component at the upper limit of a specified temperature range is admissible, but will eventually reduce the component life expectancy.

Electro-magnetic compatibility (EMV) of the electronic components is ensured as they are laid out according to ISO 7637, ISO 11451, ISO 11453 or DIN 40839 (Part 1 to 4) or VDE 0879 (Part 1 to 3).

Layout of the electric wiring, quality of the cables and of their electric connections are of fundamental importance for proper functioning of the electronic units, as they constitute the main cause of failures.

Wiring of the electronic equipment is not included in these installation directions, but forms part of the drawings in the Technical Pocket Book. Such drawings with detailed data on the PIN allocation of plugs may be taken from the documentation of the individual electronic systems. If required, the documentations can be obtained via the purchase department. Reference is also made to the

**Directions for the installation of electronic systems on DEUTZ diesel engines** order no. 0399 1990/3 (German) and 0399 1991/3 (English)

as well as to the following printed matter

**System description electronic speed regulating system GAC Analog**
Ordering No. 0297 9792 Ge/En

In every individual case, it must be inquired, whether the component can be supplied.

### 10.16.2 Installation and treatment instructions

This chapter deals with the installation and treatment instructions, which must always be observed and followed for all electronic components and systems. Only supplementary or deviating installation and treatment instructions are provided in the descriptions of the individual components or systems.

**Installation and treatment instructions included in the descriptions of the individual systems have always priority and, if applicable, may supersede the general instructions given here.**

**Installation references:**

- The specified tightening torques (see Workshop Manual) should be observed when fitting the sensors in the relevant tap holes.
- Electronic control boxes must not be mounted to the engine or on components which are connected to the engine (e.g. transmission, hydraulic pump, converter).
- Electronic control boxes must be installed at a protected place, preferably in the operator's cab, the passenger compartment or in the switch cubicle (e.g. generating sets).
- The control box is to be installed at a well ventilated location and must be protected against radiation heat.
- Control boxes and electrical components should never be encapsulated as they produce heat which needs to be continually dissipated.
- The control box should always be mounted in a vertical position with plug connection and drain holes at the bottom.
  Maximum admissible deviation from the vertical: ±15°.
- No elements are permitted to be fastened at the housing of the control box.
- There should be sufficient clearance below the control box so that the plug can be fitted to the box without problem (approx. 1 x box height).
- The first connecting point or the cable harness should not be located more than 300 mm away from the housing plug-in connector.
- Important note:
  Only generators with Zener diodes are admissible for voltage supply to electronic control boxes and electric system components.
  The supply connection should be provided separately from the "main positive lead" with fuse.
- It is mandatory to fasten the earthing cable of the battery to the engine close to the starter motor.

**Treatment instructions:**

- The electronic control box or the plug-in connector must not be cleaned with steam or water jet.
- When painting the control box, it should be ensured that
  - the type plate
  - the designation
  - the drain holes
  - the mounting surface (contact surface to base) – are spared.
- Exposed plug-in connectors must be covered up prior to painting.
- During electric welding work on the vehicle/equipment or engine, the electronics must be protected by disconnecting the plug from the electronic control box.
- It is not admissible to open the electronic control box; otherwise, you will no longer be entitled to warranty claims.
- It is not admissible to open sensors and actuators. Defective sensors and actuators must always be replaced as complete units.
- In the case of simple electronic components without self-diagnosis, e.g. cold starting aid (EKH), either DEUTZ Service should be consulted or the control box should be replaced.
- In the case of electronic control boxes and microprocessors, if failures in the system should occur, the electronic self-diagnosis shall be performed via the diagnosis interface as per ISO 9141 or via the diagnosis light.

### 10.16.3 Electro-hydraulic blower regulation (EHG)

The EHG system consists of the elements temperature sensors, control unit and solenoid valve.

Function:
In the electro-hydraulic blower regulation (EHG) the oil volume flow to the hydrodynamic coupling of the blower is synchronized by a solenoid valve. The clock frequency is triggered by the temperature of the engine lube oil which is determined by sensors and processed in the control unit.

Whereas the sensors and solenoid valve are installed in the engine control cables, the control unit (electronics box) is installed remote from the engine and connected to it by the cable harness.

The control unit has failsafe behavior, i.e. in case of a cable break, missing supply voltage, the blower is switched to “full cooling”.

Installation references:
When installing the control unit the customer must observe the following instructions:

- The admissible operating temperature range for the control box extends from -40 °C to +80 °C.
  Short-term maximum temperature is +90 °C.

- The control unit may not be installed on the engine and not on parts which are also connected with the engine (e.g. gear or hydraulic pumps etc.).

You are urgently recommended to install the control unit in the drive cab (self-driving equipment) or in the switch cabinet (gensets).

- Admissible vibratory load, permanent: 10 g – 31.5 Hz to 500 Hz

- Installation of the control unit in a well-aired place - whereby

  - the ambient temperature for the control unit during operation may not drop below –10 °C otherwise the blower regulation is not optimum.

  - the temperature at the installation position is not more than 20 °C above the outdoor temperature and

  - the control unit must be protected from radiated heat.

- The installation position of the control unit is always vertical with the plug at the bottom. Maximum admissible deviation from the vertical ± 30 °.

- No elements are permitted to be fastened at the housing of the control box.

- It is prohibited to open the control unit.

- Before mounting the cable plug on the control unit an additional sealing with a silicone sealing compound must be applied.
  After screwing together (tightening torque 4 Nm ± 0.3 Nm) the sealing compound must be applied to the housing all round the plug.

**Treatment instructions:**

- The connectors of the control unit may not be cleaned directly with a steam or water jet.

- The electrical connection (plug) may not be painted.

- For electrical welding work on the vehicle and engine, the plug must be pulled out of the control unit to protect the control unit electronics.

**Remarks on control function at “cold” temperatures:**
At engine start temperatures below 0 °C there is a danger of the blower starting as well under unfavorable installation conditions or temperature conditions.

The control unit must have the same or a lower temperature than the coldest temperature pickup point of a temperature sensor when starting to avoid the blower starting.

Operating temperatures below –10 °C should be avoided for the control unit.

### 10.16.4 Temperature switching device for cylinder head temperature and integrated speed-dependent oil pressure check (ZTS-DOEK)

The ZTS-DOEK system consists of the following elements:

- Two temperature sensors for the cylinder head temperature,
- an oil pressure switch for low switching point,
- an oil pressure switch for high switching point,
- cable harness,
- relay and
- solenoid.

Together with the terminal W of the generator as a measured value pickup the elements form an engine temperature and oil pressure monitoring system.

**Function:**

ZTS as overtemperature causes the engine to be shut down on reaching defined cylinder head temperature limits.

The coupled lube oil pressure monitor DOEK monitors the lube oil pressure dependent upon speed. Different pressure stages are assigned to certain speed classes here. If the engine drops below the oil pressure of a speed class during operation, the engine is shut down.

The switching device has failsafe behavior, i.e. the engine shuts down in the case of a cable break, missing voltage or similar.

The system is ready to operate when all parts are installed and the power supply connected.

**Installation references:**

When installing the temperature switching device please note:

- Maximum admissible permanent ambient temperature for the switching device +85 °C, temporarily 90 °C for one hour

- The installation position must be protected against splashing water and the influence of steam

- The control unit must be installed vertically with the plug at the bottom

- Admissible vibratory load, permanent: 10 g – 31.5 Hz to 500 Hz

- During electric welding work on the vehicle or engine, the control unit electronics must be protected by disconnecting the plug from the control unit.

- The switching device must be connected electrically to the engine block by a separate ground cable. This connecting point on the engine block (cylinder head on nozzle block) may not be loaded with other currents. This ensures that the temperature sensor and the switching device have the same minus potential and no switching point changes occur.

### 10.16.5 Cylinder head temperature switching system (ZTS)

The ZTS system consists of the elements temperature sensors and switching device.
**Function:**

The ZTS system serves to determine the cylinder head temperature and reports reaching the overtemperature according to specified limit values. A switching contact is triggered, e.g. an optical indicator (lamp).

**Installation references:**

See also section 10.15.5.

- Installation situation of the switching device vertical with plug at bottom.
- To rule out interference from the vehicle electrical system, the switching device is connected to the engine by a separate ground cable.
- Switching contact loads for 24 V: 250 mA
  12 V: 500 mA
- The control unit has no failsafe behavior, i.e. no switching contact trigger in the case of a cable break or similar.
- Admissible ambient temperature for the control unit –40 °C to +85 °C, temporarily up to 90 °C for one hour.

### 10.16.6 Electronic control for diesel particulate trap system (DPFS)

For individual engine applications with highest requirements to the emission level a particulate trap system can become necessary. The marginal conditions for the installation of the control unit are described below.

**Functional characteristics:**

With the DPFS system, the soot particles emitted by a diesel engine are retained in a ceramic monolith. After a defined permitted loading status – determined from the measured exhaust back pressure – the system-integrated burner is activated and the soot burnt in the monolith without residues.

The control system DPFS determines the time of regeneration and controls the regeneration process.

Moreover, specific functions are possible in the individual system states, e.g.:

- Initiation (start of the DPFS program)
- Pressure check (pressure sensor check after compressor start)
- Determination of trap loading degree (load sensing)
- Burner start (start of regeneration)
- Temperature control and flame monitoring (monitoring of combustion process)
- Trap overload (prevention of burner start to avoid thermal trap destruction)
- Diagnosis (locating and storing faults in the system)
- Communication (data exchange between control unit and a second unit)
- Failsafe (reliable operation status in case of fault) etc.

**System elements:**

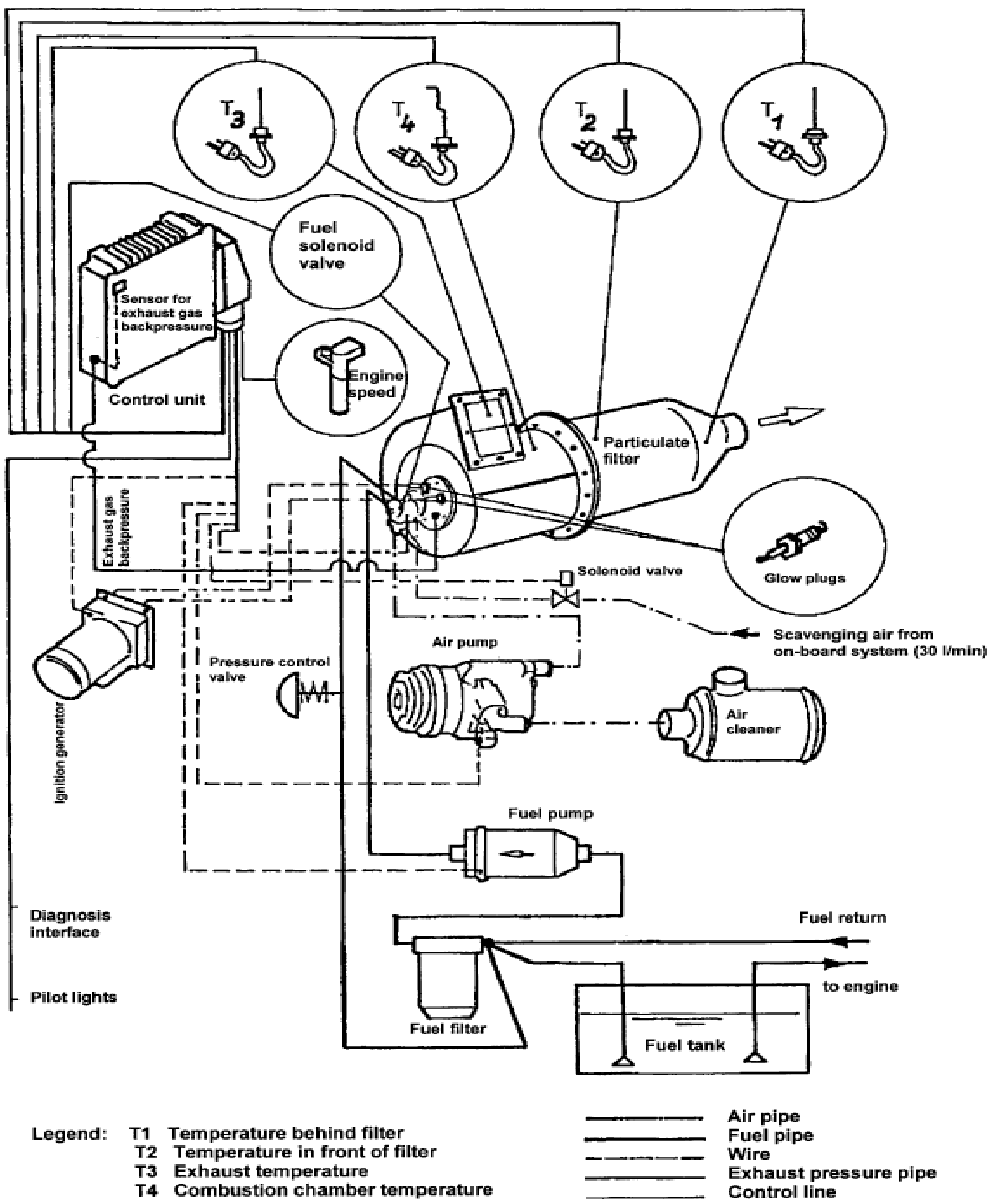
The DPFS system consists of the following elements:

- Particulate traps
- Burner with fuel solenoid valve
- Compressor with air filter
- Spark plugs and ignition spark generator

- Fuel pump and fuel filter
- Electronic control box
- Air valves (only with twin trap systems)
- Temperature sensor (burner chamber, before and behind trap, exhaust)
- Sensor, exhaust back pressure (integrated in control box)
- Speed transmitter
- Pilot lights

Further details on system elements and functional characteristics may be taken form the operating and installation manual (Brochure 0297 5748, 1st Edition 4/91 ).

**FIG. 10 – 5** **DIESEL PARTICULATE TRAP SYSTEM (DPFS)**




**Installation references:**

- See 10,15.2
- The admissible operating temperature range for the control box extends from –30 °C to +80 °C.

- It is recommended to install the control box in the operator's cab or in the passenger compartment; external mounting is also permitted, if sufficient protection is provided.
- The control box must be mounted in a vertical position, with plug connector at the side and outgoing cable harness at the bottom.
- A sufficient access space is to be provided at the side of the control box (plug connection side) to allow unhindered plug connection (approx. 1x width of control box).
- The installation location must always be above the pressure hose connection on the particulate trap housing. The pressure hose should always be routed and fastened so as to prevent any bending or squeezing.
- Because of the prevailing high temperatures, the control box should not be installed close the burner, the trap and the exhaust pipe.
- Admissible vibratory load for the control box:

| | |
|---|---|
| Vibrating amplitude: | 0.35 mm |
| Frequency range: | 10 to 60 Hz |
| Acceleration: | 5 g |
| Frequency range: | abt. 60 to 5000 Hz |

- The following general instructions should be observed for the installation of the DPFS system:
  - The cable harness should preferably be made of temperature-resistant material.

**Recommendation:**

| | |
|---|---|
| Single core min. | 1.50 mm2 for cables to the actuators |
| Single core min. | 0.75 mm2 for signal cables |

- Temperature range –40 °C to +150 °C
- The cable harness should not be fastened at places which are exposed to heat (e.g. heating tubes, oil pipes).
- The ignition cables should be routed separately from the remaining cable harness.
- The pressure hose for measuring the exhaust back pressure is to be cut off neatly with a sharp knife without leaving any butts prior to fastening it to the specific screw union.
- For repairs or extensions of thermocouple lines only compensating lines with relevant plug (no thermoelectric power) may be used. Copper lines are not admissible.

**Treatment instructions:**

See 10,15.2

# 11. HEATING SYSTEMS

With DEUTZ engines the heat contained in the cooling air, the engine oil and the hydraulic oil can be used for heating the driver's cab or other rooms.

Concepts designed by the OEMs themselves to utilize this thermal energy for heating purposes will require an official approval by relevant authorities (e.g. German Technical Supervisory Board, employers' liability insurance association) to the effect that no health risk will be involved for the user. DEUTZ refuses therefore to assume any responsibility for self-made heating installations.

## 11.1 Fresh air heating system

The fresh air supplied by the blower is utilized as hot exhaust air for heating purposes after it has passed the cylinder liners.

The hot air of the so-called fresh air heating system is directly taken off at the engine cylinders.

<u>The following points are to be observed:</u>

- With this heating system the engine cooling air must always be drawn in from the open and never from the engine room or compartment. If necessary, the fresh air from the environment is to be ducted to the blower and the duct is to be adequately sealed.
- Exhaust gases or other media involving a health hazard must not find their way to the fresh air intake.
- The lines connected to the heater box outlets for the transfer of hot air should be so dimensioned that the back pressure at the heater box outlet does not exceed the engine cowling pressure by more than 5 %.
- When the flap of a heater box is in the heating position, it must always be ensured that the air in the following duct system can flow freely and unobstructed (no additional flaps). Any obstruction in the duct system for the heater will result in an increased resistance and hence in insufficient cooling of the cylinders. This in turn may cause piston seizures.
- When actuating the flap in the heater box, it must be guaranteed that in case of faulty actuation the flap moves to the position “summer operation” and the engine exhaust air can be freely dissipated from the heater box.

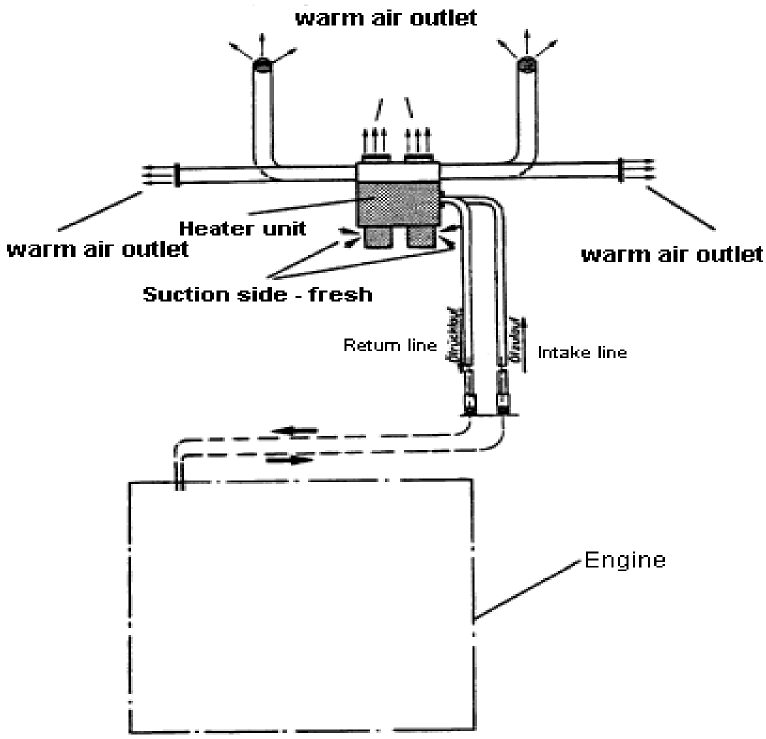
## 11.2 Engine oil heater (standard heating system)

With the engine oil heater, the engine oil is used as a heating medium. The engine oil is delivered into the heating oil circuit by the engine-mounted lube oil pump and returned back to the engine.

The heater for the generation of hot air, consisting of heat exchanger and fan with electric motor drive, is arranged in the heating oil circuit outside the engine.

The structure of the heating oil circuit is shown in the schematic diagram below:

**FIG. 11 - 1**




The heaters are matched to the existing oil flows and can be obtained according to the DEUTZ scope of supply (consult the acquisition staff for individual cases, see also “Heater” section).

Heaters (water heat exchangers) originating from previous heating circuits of water-cooled engines must not be used – especially because of insufficient compressive strength.

### 12.2.1 General installation and assembly instructions for the oil lines

For the oil-side connection between

- switch on the engine and to the heater and back or
- between engine via regulator valve to the heater and back

the following essential instructions must be observed:

- Pipes and hoses are to be laid out for an overpressure of at least 45 bar or 15 bar with BFL/M 1011F / 2011 engines.
- The hoses must be vibration, oil and fuel resistant and feature a temperature resistance from -40 °C to +140 °C.
- Up to a total pipe length (supply and return) of 6 m, the internal pipe diameter must be at least 12 mm.
- The total oil-side resistance in the heating system (pipes from regulating valve to re-entry into the engine including heat exchanger of the heater) may not exceed 1.8 bar
  at an oil temperature of 50 °C,
  a viscosity of SAE 20 W/20 and
  at full engine speed.

In B/FL/M 1011F/2011 an oil-side resistance of 1.0 bar should not be exceeded
at an oil temperature of 100 °C and
a viscosity of SAE 15/W40
and maximum engine speed.

- The heat exchangers must be pressure resistant up to 45 bar;
  in the case of B/FL/M 1011F/2011 the limit is = 2 bar.

- The oil carrying pipe connections on the heater must be fitted outside the driver's cab or be covered.

- No dissolving, oil carrying connections should be fitted in that part of the heat exchanger which is filled with heating air. This avoids contaminating the heating air with oil particles or vapors.

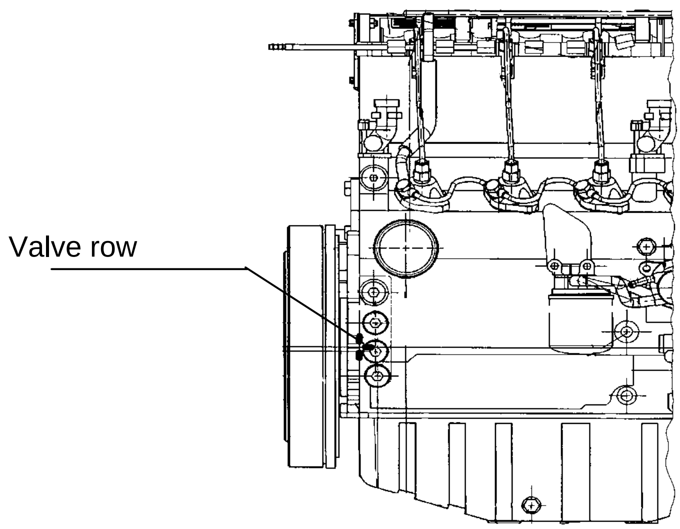
- To limit the thermal losses, the oil pipes should be kept as short as possible, insulated and guarded against airstream.

- The oil carrying hoses may not be bent and must be laid where no chafing is possible.

### 11.2.2 Heating connections in B/FL/M 1011F/2011

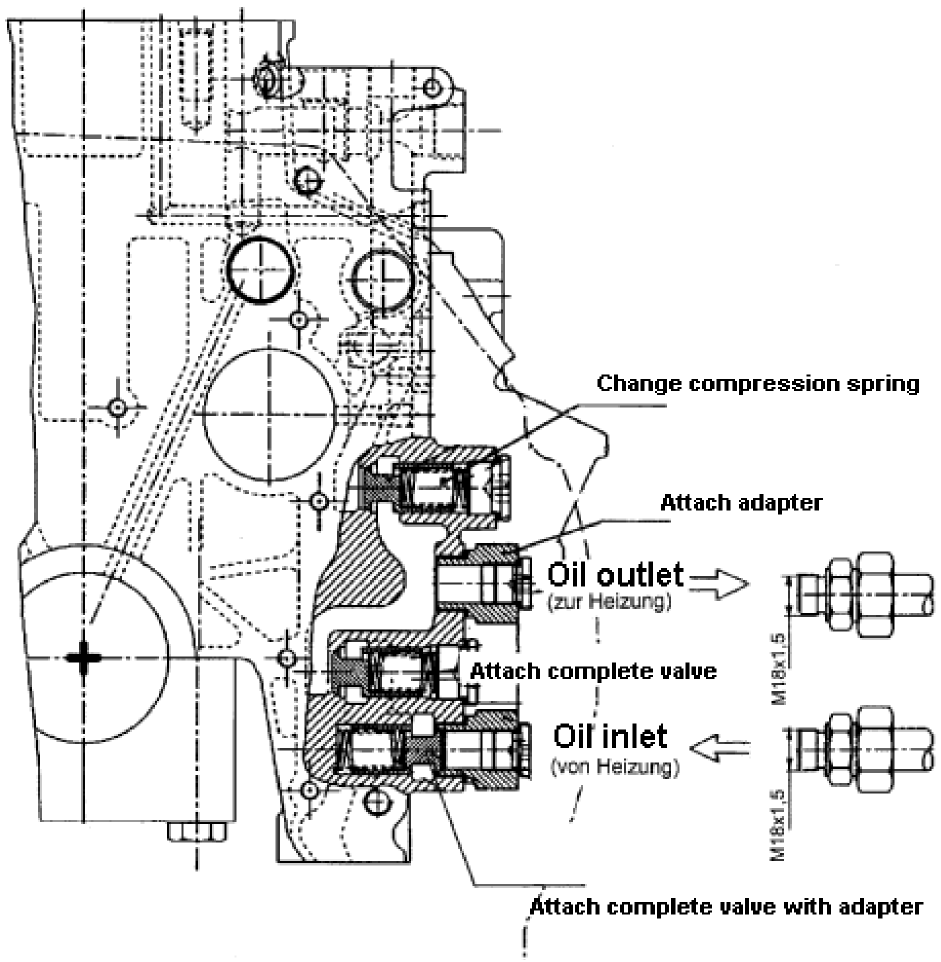
In the B/FL/M 1011F/2011 engines there is a "valve row" with four connection holes on the right hand side (looking at the flywheel) of the flywheel end of the crankcase.

**FIG. 11 - 2**




The engine oil can be tapped here to use the engine oil heat for heating purposes.

**FIG. 11 – 3** **Engine with heating system**




Engines "without" a heating system have different valve settings in the connection holes (see also oil diagram chapter 5) to the engines "with" heating system.
Therefore, oil tapping in an engine of the "without heating system" type does not provide heating. In this case the appropriate springs and valves must be changed or installed – see the Technical Product Information 0138- 16- 0058.

### 11.2.2.1 Thermal data of the heating system B/FL/M 1011F/2011

**The following oil volumes are available for the heating system:**

| | | | | |
|---|---|---|---|---|
| At | B/FL/M 1011F and 2800 1/m: | 20 l/min | for | 3-cylinder |
| | | 26 l/min | for | 4-cylinder |
| | | 26 l/min | for | BF4-cylinder |
| At | BFL/M 2011 and 2800 1/min: | 18 l/min | for | 3-cylinder |
| | | 24 l/min | for | 4-cylinder |
| | | 24 l/min | for | BF4-cylinder |

The listed oil volumes have a tolerance of –10 %....+10 % and apply at an oil temperature of approx. 110 °C and an oil viscosity SAE 15W40.

To determine the oil volumes at low speeds a linear conversion in the ratio of the speeds may be used in an initial approximation.

**Heating performances**

A cooling of the engine oil below 60°C...65°C should be avoided.

See the following diagrams for achievable heating performances.

**We would like to remind you that the specified heating performances in the diagrams can only be reached with the following heat exchangers under consideration of the specified basic conditions.**

| | | |
|---|---|---|
| Behr GmbH & Co.<br>Mauser Str. 3<br>70469 Stuttgart | to be ordered from: | Fahrzeugheizungen Kirchberg GmbH<br>Bahnhofstr. 26<br>08107 Kirchberg |

12V – unit: Heater 92.782.10.000
with radiator SK 92.750.065
24V – unit: Heater 92.783.10.000
with radiator SK 92.750.065

- Heating performances determined at –20 °C.
- Maximum outlet temperature of the heating air on blower stage I.
- For fast response of the heater speeds above n=1800 1/min and engine partial load operation (mean pressure approx. 2bar) in circulating air operation of the heater recommended.
- Cold start with blower switched off.
- Do not switch on heater blower until the engine has warmed up.
- Observe specifications for pipe dimensioning.
- $\Delta$t air = temperature difference between air inlet and outlet at the heat exchanger, i.e. heating up the air.

FIG. 11 - 4

| | Heizleistungen<br>*Heating powers* | FL 1011 F | Ausgabe / Issue: 01.11.97 | Seite / Page: 2.703 / E |
|---|---|---|---|---|
| DEUTZ | | | 2. Bearbeitung / Edition | |

**Es sind die Hinweise auf der Seite 2.702 / E zu beachten.**

***Please note directions at page 2.702 / E***

### F 2 L 1011 F

| Motordrehzahl [min$^{-1}$]<br>*Engine speed [rpm]* | 1000 | | 1800 | | 3000 | | 3000 | |
|---|---|---|---|---|---|---|---|---|
| Motorleistung [kW]<br>*Engine power [kW]* | 2,3 | | 4,1 | | 6,8 | | 22 | |
| Eff. Mitteldruck [bar]<br>*mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,44 | |
| Wärmeangebot / Heat offer<br>Gebläsestufe / Blower stage | Q [kW] | ΔT Luft *air* [K] | Q [kW] | ΔT Luft *air* [K] | Q [kW] | ΔT Luft *air* [K] | Q [kW] | ΔT Luft *air* [K] |
| I | 0,5 | 22 | 1,0 | 36 | 3,0 | 63 | 3,7 | 71 |
| II | 0,9 | 18 | 1,5 | 30 | 3,9 | 50 | 5,5 | 56 |
| III | 1,2 | 12 | 2,2 | 20 | 4,9 | 40 | 6,6 | 45 |

### F 3 L 1011 F

| Motordrehzahl [min$^{-1}$]<br>*Engine speed [rpm]* | 1000 | | 1800 | | 3000 | | 3000 | |
|---|---|---|---|---|---|---|---|---|
| Motorleistung [kW]<br>*Engine power [kW]* | 3,4 | | 6 | | 10,2 | | 33 | |
| Eff. Mitteldruck [bar]<br>*mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,44 | |
| Wärmeangebot / Heat offer<br>Gebläsestufe / Blower stage | Q [kW] | ΔT Luft *air* [K] | Q [kW] | ΔT Luft *air* [K] | Q [kW] | ΔT Luft *air* [K] | Q [kW] | ΔT Luft *air* [K] |
| I | 2,0 | 38 | 2,7 | 58 | 4,0 | 78 | 4,4 | 83 |
| II | 2,3 | 31 | 3,6 | 47 | 5,0 | 63 | 6,7 | 68 |
| III | 2,7 | 20 | 4,5 | 35 | 6,0 | 48 | 7,9 | 54 |

### F 4 L 1011 F

| Motordrehzahl [min$^{-1}$]<br>*Engine speed [rpm]* | 1000 | | 1800 | | 3000 | | 3000 | |
|---|---|---|---|---|---|---|---|---|
| Motorleistung [kW]<br>*Engine power [kW]* | 4,6 | | 8,2 | | 13,7 | | 44 | |
| Eff. Mitteldruck [bar]<br>*mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,44 | |
| Wärmeangebot / Heat offer<br>Gebläsestufe / Blower stage | Q [kW] | ΔT Luft *air* [K] | Q [kW] | ΔT Luft *air* [K] | Q [kW] | ΔT Luft *air* [K] | Q [kW] | ΔT Luft *air* [K] |
| I | 2,2 | 44 | 3,2 | 61 | 4,2 | 72 | 4,4 | 84 |
| II | 2,6 | 36 | 4,2 | 53 | 5,4 | 64 | 6,95 | 70 |
| III | 3,0 | 29 | 5,2 | 40 | 6,6 | 55 | 8,6 | 58 |

FIG. 11 - 5

| DEUTZ | **Heizleistungen**<br>*Heating powers* | **BF4L 1011 F/T** | Ausgabe / Issue: 01.11.97 | Seite / Page: **2.704 / E** |
|---|---|---|---|---|
| | | | 3. Bearbeitung / Edition | |

**Es sind die Hinweise auf der Seite 2.702 / E zu beachten.**

***Please note directions at page 2.702 / E***

**BF 4 L 1011 FT**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Motordrehzahl [$min^{-1}$]<br>*Engine speed [rpm]* | 1000 | | 1800 | | 2500 | | 2500 | |
| Motorleistung [kW]<br>*Engine power [kW]* | 4,6 | | 8,2 | | 11,4 | | 46 | |
| Eff. Mitteldruck [bar]<br>*mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 8,07 | |
| Wärmeangebot / Heat offer<br>Gebläsestufe / Blower stage | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,4 | 46 | 3,4 | 63 | 3,8 | 72 | 4,4 | 84 |
| II | 2,8 | 38 | 4,4 | 55 | 6,3 | 64 | 6,95 | 70 |
| III | 3,2 | 31 | 5,4 | 45 | 8,1 | 55 | 8,6 | 58 |

**BF 4 L 1011 F**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Motordrehzahl [$min^{-1}$]<br>*Engine speed [rpm]* | 1000 | | 1800 | | 2800 | | 2800 | |
| Motorleistung [kW]<br>*Engine power [kW]* | 4,6 | | 8,2 | | 12,7 | | 55,5 | |
| Eff. Mitteldruck [bar]<br>*mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 8,71 | |
| Wärmeangebot / Heat offer<br>Gebläsestufe / Blower stage | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,4 | 46 | 3,4 | 63 | 3,8 | 72 | 4,4 | 84 |
| II | 2,8 | 38 | 4,4 | 55 | 6,3 | 64 | 6,95 | 70 |
| III | 3,2 | 31 | 5,4 | 45 | 8,1 | 55 | 8,6 | 58 |

## FIG. 11 - 6

| DEUTZ | **Heizleistungen**<br>*Heating powers* | **FM 1011 F** | Ausgabe / Issue<br>**01.11.97** | Seite / Page<br>**2.705 / E** |
|---|---|---|---|---|
| | | | **2**. Bearbeitung / Edition | |

**Es sind die Hinweise auf der Seite 2.702 / E zu beachten.**

***Please note directions at page 2.702 / E***

### F 2 M 1011

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Motordrehzahl [min$^{-1}$]<br>*Engine speed [rpm]* | 1000 | | 1800 | | 3000 | | 3000 | |
| Motorleistung [kW]<br>*Engine power [kW]* | 2,3 | | 4,1 | | 6,8 | | 22,6 | |
| Eff. Mitteldruck [bar]<br>*mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,61 | |
| Wärmeangebot / Heat offer<br>Gebläsestufe / Blower stage | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 0,7 | 25 | 1,2 | 40 | 3,6 | 75 | 4,4 | 83 |
| II | 1,2 | 20 | 1,9 | 33 | 4,7 | 60 | 6,7 | 68 |
| III | 1,5 | 13 | 2,5 | 23 | 5,8 | 47 | 7,9 | 54 |

### F 3 M 1011 F

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Motordrehzahl [min$^{-1}$]<br>*Engine speed [rpm]* | 1000 | | 1800 | | 3000 | | 3000 | |
| Motorleistung [kW]<br>*Engine power [kW]* | 3,6 | | 6,6 | | 10,9 | | 35,6 | |
| Eff. Mitteldruck [bar]<br>*mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,52 | |
| Wärmeangebot / Heat offer<br>Gebläsestufe / Blower stage | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,3 | 48 | 3,0 | 62 | 4,2 | 80 | 4,4 | 83 |
| II | 2,4 | 34 | 3,7 | 50 | 5,6 | 65 | 6,7 | 68 |
| III | 2,5 | 23 | 4,5 | 38 | 7,0 | 50 | 7,9 | 54 |

### F 4 M 1011 F

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Motordrehzahl [min$^{-1}$]<br>*Engine speed [rpm]* | 1000 | | 1800 | | 3000 | | 3000 | |
| Motorleistung [kW]<br>*Engine power [kW]* | 4,8 | | 8,7 | | 14,6 | | 48,1 | |
| Eff. Mitteldruck [bar]<br>*mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,61 | |
| Wärmeangebot / Heat offer<br>Gebläsestufe / Blower stage | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,7 | 52 | 3,7 | 6,8 | 3,8 | 72 | 4,4 | 84 |
| II | 3,0 | 43 | 4,7 | 60 | 6,3 | 64 | 6,95 | 70 |
| III | 3,5 | 34 | 5,7 | 51 | 8,1 | 55 | 8,6 | 58 |

**FIG. 11 - 7**

| | | Ausgabe / Issue | Seite / Page |
|---|---|---|---|
| DEUTZ | **Heizleistungen** *Heating powers* | 01.11.97 | 2.706 / E |
| | BF4M 1011 F | 2. Bearbeitung / Edition | |

**Es sind die Hinweise auf der Seite 2.702 / E zu beachten.**

***Please note directions at page 2.702 / E***

**BF 4 M 1011 F**

| Motordrehzahl [min$^{-1}$] / *Engine speed [rpm]* | 1000 | | 1800 | | 2800 | | 2800 | |
|---|---|---|---|---|---|---|---|---|
| Motorleistung [kW] / *Engine power [kW]* | 4,8 | | 8,7 | | 13,6 | | 61 | |
| Eff. Mitteldruck [bar] / *mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 8,98 | |
| Wärmeangebot / Heat offer — Gebläsestufe / Blower stage | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,8 | 52 | 4 | 70 | 3,8 | 72 | 4,4 | 84 |
| II | 3,2 | 43 | 4,9 | 62 | 6,3 | 64 | 6,95 | 70 |
| III | 4,0 | 36 | 6 | 51 | 8,1 | 55 | 8,6 | 58 |

FIG. 11 – 8

| DEUTZ | **Heizleistungen** *Heating powers* | **FL 2011** | Ausgabe / Issue: **01.01.2001** | Seite / Page: **2.703 / E** |
|---|---|---|---|---|
| | | | 1. Bearbeitung / Edition | |

**Es sind die Hinweise auf der Seite 2.702 / E zu beachten.**
***Please note directions at page 2.702 / E***

| | **F 2 L 2011** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Motordrehzahl [min$^{-1}$] *Engine speed [rpm]* | 1000 | | 1800 | | 2800 | | 2800 | |
| Motorleistung [kW] *Engine power [kW]* | 2,6 | | 4,7 | | 7,2 | | 23 | |
| Eff. Mitteldruck [bar] *mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,36 | |
| Gebläsestufe / Blower stage — Wärmeangebot / Heat offer | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 0,53 | 25 | 1,05 | 39 | 3,15 | 66 | 3,9 | 74 |
| II | 0,95 | 20 | 1,6 | 32 | 4,1 | 52 | 5,8 | 58 |
| III | 1,26 | 13 | 2,3 | 21 | 5,15 | 41 | 6,95 | 46 |

| | **F 3 L 2011** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Motordrehzahl [min$^{-1}$] *Engine speed [rpm]* | 1000 | | 1800 | | 2800 | | 2800 | |
| Motorleistung [kW] *Engine power [kW]* | 3,9 | | 7 | | 10,9 | | 35,8 | |
| Eff. Mitteldruck [bar] *mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,58 | |
| Gebläsestufe / Blower stage — Wärmeangebot / Heat offer | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,1 | 41 | 2,85 | 61 | 4,2 | 81 | 4,65 | 86 |
| II | 2,45 | 33 | 3,8 | 49 | 5,25 | 65 | 7,05 | 70 |
| III | 2,85 | 21 | 4,75 | 36 | 6,3 | 49 | 8,3 | 55 |

| | **F 4 L 2011 / BF 3 L 2011** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Motordrehzahl [min$^{-1}$] *Engine speed [rpm]* | 1000 | | 1800 | | 2800 | | 2800 | |
| Motorleistung [kW] *Engine power [kW]* | 5,2 | | 9,3 | | 14,5 | | 47,8 | |
| Eff. Mitteldruck [bar] *mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,59 | |
| Gebläsestufe / Blower stage — Wärmeangebot / Heat offer | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,3 | 47 | 3,35 | 64 | 4,4 | 75 | 4,65 | 87 |
| II | 2,75 | 38 | 4,4 | 55 | 5,7 | 66 | 7,3 | 72 |
| III | 3,15 | 30 | 5,5 | 41 | 6,95 | 56 | 9,05 | 59 |

| | **BF 4 L 2011** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Motordrehzahl [min$^{-1}$] *Engine speed [rpm]* | 1000 | | 1800 | | 2800 | | 2800 | |
| Motorleistung [kW] *Engine power [kW]* | 5,2 | | 9,3 | | 14,5 | | 58,1 | |
| Eff. Mitteldruck [bar] *mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 8,01 | |
| Gebläsestufe / Blower stage — Wärmeangebot / Heat offer | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,55 | 49 | 3,6 | 66 | 4,0 | 75 | 4,65 | 87 |
| II | 2,95 | 40 | 4,65 | 57 | 6,65 | 66 | 7,3 | 72 |
| III | 3,35 | 32 | 5,7 | 46 | 8,5 | 56 | 9,05 | 59 |

## FIG. 11 - 9

| DEUTZ | **Heizleistungen** *Heating powers* | **FM 2011** | Ausgabe / Issue: **01.01.2001** | Seite / Page: **2.704 / E** |
|---|---|---|---|---|
| | | | 1. Bearbeitung / Edition | |

**Es sind die Hinweise auf der Seite 2.702 / E zu beachten.**
***Please note directions at page 2.702 / E***

| Motordrehzahl [$min^{-1}$] *Engine speed [rpm]* | **F 2 M 2011** 1000 | | 1800 | | 2800 | | 2800 | |
|---|---|---|---|---|---|---|---|---|
| Motorleistung [kW] *Engine power [kW]* | 2,6 | | 4,7 | | 7,2 | | 24,2 | |
| Eff. Mitteldruck [bar] *mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,69 | |
| Gebläsestufe / Blower stage \ Wärmeangebot / Heat offer | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 0,75 | 28 | 1,25 | 43 | 3,8 | 78 | 4,65 | 86 |
| II | 1,26 | 22 | 2,0 | 35 | 4,95 | 62 | 7,05 | 70 |
| III | 1,6 | 14 | 2,65 | 24 | 6,1 | 48 | 8,3 | 55 |

| Motordrehzahl [$min^{-1}$] *Engine speed [rpm]* | **F 3 M 2011** 1000 | | 1800 | | 2800 | | 2800 | |
|---|---|---|---|---|---|---|---|---|
| Motorleistung [kW] *Engine power [kW]* | 3,9 | | 7 | | 10,9 | | 36,5 | |
| Eff. Mitteldruck [bar] *mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,71 | |
| Gebläsestufe / Blower stage \ Wärmeangebot / Heat offer | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,45 | 51 | 3,15 | 65 | 4,4 | 83 | 4,65 | 86 |
| II | 2,55 | 36 | 3,9 | 52 | 5,9 | 67 | 7,05 | 70 |
| III | 2,65 | 24 | 4,75 | 39 | 7,35 | 51 | 8,3 | 55 |

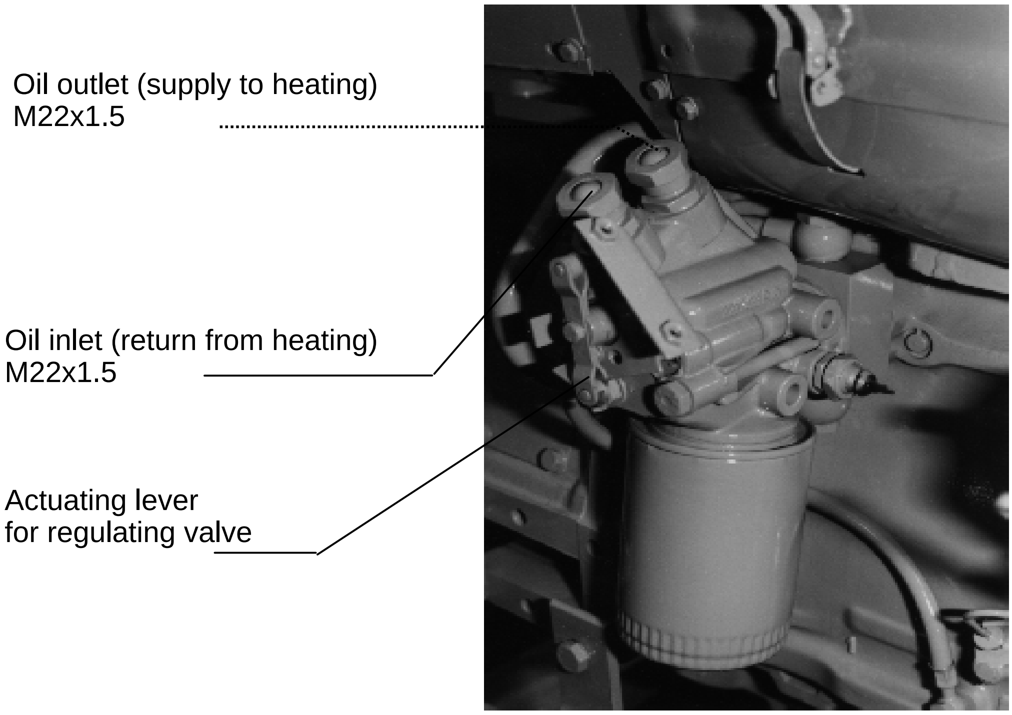
| Motordrehzahl [$min^{-1}$] *Engine speed [rpm]* | **F 4 M 2011 / BF 3 M 2011** 1000 | | 1800 | | 2800 | | 2800 | |
|---|---|---|---|---|---|---|---|---|
| Motorleistung [kW] *Engine power [kW]* | 5,2 | | 9,3 | | 14,5 | | 48,5 | |
| Eff. Mitteldruck [bar] *mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 6,69 | |
| Gebläsestufe / Blower stage \ Wärmeangebot / Heat offer | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,85 | 55 | 3,9 | 71 | 4,0 | 75 | 4,65 | 87 |
| II | 3,15 | 45 | 4,95 | 62 | 6,65 | 66 | 7,3 | 72 |
| III | 3,7 | 35 | 6,0 | 52 | 8,5 | 56 | 9,05 | 59 |

| Motordrehzahl [$min^{-1}$] *Engine speed [rpm]* | **BF 4 M 2011** 1000 | | 1800 | | 2800 | | 2800 | |
|---|---|---|---|---|---|---|---|---|
| Motorleistung [kW] *Engine power [kW]* | 5,2 | | 9,3 | | 14,5 | | 65 | |
| Eff. Mitteldruck [bar] *mean eff. pressure [bar]* | 2,0 | | 2,0 | | 2,0 | | 8,96 | |
| Gebläsestufe / Blower stage \ Wärmeangebot / Heat offer | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] | Q [kW] | Δ T Luft *air* [K] |
| I | 2,95 | 55 | 4,2 | 73 | 4,0 | 75 | 4,65 | 87 |
| II | 3,4 | 45 | 5,15 | 64 | 6,65 | 66 | 7,3 | 72 |
| III | 4,2 | 37 | 6,3 | 52 | 8,5 | 56 | 9,05 | 59 |

### 11.2.3 Heating connections in B/FL 913 / 914

The connections for the supply and return of the heating oil are on a switch housing with regulating valve arranged in the lube oil filter console of the engine oil filter (arrangement on flywheel housing).

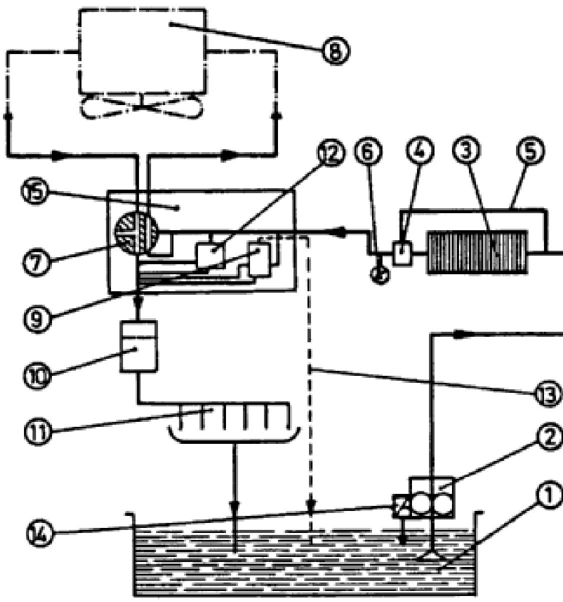
**FIG. 11 - 10**




There is a low pressure valve or a differential pressure valve in the switch housing to ensure sufficient oil pressure for the engine lubrication at engine start or inadmissible high resistances of the heating circuit (above 2 bar).

Since the engine oil cooler, heat exchanger and engine lubrication are connected in series, we refer to a SINGLE CIRCUIT heating in the series
B/FL 913/914

**FIG. 11 - 11** Single circuit system



1 Oil pan
2 Oil pump with relief valve
3 Engine oil cooler
4. Thermostat valve
5 Bypass pipe
6 Oil temperature sensor
7 Controll valve
8 Heat exchanger with fan
9 Low pressure valve
10 Oilfilter
11 Piston cooling and engine lubrication

### 11.2.3.1 Thermal data of the heating system B/FL 913/914

**The following oil volumes as a function of the engine speed are available to the heating system:**

| **Oil volumes** [l/min] | **2500** 1/min | **2000** 1/min | **1500** 1/min |
|---|---|---|---|
| | | | |
| F3/4L 912 | 21 | 17 | 13 |
| F5/6L 912 | 31 | 25 | 19 |
| F3/4L 913 | 21 | 17 | 13 |
| F3/4L 914 | 21 | 17 | 13 |
| **F6L 913** | 31 | 25 | 19 |
| F5/6L 914 | 31 | 25 | 19 |
| BF4L 913 | 31 | 25 | 19 |
| BF6L 913/C | 44 | 35 | 26 |
| BF4L 914 | 31 | 25 | 19 |
| BF6L 914/C | 44 | 35 | 26 |

The specified values of the oil volumes have a tolerance of –10 % ...+1 % and apply at oil temperatures of 110 °C at an oil viscosity of SAE 15W40.

**Heating performances**

The heating performances depend especially on the quality of the heating device (heat exchanger combined with a blower with an electric motor) and on the respective engine speeds and performances.

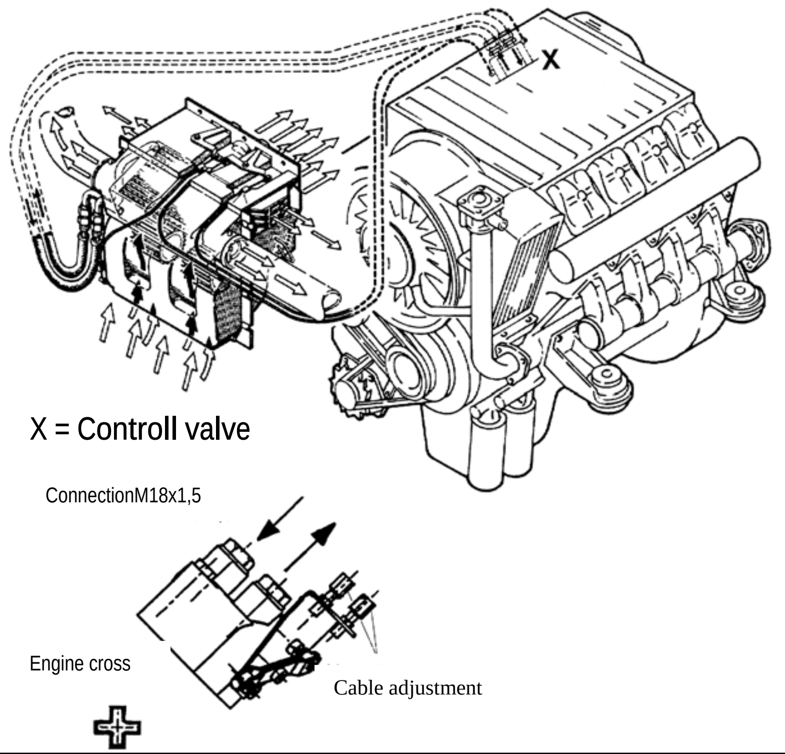
Further details about the heating performances for the different numbers of engine cylinders are therefore subject to consultation with head office or Technical Sales Support.

A cooling of the engine oil below 60 °C...65 °C should be avoided.

## 11.2.4 Heating connections in B/FL 413 / 513

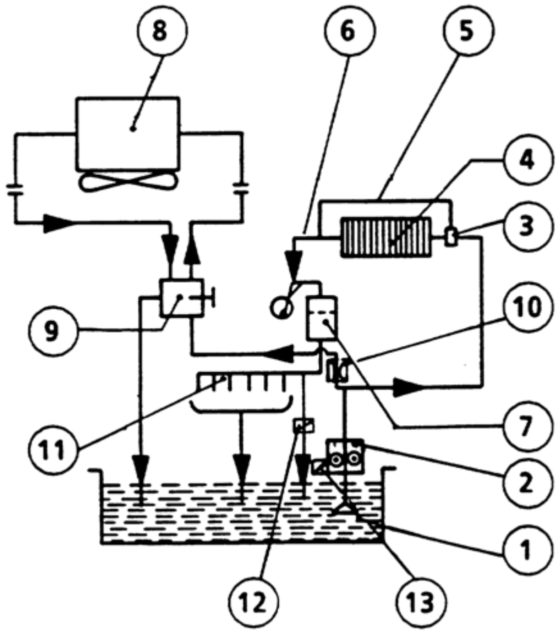
The connections for supply and return of the engine oil for the heating system are on the regulating valve which is arranged near to the flywheel housing on the engine crankcase.

**FIG. 11 - 12**




In the case of series 413F/513 the heating oil is drawn as a partial flow from the engine lube oil circuit by a throttle after the lube oil pump. Then the oil flows directly back to the oil sump. The performance of the lube oil pump is increased to compensate for the oil loss due to the sub-flow.

**FIG. 11 - 13** Sub-flow system

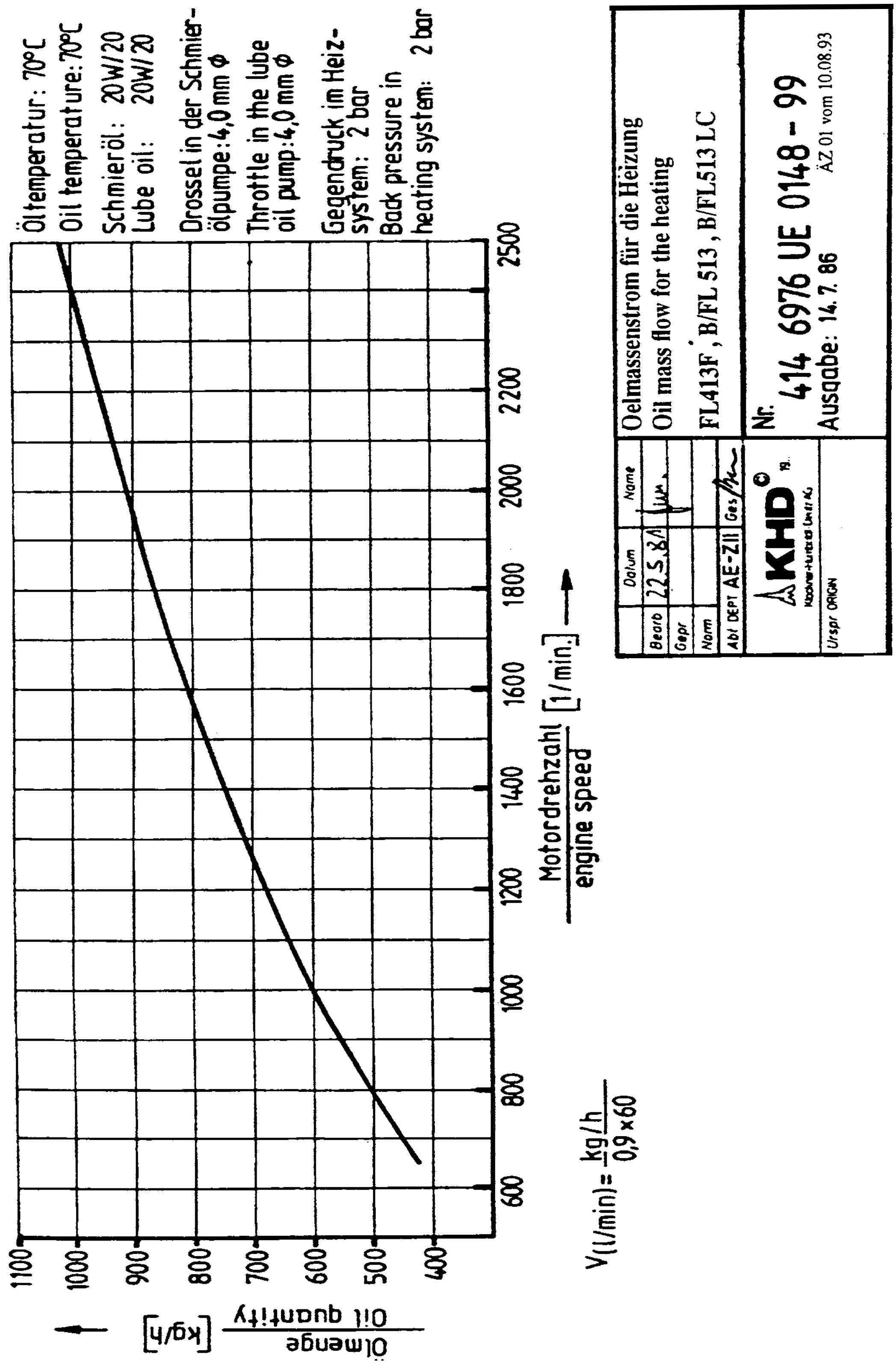



| | | |
|---|---|---|
| 1 | Ölwanne | oil pan |
| 2 | Schmierölpumpe | Lube oil pump |
| 3 | Thermostatventil | thermostat valve |
| 4 | Motorölkühler | engine oil cooler |
| 5 | Umgehungsleitung des Motorölkühler | by - pass of oil cooler |
| 6 | Öltemperaturanzeige | oil-temperatur gauge |
| 7 | Schmierölfilter | Lube oil filter |
| 8 | Wärmetauscher mit Gebläse | heat exchanger with blower |
| 9 | Regulierventil | regulating valve |
| 10 | Drossel | throttle valve |
| 11 | Kolbenkühlung und Motorschmierstellen | piston cooling and engine lube points |
| 12 | Endregelventil | valve for max. speed |
| 13 | Überdruckventil | overpressure valve |

### 11.2.4.1 Thermal data of the heating system B/FL 413F/513

**The following oil volumes as a function of the engine speed are available to the heating system:**

**FIG. 11 - 14**



## Heating performances

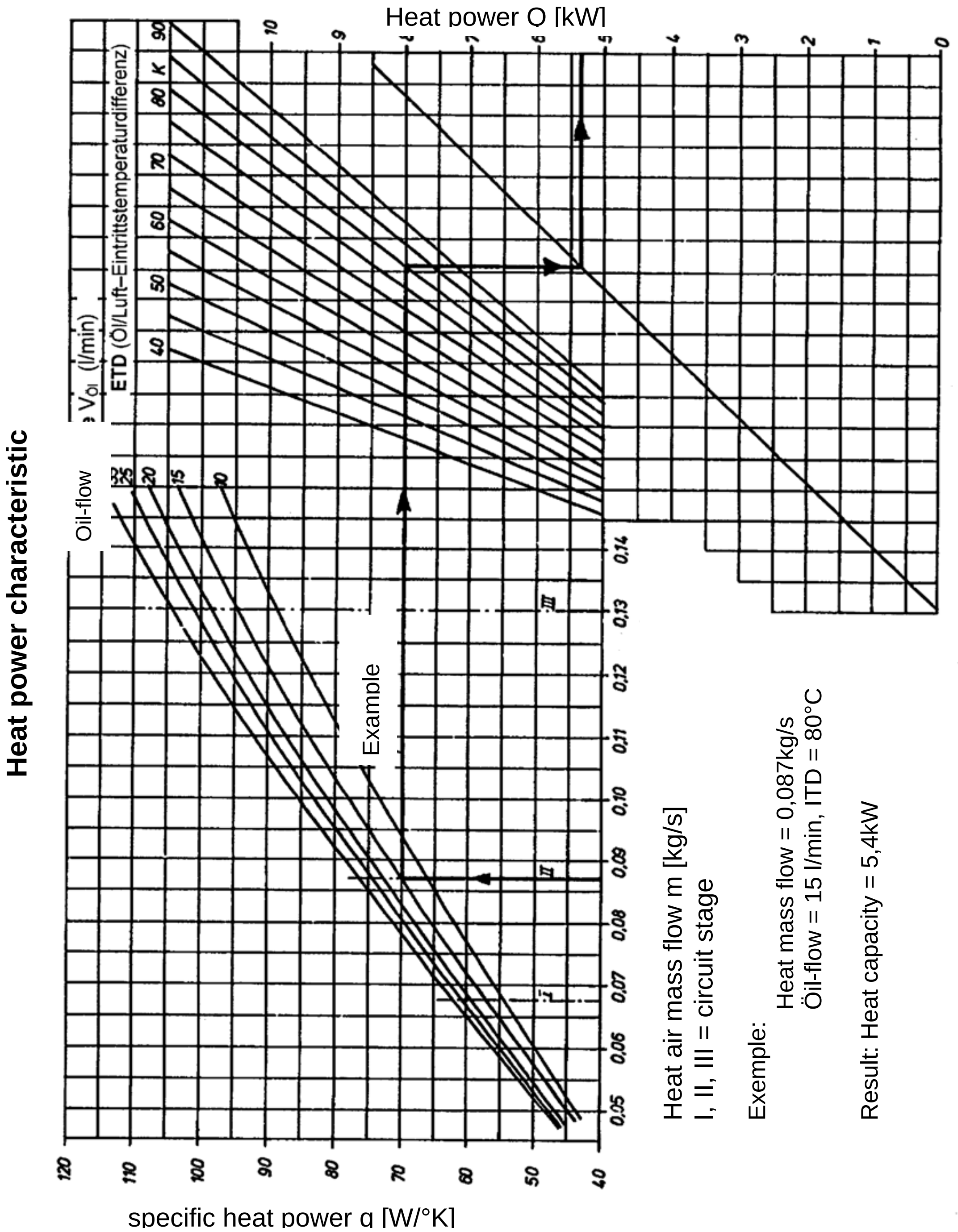
The achievable heating performances depend on the quality of the heating device (heat exchanger combined with a blower with an electric motor) as well as on the respective engine speeds (oil volumes, oil-side flow resistance of the heat exchanger), motor performances (oil temperatures) and the input temperature differences (ITD values) between the oil inlet and the air inlet at the heat exchanger network as well as the supplied air volume (blower stage) through the heat exchanger network.

The following figure shows the heating capacity of the heater 224 7763 KZ 0199-15 for 12 V or 224 7764 KZ 0199-15 for 24 V according to Deutz scope of supply.

This diagram is transferable to the engines of other series.

A cooling of the engine oil below 60 °C...65 °C should be avoided here too.

**FIG. 11 - 15**

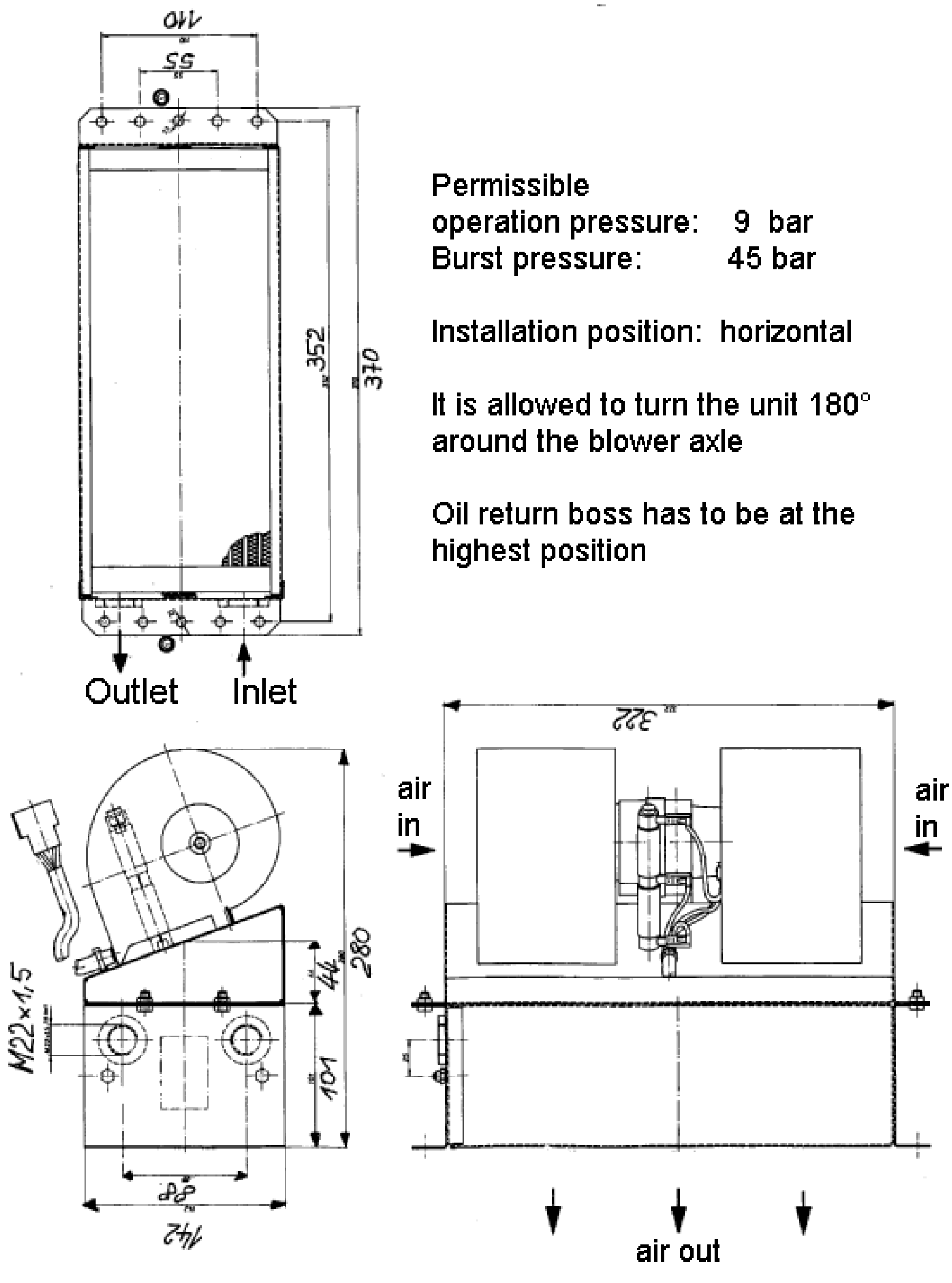


### 11.2.4.2 Heating device

The technical data of the heating device according to 224 7763 KZ 0199-15 for 12V or 224 7764 KZ 0199-15 for 24V can be taken from the following figures.

The heating device can also be used for other engine series.

**FIG. 11 - 16**

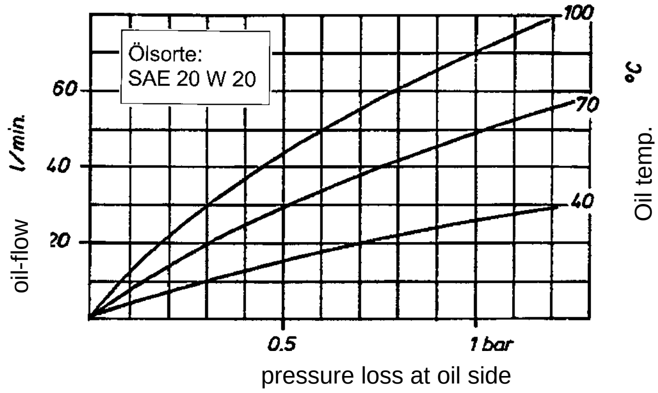



**Power consumption of the heating device 0224 7763:**

| | |
|---|---|
| On blower stage I | 55 Watts |
| On blower stage II | 80 Watts |
| On blower stage III | 145 Watts |

**FIG. 11 - 17**

**Oil flow resistance of heater unit**




## 11.3 Aqua-fluid heating system

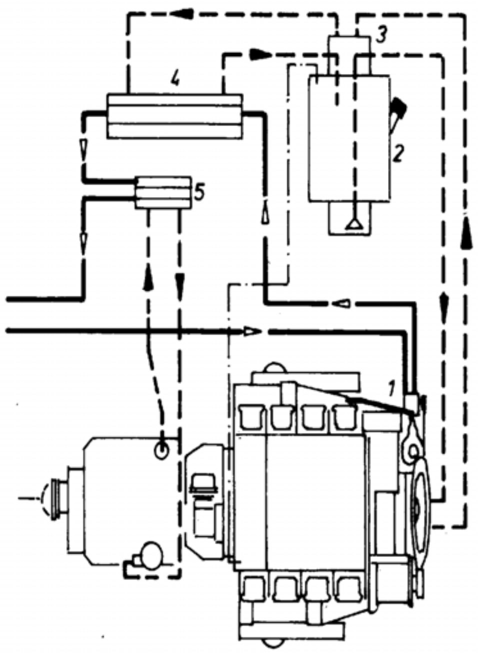
With the Aqua-fluid heating system, the engine oil heat is transferred into a heating water circuit through an oil/water heat exchanger. This heating water is supplied to convectors or air/water fan heat exchangers which act as heaters and dissipate the heat into the passenger compartment.

When installing transmission oil or retarder oil heat exchangers in the water circuit, the heat output for the passenger compartment can still be increased.

With an additional externally driven heater in the water circuit the passenger compartment can also be heated when the engine is shut off.

The schematic diagram of the **Aqua-fluid** heating system is shown below:

**FIG. 11 - 18**




**1 Water- pump**
**2 Oil tank**
**3 Control valve**
**4 Oil – water heat exchanger**
**5 Transmission oil – water heat exchanger**

**Water circuit**

**Oil circuit**

**Vent. line (Oil-tank /engine)**

The engine lube oil pump draws in the oil from the separate oil tank and forces the oil to the lubricating points.
Another engine-integrated oil pump draws in the oil accumulated in the oil pan and returns it – via the oil flow diverter – into the separate oil tank when the h eating system is switched off.

When the heating system is on, the oil coming from the oil flow diverter first passes the oil/water heat exchanger before being delivered to the separate oil tank. See also section “Lube oil system”.

The oil/water heat exchanger is obtainable from the usual cooler manufacturers. It is to be installed in accordance with the manufacturer’s specifications and instructions.

It will be up to the end user/OEM to decide upon the temperature control of the overall Aqua-fluid heating system.

We recommend, however, to provide at least one water temperature controller which actuates the flow diverter (no engine oil passing through the oil/water heat exchanger) when a specified limit (e.g. 95 °C) is exceeded and simultaneously switches the heating system over to “cooling” mode.

There is no risk of engine damage from excessive lube oil temperatures, as the engine-integrated lube oil cooler remains independent with its thermostatic control.

## 11.4 Hydrostatic oil heating system

When installing diesel engines with hydrostatic PTOs, a return cooling system for the hydraulic oil of the hydrostatic system will normally be required, too.

In the case of diesel engines in the lower power range it is recommended therefore to take special measures when fitting the separate heat exchanger units to the effect that the hot air from the heat exchanger is directed either into the driver’s cab (winter operation) or into the atmosphere (summer operation).

It must be ensured – similar to the fresh air heating system – that no air takes its course to the heat exchanger that contains exhaust gases or other media hazardous to health. It is therefore not admissible to draw in the air from the engine compartment or engine room.

Such a heating system features relatively short response times, as the hydraulic oil is heated up fast because the engine and hydrostatic system operate against the pressure relief valve of the hydrostatic oil circuit.

The guidelines drawn up for the engine oil heating system apply analogously to the installation of the hydraulic oil heat exchanger with its fan and the respective hose connections.

## 11.5 Exhaust gas heating system

It is very problematical to use the heat in the exhaust gas for cab or space heating purposes.

In view of the toxicity of the exhaust gas, very high safety requirements have to be met by heating systems using the exhaust heat as a heating medium. One of the demands refers to the high corrosion resistance specified for piping and heat exchangers in the cab area.

When dimensioning the system, the admissible exhaust back pressure of the engine must be taken into account.

As the exhaust heat flow is dependent on the engine load and speed, the heat flow will highly fluctuate according to the equipment application and the resulting heating performance will be unsatisfactory.

> The intermediate circuiting of carrier media between exhaust gas and heating air has not provided a lasting solution acceptable for series production to date.
>
> Heating systems with exhaust heat therefore remain special solutions and must be agreed with the head office in the individual case.

## 11.6 Electrical heating fans

Electrical heating fans (heating wire and fan) should only be used in very small driver cabs because the heat potential on offer is on the one hand very low and on the other hand the generator load is very high. The generator load could be reduced by using larger generators whereby the cost/benefit ratio would always have to be examined.

The advantages of the electrical heating fans is that they also operate independently of the engine and can operate briefly as stationary heaters depending on the battery capacity.

## 11.7 Fresh air or circulating air operation

In all heating systems it is recommended that the heating devices (cooler-fan systems) in the cabs or spaces are operated not only in so-called fresh air operation – i.e. suction intake of fresh cool air from the environment – but also that the so-called circulating air operation (suction intake from the heated room) is enabled.

The circulating air operation causes a considerable increase in the heating effect.

## 11.8 Stationary heating systems

Stationary heating systems are heating devices with which the cab or spaces can be heated even when the engine is at a standstill – they are therefore engine-independent.

Hot air for heating is generated in the stationary heating systems by combustion of diesel fuel.

Stationary heating systems are therefore complex systems and require a great deal of installation effort (suction intake air for combustion, exhaust gas system, electrical equipment and wiring, hot air supply, etc.).

The following companies offer or manufacture such heating systems on the market:

| | | |
|---|---|---|
| Eberspächer | 73730 Esslingen | Tel.: 0711 939 00 |
| Webasto | 82166 Gräfelfing | Tel.: 089 853983 |
| Krämer | 45527 Hattingen | Tel.: 02324 93620 |

Please observe the manufacturer's instructions for installing such stationary heating systems.

# 12. COLD CLIMATE APPLICATIONS

Cold start means starting of the engine without starting aid down to a specific ambient temperature.

Cold start at lower temperatures (down to abt. –30 °C) is possible in different engine types and different numbers of cylinders with an adequate battery, starter and engine-integrated starter aid (heating tube, sparking system, spark plug for engines with two-stage combustion, ether).

Consult the head office or acquisition staff for cold start limit temperatures and the necessary engine equipment.

In case of increased cold start requirements (up to abt. -40 °C), preheating is necessary for battery and fuel.

Extreme cold start requirements (colder than -40 °C) make further measures necessary. These include complete engine enclosure (avoidance of heat losses upon pre-heating) and internal engine and component pre-heating.
Consult Technical Sales Support at head office or acquisition staff for further data.

# 13. SOUND INSULATION / SOUND ABSORPTION

## 13.1 General

The nose of a diesel engine originates from many individual noise sources, e.g. intake and exhaust noise, injection-, combustion- noise, noise generated by the operation of valves, gears, bearings and the blower. Consequently, the entire surface of a diesel engine radiates air-borne noise and transmits structure-borne noise via all connecting elements and its mounting. The noise level increases, the higher the engine speed.

To reduce the noise of a diesel engine installation, special sound insulation and absorption measures will have to be taken so as to meet the – partly equipment-specific – legal regulations in the different countries.

## 13.2 Sound insulation

This is the most important acoustic measure and provides comprehensive acoustic insulation of the noise source from the environment. According to the type of installation concerned, this can be achieved by partition walls, enclosure of the engine and structure-borne sound insulation.

Partition walls or enclosures should be insulated against structure-borne sound at engine end. This is realised in the most simple way by a flexible engine mount. Sound-absorbing materials must be mounted towards the engine. Enclosures must be sealed as much as possible; the respective passages for operating elements or supply lines to the engine must also be sealed.

To increase the insulating effect of enclosures, we recommend to have them made of sandwich plates or plastic material or to mount heavy-duty laminated mats on steel plates.

In front of the engine cooling air blower or at the inlet of a cooler/fan unit, the ducting should be deflected to avoid direct noise radiation. It should be made sure that the intake duct is adequately dimensioned to keep the cooling air volume losses within permissible limits. Such ducts must be cladded with sound-absorbing materials.

Analogous measures must be taken for the discharge air and scavenging ducts of enclosed engine installations.

An initial structure-borne sound insulation is obtained when using flexible engine mounting elements. The insulation effect increases the softer the flexible mounting elements. To increase the damping effect for cab floors, a combination of mats is recommended (mass and soft intermediate layer).

## 13.2 Sound absorption

In spaces or enclosures, the effective noise level can increase, if freely reflected from the walls or side panels; thus, an additional expenditure for the insulating measures may be involved.

To reduce the vibrations and thus the sound emitted from the walls or body components, these must be covered with appropriate sound absorbing material.

Sound absorption includes, above all, lining of the enclosure with foamed or fibrous materials, the surface of which may be covered with a perforated sheeting (hole portion 50%).

When lining the enclosure of the air intake and discharge ducts, it must be made sure that the used material and adhesive are temperature-resistant (up to + 130°C). It is recommended to secure the lining mechanically to prevent loosening and obstruction of flow cross sections.

## 13.4 Sound insulation and absorption materials

Beyond sound absorption, the material examples listed below have, at the same time, an insulating effect because of material structure and weight and vice versa.

**Sound insulation:**
Sound-deadener sprayed on; thickness of the sound-deadener max. 3x plate thickness
Heavy twin-layer matting, bonded
Sandwich sheeting
Plastic plates
Double-walled construction of enclosures

**Sound absorption:**
Foamed material, at least 20 mm thick or more for air ducts, permanently bonded or mechanically fastened.

Fibrous or foamed materials, treated against trickling or soaking by a thin foil covered with perforated sheeting with a large hole portion exceeding 50%.

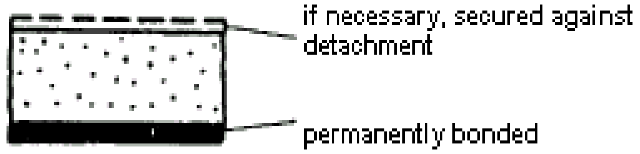
**Sound insulation:**
Uncoupling via flexible mountings or coupling of enclosure walls via flexible elements.

**Material examples:** see Fig. 13 - 1

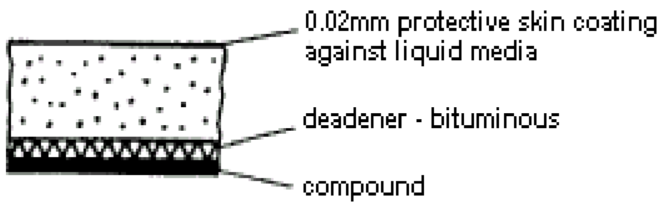
**FIG. 13 – 1** **Material examples**

**Sound-deadening material large-size sheeting and cowlings**

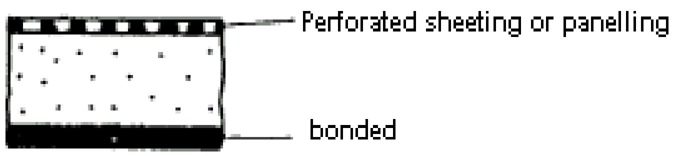

**Foamed material**
Intake air and discharge ducts



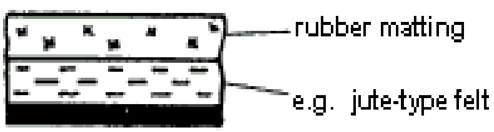

**Foamed material**
(skin-type coating)
e.g. lining of engine compartment




**Fibrous material**
e.g. rock wool or
softer fibrous material
engine compartment




**Floor covering**
driver's cabs




**Insulation matting**
partition walls

## 13.5 Additional measures required for engine enclosures

The sound insulation features a high thermal insulation which must be considered for the heat dissipation.

The temperatures inside an engine enclosure can considerably increased; therefore, attention must be paid to the temperature resistance of the engine components and used construction elements.

To reduce the thermal load in an engine compartment, it is recommended to provide a forced ventilation via an auxiliary fan or by suitable installation measures at the air intake and discharge ducts of an engine installation.

## 13.6 Notes

Detailed enclosure measure to reduce the noise generated by the diesel engine are not described here, as all silencing measures have to be matched to the overall arrangement of the driven equipment and the engine and its power take-off units.

In view of the complexity of this subject, please contact application engineering for individual applications or the Technical Support of the head office.

## 14. COOLING OF THE VIBRATION DAMPER

The torsional vibration damper fitted to the free crankshaft end of the engine must emit vibration energy to the environment in the form of heat.

To prevent damage to the vibration damper, it must be made sure that the heat energy generated in the vibration damper is dissipated by cooling.

In the case of enclosed engine installations, therefore, make sure that air – as cool as possible – circulates at the crankshaft end.

# 15. VENTILATING THE ENGINE COMPARTMENT

## 15.1. Radiation heat

The air in the engine compartment is heated up by the radiation heat of the engine, the exhaust gas system, the discharge air ducts, the power take-off units at the engine (e.g. generators, transmissions, hydraulic pumps, compressors etc.) as well as of possible auxiliary systems (heating, hot water boiler etc.).

At no point in the engine compartment, the air temperature should exceed 60 °C. Therefore, the engine compartment must be ventilated at all times.

Considering the withdrawal of cold air of the generators from the engine compartment, in the case of generator systems, the compartment temperature must be limited to lower values – observe the instructions of the generator manufacturer as regards the maximal cooling air temperature at the generator inlet.

The overall air volume passing the engine compartment is made up of:

- Combustion air - providing the combustion air can be evacuated from the compartment for thermal reasons
- Cooling air for the engine cooler
- Cooling air for the generator
- Cooling air for the hydrostatic cooler
- Air for auxiliary consumers (compressor, heating system...)
- Additional air for dissipating radiation heat

### 1. Engine radiation heat $Q_{Eng}$ :

As an average radiation heat of a diesel engine (4-stroke), 3...6% of the heat supplied by the fuel ( approx. 3...4% in turbocharged engines, approx. 5...6% in naturally aspirated engines ) applies:

$$Q_{Eng} = (0.03...0.06) \times P \times b_e \times H_U \quad [kJ/h]$$

P = Engine power in [kW]
$b_e$ = spec. fuel consumption in [kg/kWh]
$H_U$ = Calorific value fuel with 43000 [kJ/kg]
3600 [kJ] = 1 [kWh]

### 2. Generator radiant heat $Q_{Gen}$ :

The generators are normally cooled via installed fans. The cooling air is withdrawn from the compartment and returned to it again. When designing the engine compartment ventilation, this heat must be considered. This heat (lost heat) is calculated as follows:

$$Q_{Gen} = P_{Gen} \times [1-(\eta/100)] \times \cos\varphi \times 3600 \quad [kJ/h]$$

$P_{Gen}$ = Generator power [kVA]
$\cos\varphi$ = Power factor [ - ]
$\eta$ = mech. Efficiency Generator [%]
3600 [kJ] = 1 [kWh]

The specific cooling air requirement of the generators is abt. 3 [m³/(min and kW-lost heat)]

### 3. Auxiliary systems $Q_{aux}$:

It is difficult to determine the radiation heat amounts of exhaust gas pipes, silencers, oil lines, discharge air ducts and discharge air leaks, pump units, compressors, boilers or similar. From experience, it is known that these radiation portions are considered sufficiently precise with abt. 10 % of the engine radiation heat.

$$Q_{aux} = 0.1 \times Q_{Eng} \quad [kJ/h]$$

## 4. Overall radiation heat $Q_{total}$:

| |
|---|
| $Q_{total} = Q_{Engine} + Q_{Gen} + Q_{z\ total}$ [kJ/h] |

## 15.2 Air volume for ventilating the engine compartment:

The air volume required for ventilating the engine compartment results from

| | |
|---|---|
| $M_{Air} = Q_{total} / (\Delta T \times c_p)$ [kg/h] with | $c_p$ = specif. heat of air = 1 [kJ/kg°C]<br>$\Delta T$ = perm. temperature increase in the engine compartment [°C]<br>usually about 12 °C at 35 °C ambient temperature at outside. |

or the required air volume according to the following relation

| |
|---|
| $V_{Air} = M_{Air} / \rho$ [m³/h] with $\rho$ = 1.29 [kg/m³] as spec. air weight at 0 °C, 1 bar |

For many engine installations, the air flow of the engine cooler fan or axial fan of separate cooling systems is simultaneously used for ventilating the engine compartment. Here, it must be checked, in how far the related pre-heating of the cooling air and the subsequent reduced cooling capacity of the separate cooling system can still be tolerated.

Tolerable pre-heating of the cooling air and the combustion air is up to 10 °C but you are urgently recommended to always take the combustion air for the engine from the free, unheated environment with a pipe.

The influence of the cold engine compartment walls as well as floors and ceilings on the heat dissipation must be individually assessed for the respective case.

## 15.3 Crankcase breathing system:

NOTE: **Crankcase breathing system**

In the case of engines without re-circulating crankcase breathing, the crankcase gases flow into the engine compartment so that particular precautionary measures may become necessary.

The DEUTZ engines are fitted almost exclusively with re-circulating crankcase breathing systems so that here no further measures are required for breathing the engine compartment.

# 16. INSTALLATION SURVEY BY MEASUREMENT

For a final assessment of an engine installation, the following examinations must be made by measurement:

## 16.1 Temperature test:

In installed condition (in the equipment), an engine must operate at its full power- without restrictions.

Therefore, the temperature test is performed under full engine power (nominal power of the engine at nominal speed) over a period of at least 45 minutes or until all temperature values are steady.

If, in view of a specific application, continuous operation of the engine at its maximal speed must be expected, an additional test run must be made also at that operating point.

If engine full load cannot be represented in this test, as the equipment is not suitable regarding its operating capacity (equipment utilization under 100% engine full load), the test must be run with the maximally possible equipment utilization and this condition must be remarked in the log of results as "practical utilization".

**The oil thermostat in the B/FL/M1011F/2011 must be short-circuited and the blower regulator in the B/FL413F/513/913/914 bypassed additionally if necessary prior to starting the test.**

The following temperatures must be measured – also see measuring diagram:

| | |
|---|---|
| 1 | Ambient temperature of the free environment (in shadow).<br>This temperature value is important for assessing the cooling system (application limit). |
| 2 | Air temperature at the cooling air inlet in front of the equipment |
| 3<br>4<br>5<br>6 | At least four pickup points in 12°°, 3°°, 6°°, 9°° position at the blower inlet to determine the cooling air temperature of the engine (integrated cooling) or before the cooler network (external cooling B/FM1011/2011) |
| 7 | Combustion air temperature at filter inlet |
| 8 | Combustion air temperature in front of turbo charger inlet |
| 9 | Charge air temperature in front of intercooler (combustion air behind turbocharger)<br>(with separate intercoolers) |
| 10 | Charge air temperature behind intercooler<br>(with separate intercoolers) |
| 11 | Exhaust gas temperature behind turbocharger<br>(approx. 180 mm to 250 mm after turbocharger outlet) |
| 12 | Lube oil temperature behind engine outlet (1011/2011) or in the oil tray or at the oil filter console (912/913/413/513)<br>This temperature value is important for evaluating the cooling system or for determining the application limit of the engine installed in the equipment. |
| 13 | Cylinder head temperature at cyl. 1 or 2<br>(not in oil-cooled engines 1011/2011) |
| 14 | Engine compartment temperature left-hand/right-hand above engine<br>at a distance of abt. 0.2 to 0.4 m from engine surface<br>(only in B/FM1011/2011) |

**15** Cooling air inlet temperature alternator

**16** Fuel temperature (in tank, if necessary, in front of feed pump inlet)
(tank at least ½ full)

**17** In the close vicinity of the starter solenoid switch

**18** Vicinity of electronic control unit

## 16.2 Pressure measurements:

**P0** Pressure in the free atmosphere at the time of temperature measurement.
The sufficient supply of the engine with cooling air is assessed by determining the flow resistances in the air inlet and outlet on the results of which the actual engine application limit depends with regard to ambient temperature.
Especially when using the BFM1011/2011 engines it is necessary to record the air pressure P0 in the free atmosphere effective at the time of the temperature measurement because the actual ambient temperature limit for the equipment application can be determined in the external cooling systems by a computer program (available from application engineering).

**P1** Cooling air back pressure (also known as hood pressure) behind blower in free standing engine (without inlet and outlet air).
Measurement at high idle speed. Measuring sites see chapter 1.

**P2** Cooling air back pressure (also known as hood pressure) behind blower in engine **with** inlet air, **without** outlet air. Measurement at high idle speed.
Difference $P_1 – P_2$ is the inlet air resistance.
{[ $P_1 – P_2$ ] / $P_1$ } 100 is the percentage cooling air loss $\Delta P_{in}$

**P3** Cooling air back pressure (also known as hood pressure) behind blower in engine **without** inlet air, **with** outlet air. Measurement at high idle speed
Difference $P_3 – P_1$ is the outlet air resistance.
{[ $P_1 – P_2$ ] / $P_1$ } 100 is the percentage cooling air loss $\Delta P_{out}$

**THE SUM OF $\Delta P_{IN}$ + $\Delta P_{OUT}$ MUST BE BELOW 10% IF POSSIBLE.**

**P4** Combustion air vacuum pressure at filter outlet (connection servicing switch).
For new filter cartridges, the vacuum pressure should not exceed 20 mbar (2 kPa).
Measurement at rated idling speed in suction intake engines Always measure under full load in turbocharged engines.

**P5** Charge air pressure behind turbocharger or in front of intercooler.
Measurement only in engines with external cooling systems but always under engine full load.

**P6** Charge air pressure behind intercooler or in front of engine inlet.
Measurement only in engines with external cooling systems but always under engine full load.
The test is considered passed, if the pressure difference is P5 - P6 ≤ 120 mbar.

**P7** Exhaust gas back pressure behind exhaust manifold / behind turbocharger outlet
Measurement in suction intake engines at rated idling speed, the measured value must be multiplied by 1.66 to get the full load value to be evaluated.
Measurement in engines with turbocharger always under full load.
The test is considered passed, if the pressure value is equal or below 75 mbar (7.5 kPa)

**P8** Fuel vacuum in front of inlet of fuel feed pump.
The test is considered passed if the pressure value is between –0.20 bar to 0 bar at a max. rated engine speed and clean pre-filters.

**Pickup points:**

| | | |
|---|---|---|
| for pressures: | Threaded nipple M12x1.5 or threaded bore M10x1 | (P1,P5,P6) |
| | Threaded nipple M10x1 | (P8) |
| for temperatures: | Threaded bore M8x1 or M14x1.5 | (9,10,11) |

## 16.3. Temperature limit values

The engine installation must be such that, during continuous operation of the engine under nominal load (or at max. torque) and the respective application limit temperatures of the equipment, the following temperatures are not exceeded:

- Cooling air temperature (at the blower inlet) $T_{anbient}$ + 10 [°C]
- Cooling air (suction fan in internal cooling systems) $T_{ambient} + \leq 5$ [°C]
- Cooling air (pusher-type fan in external cooling systems) $T_{ambient} + \leq 15$ [°C]

- cylinder head temperature (cylinder head base, air inlet side)

| | | | |
|---|---|---|---|
| FL 912/912F | on cylinder 1 | Warning temperature | 190 [°C] |
| FL 913/914 | on cylinder 1 | Warning temperature | 205 [°C] |
| BF4/6L 913/914 | on cylinder 1 | Warning temperature | 230 [°C] |
| BF4/6L 913C/914C | on cylinder 1 | Warning temperature | 220 [°C] |
| B/FL 413 F/FC | A2 / B3 | Warning temperature | 220 [°C] |
| B/FL 413 FW | A1 / B1 | Warning temperature | 220 [°C] |
| B7FL 513 C/CP | A2 / B2 | Warning temperature | 220 [°C] |

- Engine oil (measured in sump) 140 [°C]
- Engine oil as coolant in B/FM1011F/2011 (cooler inlet) 135 [°C]

- Fuel (in tank) 60 [°C]
  (inlet feed pump) 60 [°C]

- Exhaust gas (behind outlet of exhaust manifold in suction intake engines)

| | | |
|---|---|---|
| (behind outlet of exhaust manifold in suction intake engines) | 913/914 | 650 [°C] |
| | 413F/513 | 650 [°C] |
| | 1011F/2011 | 700 [°C] |
| (behind turbocharger outlet ) | 913/914 | 600 [°C] |
| | 413F/513 | 600 [°C] |
| | 1011F/2011 | 650 [°C] |

- Combustion air (inlet engine) $T_{anbient}$ + 10 [°C]
  (inlet air filter) $T_{anbient}$ + 10 [°C]

- Combustion air behind intercooler
  ( at 25°C T-ambient to be observed in view of EUROI,COMI : 60°C) 90 [°C]
  ( at 25°C T-ambient to be observed in view of EUROII,COMII : 50°C) 80 [°C]
  ( at 25°C T-ambient to be observed in view of EUROIII : 42°C) 70 [°C]

- Starter (housing and housing solenoid switch) 100 [°C]

- Generator (cooling air, inlet to suction nozzles) 80 [°C]
  (housing) 80 [°C]

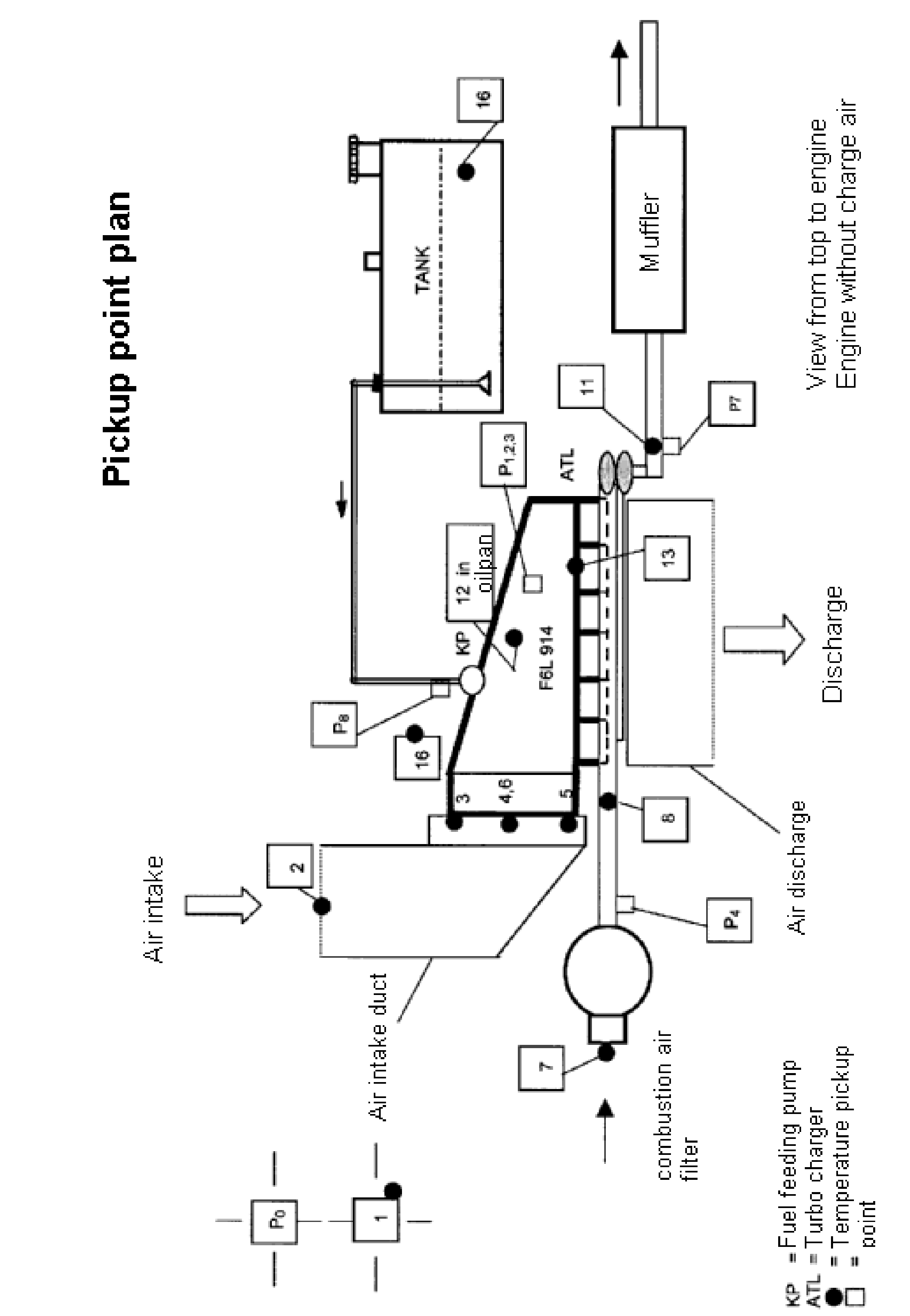
- External voltage regulator (housing) 75 [°C]

- Solenoid valve 65 [°C]

| | | |
|---|---|---|
| • Ignition/starter switch | | 55 [°C] |
| • Relay (ignition plug, heating flange) | | 65 [°C] |
| • Fuel feed pump | (ambient air) | 80 [°C] |
| • Battery | (ambient air) | 60 [°C] |
| • Electronic control units | | 80 [°C] |

## 16.4 Pickup point plan

**Figure 16 – 1**



# 17. ACCESSIBILITY FOR SERVICING AND MAINTENANCE JOBS

## 17.1 General

A correct installation must not only meet the technical requirements but also ensure an easy access to parts requiring maintenance work.

If this accessibility is not given, there is always the risk that the necessary maintenance jobs are not carried out at all or not at the specified intervals. This will inevitably lead to increased wear and premature failure of the engine.

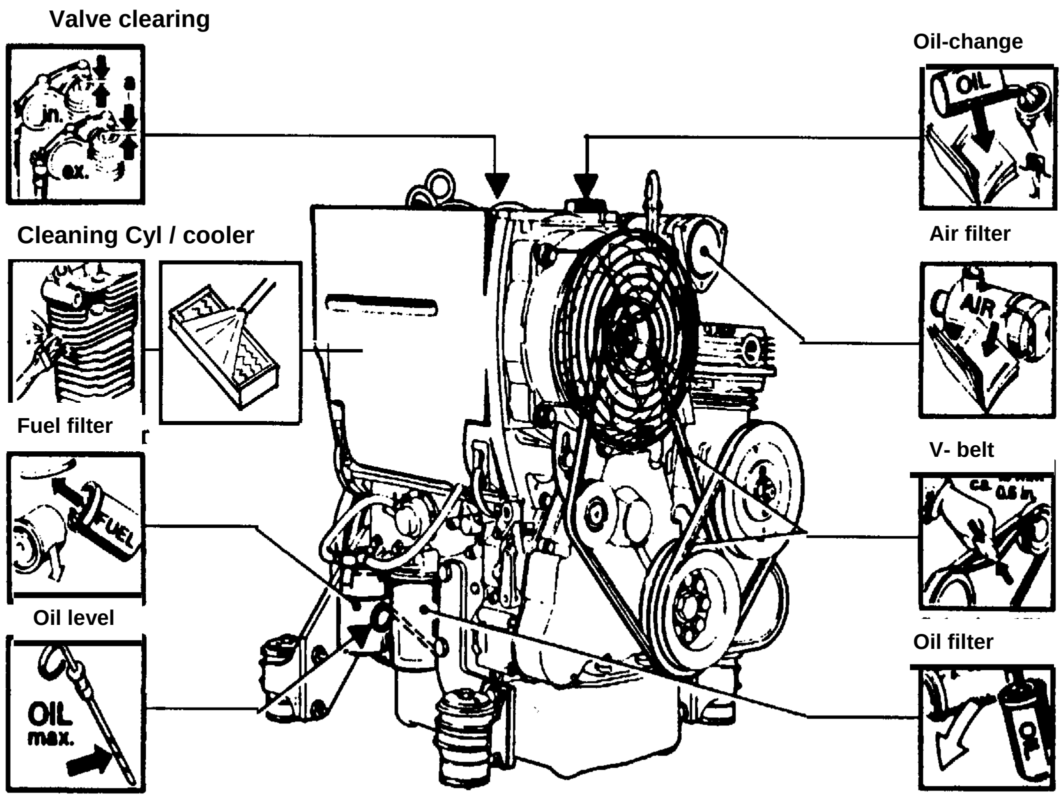
> **The self-adhering servicing pictures (see also operating manuals) with the references to the engine servicing works or filter changing works must be stuck at a well-visible place within the working area of the operating staff.**

## 17.2 Maintenance jobs requiring easy and convenient access

Maintenance jobs which should be carried out with direct access wherever practicable, i.e. without having to remove parts or plates and without having to overcome other kinds of access problems:

- Checking oil level in engine
- Refilling oil
- Engine oil change
- Cleaning spin filter (fan hub)
- Renewing lube oil filter and fuel filter cartridge
- Checking and cleaning air filter
- Cleaning cooling fins and cooling system
- Draining oil/water condensation in LLK
- Checking and, if necessary, tightening V-belt tension
- Checking spark plug function
- Battery servicing works
- Breathing fuel pipes

Fig. 17-1




## 17.3 Maintenance jobs not requiring easy access

For the following maintenance works, reduced accessibility can be accepted in view of extended maintenance intervals:

- Checking generators and regulators
- Checking starter
- Checking injection pump
- Setting valves
- Checking and renewing injectors
- Cleaning exhaust gas turbocharger
- Renewing toothed belts
- Turning over

<u>Note:</u>

The transport eyes may not be left on the engine, they must be dismantled.

# 18. ANNEX

## 18.1 Calculation formulae for internal combustion engines

### Exhaust gas volume flow rate:

In the pocket book, the exhaust gas volume flow rate M [kg/h] is indicated related to 25 °C. To determine the actual volume flow rate $V_W$, the first "cold" volume flow rate $V_K$ is ascertained:

| | | |
|---|---|---|
| $V_K = M / \rho$ [m³/h] | with | M [kg-exhaust/h] from pocket book<br>$\rho$ [kg-exhaust/m³] = 1.18 |

The actual volume flow rate $V_W$ is calculated with the aid of the exhaust gas temperature "t" at the respective power – see engine map – neglecting the influence of pressure:

$$V_W = V_K \times (273 + t) / 298 \quad [m^3/h]$$

### Swept volume:

$$V_H = (\pi \times D^2 \times s \times z) / 4 \times 10^6 \quad [ltr]$$

| | | |
|---|---|---|
| $V_H$ | = Swept volume | [ltr] |
| D | = Bore diameter | [mm] |
| s | = Stroke | [mm] |
| z | = Number of cylinders | |
| $\pi$ | = 3.12 for German swept volume | |

### Piston speed:

$$c_m = s \times n / 30000 \quad [m/s]$$

| | | |
|---|---|---|
| $c_m$ | = Mean piston speed | [m/s] |
| s | = Stroke | [mm] |
| n | = Engine speed | [1/min] |

### Circumferential speed

$$c_U = r \times (\pi \times n) / 30 \quad [m/s]$$

| | | |
|---|---|---|
| $c_U$ | = Circumferential speed | [m/s] |
| r | = Radius | [m] |
| n | = Speed | [1/min] |

### Power/torque

**Old units**

$$N = V_H \times p_e \times n / 900 \quad [PS]$$

$$T_d = 716,2 \times N / n \quad [kpm]$$

**SI-units**

$$P = V_H \times p_{me} \times n / 1200 \quad [kW]$$

$$T = 9550 \times P / n \quad [Nm]$$

| | | |
|---|---|---|
| N | = Power | [PS] |
| $V_H$ | = Swept volume | [ltr] |
| $P_e$ | = Mean effect. pressure | [kp/cm²] |
| n | = Engine speed | [1/min] |
| $T_d$ | = Torque | [kpm] |

| | | |
|---|---|---|
| P | = Power | [kW] |
| $V_H$ | = Swept volume | [ltr] |
| $p_{me}$ | = Mean effec. pressure | [bar] |
| n | = Engine speed | [1/min] |
| T | = Torque | [Nm] |

## 18.2 Formal connections concerning fans and coolant pumps

The centrifugal pumps used as coolant pumps on DEUTZ diesel engines and the fans are fluid flow engines and, as such, are subject to the same physical laws.

For the calculation of the volume flow rates, pressures and the power requirement at different speeds, the following equations apply.

**Volume flow rate**: $V_1 = n_1 \times V / n$ [m³/min]

**Delivery head:** $\Delta p_1 = (n_1 / n)^2 \times \Delta p$ [mbar]

**Power requirement:** $P_1 = (n_1 / n)^3 \times P$ [kW]

**Torque:** $T_1 = (n_1 / n)^2 \times T$ [Nm]

Where:

**n** = Speed of coolant pump or of fan [1/min)

**Δp** = Pressure difference between suction- and delivery side [mbar]

**P** = Power requirement in [kW] at speed n

**T** = Torque requirement in [Nm] at speed n

$_1$ = Index 1 (condition 1)

## 18.3 Engine lube oil

Technical Circular 0199 – 99 – 1119

Technical Circular 0199 – 99 – 3002

# Technical Circular

## 0199 - 99 - 1119 en

## 3rd Exchange

Product :

**High-speed DEUTZ engines**

| Date : 19.03.1999 | This Circular supersedes TC : 0199-99-1119 2nd Exchange 10.06.1998 |
|---|---|

TR

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Address:

Note : The part numbers stated in this documentation are not subject to the modifikation service. For identifying spare parts, the spare part documentation has to be referred to.

## DEUTZ engine - Lube oil change after analysis

The lube oil change for air-cooled and liquid-cooled DEUTZ engines is to be primarily based on running hours, see Technical Circular 0199-3002 and Operation Manual. The lube oil change intervals specified therein have been detemined during test runs; in this case the engine condition after termination of the trest runs served in the first place as reference basis and only in the second place the condition of the lube oil.

The specified lube oil change intervals may be extended if it is ensured through a sufficient number of use-oil analyses (approx. 4 measurements within a lube oil change interval) that the limits specified in the enclosure are observed. In this connection, the lube oil change intervals specified in TC 0199-3002 and the Operation Manual must not be exceeded by more than 50%.

The measuring methods for determining the limit values must be applied according to the applicable DIN standards. Equivalent analysis methods (e.g. ISO, ASTM, IP, CEC) may be used analogously.

Lube oil analyses must be conducted in an appropriate laboratory, e.g. of the lubricant suppliers. In our fuel and oil laboratory analyses can be conducted, against reimbursement of the costs involved, at the following address:

DEUTZ AG
R&D Center Porz
Dept. EK-T 1, Chemical Laboratory
Ottostrasse 1
D-51149 Köln

The following will be required to carry out an oil analysis:

- approx. 0.25 - 0.5 l of used oil, if possible a fresh-oil sample
- data on operating hours with the oil filling
- data on engine (type, power, operating conditions, engine running hours, engine serial number)
- type and data sheet of the lube oil used

☞ It is not possible to draw any conclusions on the engine wear characteristics solely from the results of the lube oil analysis.

If extended lube oil change intervals are applied after the analysis, please inform our chemical laboratory accordingly.

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## Explanation of major lube oil characteristics

**Viscosity**
The kinematic viscosity is quoted in $mm^2/s$ at a given temperature (1 $mm^2/s$ = 1 cSt - Centistoke-). A too high viscosity may involve engine starting problems, a too low viscosity may deteriorate the lubricating effect and result in increased lube oil consumption.

**Water content**
The water content permits conclusions concerning a possible cooling water loss and results in mechanical engine stress.

**Base number**
The base number (TBN = Total Base Number) is a measure for the possibility to neutralize acid compounds, which as a result of engine combustion enter the lube oil.

**Diesel fuel or bio fuel content**
The ingress of fuel into the engine oil may considerably change the viscosity.

**Soot content**
The soot content gives an indication of the remaining dirt sustaining capacity of the used lube oil. The method is not suited for determining other contaminations, such as dust, metal abrasion and calcium sulfate.

**Silicon**
The silicon content in used lube oils, caused, for instance, by dust and abrasion, gives an indication of the mechanical wear in the engines.

**Total contamination**
The total contamination (=content of solid particles) is primarily caused by unsolved substances, e.g. soot, oil-insoluble reaction products, metal abrasion. It permits to draw conclusions concerning the usability of the lube oil and the operating conditions.

DEUTZ AG
Service-Engineering

i.V. Sonntag
- Sonntag -

i.A. Asselborn
- Asselborn -

| DEUTZ | Limit Values for<br>Lube Oil Change after Analysis<br>DEUTZ Engines | Annexo to<br>TR 0199-99-1119<br>3rd Exchange |
|---|---|---|

| Measured value | Limit value | Test method |
|---|---|---|
| Viscosity | Change of kinematic viscosity at 100°C by max. one SAE class (see definition of SAE viscosity class) | DIN 51366 |
| Base number (TBN) | drop by max. 50 % | DIN ISO 3771 |
| Contamination | | |
| Water content | max. 0,2 % by weight | DIN 51777 |
| Fuel content | max 10,0 % by weight | DIN 51380 or DIN 51356 |
| Bio diesel fuel | max. 5,0 % by weight series 1012/1013<br>max. 10,0 % by weight all other engines | (evaluation C=O-Bande w. 1745 $cm^{-1}$) DIN 51451 |
| Soot content | max. 3,0 % by weight | DIN 51452 |
| Total contamination | max. 4,0 % by weightt (solid foreign matter) | DIN 51365 |
| Silicon | max. 20,0 mg/kg | DIN 51396 or 51390 |
| Wearing metals | | |
| Iron | max. 150,0 mg/kg | DIN 51396 or 51397 |
| Copper | max. 20,0 mg/kg | DIN 51396 |
| Aluminium | max. 25,0 mg/kg | DIN 51396 |
| Lead | max. 30,0 mg/kg | DIN 51396 |
| Chromium | max. 20,0 mg/kg | DIN 51396 |
| Zinc | max. 15,0 mg/kg | DIN 51396 |

Definition of SAE viscosity classes for engine oils to DIN 51511:

| SAE classes | Viscosity in fresh oil at 100°C ($mm^2/s$) | Viscosity still permissible in used oil at 100°C ($mm^2/s$) |
|---|---|---|
| SAE 20 (single-grade oil)<br>SAE ..W20 (multi-grade oil) | 5,6 - 9,3 | 4,1 - 12,5 |
| SAE 30 (single-grade oil)<br>SAE ..W30 (multi-grade oil) | 9,3 - 12,5 | 5,6 - 16,3 |
| SAE 40 (single-grade oil)<br>SAE ..W40 (multi-grade oil) | 12,5 - 16,3 | 9,3 - 21,9 |

If one or several values are exceeded or not reached, the engine oil must be changed.

DEUTZ AG
Deutz-Mülheimer Straße 147-149
51063 Köln

# Technical Circular
## 0199 - 99 - 3002 en
## 5th Exchange

Product :
**High-speed DEUTZ engine**

Date : 30.04.2002

This Circular supersedes TC :
0199-3002 4st Exchange of 31.7.2001

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Drawn up by : VS-TII 1 Phone: (0221) 822 - 3687
Fax: (0221) 822 - 2752

Note : The part numbers indicated in this document serve technical explanation purposes. Exclusively the spare parts documentation is binding for the definition of spare parts.

## Lube oil

The 5th exchange circular will be issued because of

- introduction of DEUTZ lube oil quality classes
- supplement of engine series 914
- updating section 4, lube oil change intervals
- updating section 5, lube oil filter servicing
- updating of lube oil table, enclosure 1

This Technical circular applies to all air-cooled and liquid-cooled high-speed DEUTZ engines.

In case you need clarification concerning any predecessor engines no longer included in the build program, please contact your DEUTZ service.

## Table of contents



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## 1 Lube oil in general

Modern diesel engines make very high demands of the lube oil used. The specific engine powers having been continuously uprated in the course of the past few years result in an increased thermal load acting on the oil; furthermore reduced oil consumptions and extended oil change intervals increase the load to which the oil is subjected through contamination. For this reason it is necessary to observe the requirements and recommendations described in this Technical Circular in order not to reduce the engine service life.

Lube oils always consist of a basic oil and an additive package. The major tasks a lube oil has to fulfil (e.g. protection against wear, protection against corrosion, neutralization of acids from combustion products, preventing coke and soot deposits on engine components) are taken over by the additives. The properties of the basic oil co-determine, however, the quality of the product, e.g. with regard to thermal load.

Engine oil mixtures should be avoided as the poorest properties of the mixture always dominate. As a rule, all engine oils are intermixable so that a complete lube oil change from one oil type to another is no problem under the aspect of mixability

For the use of high-speed DEUTZ engines, we recommend the **DEUTZ OIL TLS-15W40D**. This oil meets all requirements of the DEUTZ lube oil quality class **DQC II**, it is matched to the requirements of the engines and has proven best during engine operation under rough conditions.

For engines with special oil requirements (turbocharged engines with increased power and engines with high load, see section 6), the **DEUTZ OIL TLX-10W40FE** is recommended (corresponding to the DEUTZ lube oil quality class **DQC III**).

## 2 Lube oil grade

The lube oil grade has an essential influence on service life, power and thus operating economy of the engine. The performance and thus the quality of the lube oil is determined through standardized lab tests and test bench runs.

Lube oils which are mainly intended for the European market are tested and classified according to ACEA regulations (ACEA = Association des Constructeurs Eureopean d'Automobiles, previously CCMC = Comité des Constructeurs Européen d'Automobile du Marché Commun). The test comprises lab tests to determine physical-chemical properties of the oils and comprehensive engine tests on European engines representing state-of-the-art technology.

Lube oils for the American market are tested analogously in accordance with API (American Petroleum Institute).

These specifications are applied worldwide. In Europe, the ACEA classification should be given preference over the API classification. With DHD-1, ACEA and the American and Japanese associations of engine manufacturers EMA and JAMA have introduced a new worldwide lube oil specification which incorporates the requirements specified by ACEA E5-99, API CH-4 and JAMA DX(H).

Permissible lube oil grades for DEUTZ engines:

| DEUTZ lube oil quality class | DQC I | DQC II | DQC III |
|---|---|---|---|
| ACEA-classification | E2-96 | E3-96/E5-02 | E4-99 |
| API-classification | CF/CF-4 | CG-4/CH-4 | - |
| Worldwide specification | - | DHD-1 | - |

The precise assignment of the admissible oil qualities to the engines is indicated in the tables of section 4.

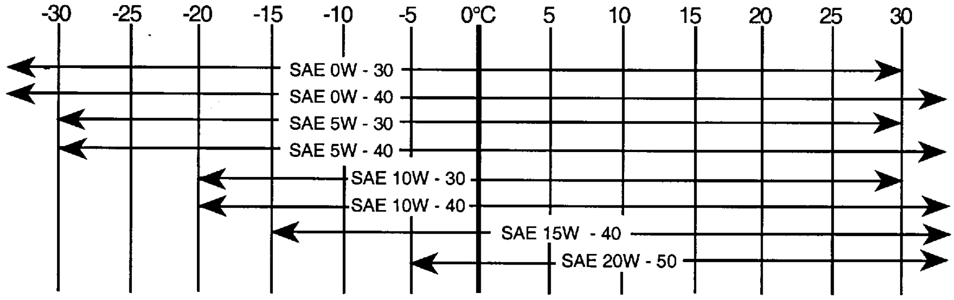
In regions where none of these grades is available, please contact the relevant DEUTZ service.

## 3 Lube oil viscosity

The ambient temperature at the operating site or operating area of the engine is decisive for selection of the proper viscosity class. An extremely high viscosity may cause starting problems, a too low viscosity may affect the lubricating efficiency and lead to excessive oil consumption. At too low ambient temperatures the engine oil may have to be preheated.

The viscosity is classified according to SAE. Generally, multi-grade oils shall be used. In closed heated rooms at temperatures >5°C, also single-grade oils can be used. The indicated lube oil grades must, of course, also be observed for single-grade oils.

We recommend the following commonly used viscosity classes depending on the ambient temperature:




## 4 Lube oil change intervals

The lube oil change intervals depend on the lube oil grade, the sulphur content in the fuel and the operating conditions. The first lube oil change after initial commissioning or restarting after a major repair (general overhaul) is made after about 50 running hours for engines 226/413/513/912/913/1008, see operating manual.

The lube oil change intervals specified for industrial engines are indicated in running hours (hrs), and for automotive engines in mileage (km). It is possible to adapt the lube oil change intervals to the service intervals specified by our OEMs for the equipment (construction equipment, tractors, etc.). In such a case the lube oil change intervals indicated in tables 4.1 and 4.2 must not be exceeded, however.

An extension of the specified lube oil change intervals is possible, if it is made sure by a sufficient number of old oil analyses that the lube oil quality is still sufficient, see TC 0199-99-1119.

<u>Notes to table 4.1, lube oil change for industrial and marine engines</u>

Oil use under normal duty for engines with low to medium load (up to 70%)

Examples for industrial engines:

Rollers, industrial trucks, rail traction units, emergency pumps

Examples for marine engines:

Ferries, port boats, light fishing boats, river boats, auxiliary drives

Oil use under high duty for engines with high load (> 70%) or upon other affecting factors (e.g. high dust load or strongly dynamic operation)

Examples for industrial engines:

Tractors, harvesting machines, underground equipment, wheel loaders, hydraulic excavators, road graders, waste compactors, block-type thermal power stations, gensets for running in parallel with the mains, engines with two-stage combustion

Examples for marine engines:

High-speed boats, catamarans, yachts, gliders, genset drives

The assignment of the load to the applications is oriented to the examples. In the individual case, another assignment can result.

<u>Notes to tables 4.1 and 4.2</u>

- If the indicated times or mileages are not reached within one year, the lube oil change must be made at least once per year.
  Special data for emergency power unit as per TC 0199-99-1126.

- The oil change intervals are subject to the following conditions:
  - Prevailing ambient temperatures ≥ -10°C ( ≥ +14 °F)
  - Sulfur content in the fuel ≤0.5 % by weight
- The oil change intervals shall be halved with
  - prevailing ambient temperatures < -10°C (< +14°F) and oil temperatures < 60°C
  **or**
  - sulfur content in the fuel > 0.5 % to 1 % by weight
  **or**
  - operation on bio diesel fuel according to DIN 51606-FAME.

### 4.1 Lube oil change intervals for industrial and marine engines

| | Lube oil grade | | |
|---|---|---|---|
| **Deutz lube oil quality class** | **DQC I** | **DQC II** | **DQC III** |
| ACEA-specfication | E2-96 | E3-96/E5-02 | E4-99 |
| API-specification | CF/CF-4 | CG-4/CH-4 | - |
| Worldwide specification | - | DHD-1 | - |
| special DEUTZ release list | - | - | Enclosure 1 |
| Standard lube oil code for building equipment and nonraod vehicles | EO... EO...A, EO...B | EO...C | - |

| Engine series | Engine version | Lube oil change intervals in op. hours | | | | | |
|---|---|---|---|---|---|---|---|
| | | Oil use (DQC I) | | Oil use (DQC II) | | Oil use (DQC III) | |
| | | normal | high | normal | high | normal | high |
| 1008 | All engines | 125 | 125 | 125 | 125 | 125 | 125 |
| 1011/2011 | Naturally aspirated engines | 1000 | 500 | 1000 | 500 | 1000 | 500 |
| | Turbocharged engines | 250 | 125 | 500 | 250 | 500 | 250 |
| 226/413 | Naturally aspirated engines | 500 | 250 | 500 | 250 | 500 | 250 |
| 513/912 | Turbocharged engines | 250 | 125 | 500 | 250 | 500 | 250 |
| 913/914 | Naturally aspirated engines | 500 | 250 | 500 | 250 | 500 | 250 |
| | Turbocharged engines | 250 | 125 | 500 | 250 | 500 | 250 |
| | BF6L913/914C with 176kW at 2500 1/min | - | - | - | - | 500 | 250 |
| 1012 | All engines except for: | 250 | | 500 | | 500 | |
| | eng. in harv. machines, block-typethermal power stat., gensets* | - | | - | | 500 | |
| 1013 | All engines except for: | 250 | | 500 | | 500 | |
| | engines from nonroad stage II | - | | 500 | | 500 | |
| | eng. in harv. machines, block-typethermal power stat., gensets* | - | | - | | 500 | |
| | BF4M1013FC | - | | - | | 500 | |
| | BF6M1013FC, P≤200 kW | - | | - | | 500 | |
| | BF6M1013FC, P>200 kW | - | | - | | 250 | |
| 2012 | All engines except for: | 250 | | 500 | | 500 | |
| | BF4M2012C P>95 kW | - | | - | | 500 | |
| | BF6M2012C P > 143 kW, from nonroad stage II at cylinder bore 101 mm or 98 mm with MV system | - | | - | | 500 | |
| | BF6M2012C P > 135 kW, from nonroad stage II at cylinder bore 98 mm with mech. injection system | - | | - | | 500 | |
| | Other engines from nonroad stage II | - | | 500 | | 500 | |
| | eng. in harv. machines, block-typethermal power stat., gensets* | - | | - | | 500 | |
| 2013 | All engines except for: | 250 | | 500 | | 500 | |
| | Engines from nonroad stage II | - | | 500 | | 500 | |
| | BF4M2013C, P>90 kW | - | | - | | 500 | |
| | BF6M2013C, P>120 kW | - | | - | | 500 | |
| | eng. in harv. machines, block-typethermal power stat., gensets* | - | | - | | 500 | |
| 1015 | All engines except for: | 250 | 125 | 500 | 250 | 500 | 250 |
| | 1015C from nonroad stage II | - | - | 500 | 250 | 500 | 250 |
| | 1015CP | - | - | - | - | 500 | 250 |
| | BF6M1015MC P≤300 kW | - | - | 500 | 250 | 500 | 250 |
| | BF8M1015MC P≤400 kW | - | - | 500 | 250 | 500 | 250 |
| | BF6M1015MC P>300 kW | - | - | - | - | 500 | 250 |
| | BF8M1015MC P>400 kW | - | - | - | - | 500 | 250 |
| 2015 | All engines | - | - | - | - | 500 | |

* Gensets as referred to here are units operating in parallel with the mains / with each other.
Emergency power units are dealt with in TC 0199-99-1126.

Printed in Germany  Page 4 of 8

## 4.2 Oil change intervals for vehicle engines

| Application | Average speed in km/h approx. | Engine version | | | DQC I | DQC II | DQC III |
|---|---|---|---|---|---|---|---|
| | | | | | Schmieröl-Qualität | | |
| | | **Deutz lube oil quality class** | | | **DQC I** | **DQC II** | **DQC III** |
| | | ACEA specification | | | E2-96 | E3-96/E5-02 | E4-99 |
| | | API specification | | | CF/CF-4 | CG-4/CH-4 | - |
| | | worldwide specification | | | - | DHD-1 | - |
| | | special DEUTZ release | | | - | - | Enclosure 1 |
| **Application** | | **Engine version** | | | **Lube oil change intervals in km** | | |
| Site vehicles/ city busses | 25 | **226/413/513/912/913/914** | | Naturally aspirated engines | 15000 | 15000 | 20000 |
| | | | | Turbocharged engines | 10000 | 15000 | 20000 |
| | | **1012/1013/2012/2013** | | Euro I | 10000 | 15000 | 20000 |
| | | | | Euro II and Euro III, except for: | - | 15000 | 20000 |
| | | | BF4M1013FC | Euro II ≤ 14 l oil contents (first filling) | - | - | 10000 |
| | | | | > 14 l oil contents (first filling) | - | - | 20000 |
| | | | | Euro III | - | - | 20000 |
| | | | BF6M1013FC | Euro II ≤ 19 l oil contents (first filling) | - | - | 10000 |
| | | | | > 19 l oil contents (first filling) | - | - | 20000 |
| | | | | Euro III | - | - | 20000 |
| | | | BF4M2012C | > 95 kW from Euro II | - | - | 20000 |
| | | | BF6M2012C | > 143 kW from Euro II at cylinder bore 101 mm with or 98 mm with MV system | - | - | 20000 |
| | | | | > 135 kW from Euro II at cylinder bore 98 mm with mechanical injection system | - | - | 20000 |
| | | | BF4M2013C | > 90 kW | - | - | 20000 |
| | | | BF6M2013C | >120 kW | - | - | 20000 |
| | | **1015** | | Euro I, except for: | - | 15000 | 20000 |
| | | | 1015CP | Euro II | - | - | 20000 |
| | | **2015** | | Euro III | - | - | 20000 |
| Local traffic | 40 | **226/413/513/912/913/914** | | Naturally aspirated engines | 20000 | 20000 | 30000 |
| | | | | Turbocharged engines | 15000 | 20000 | 30000 |
| | | **1012/1013/2012/2013** | | Euro I | 15000 | 20000 | 30000 |
| | | | | Euro II and Euro III, except for: | - | 20000 | 30000 |
| | | | BF4M1013FC | Euro II ≤ 14 l oil contents (first filling) | - | - | 15000 |
| | | | | > 14 l oil contents (first filling) | - | - | 30000 |
| | | | | Euro III | - | - | 30000 |
| | | | BF6M1013FC | Euro II ≤ 19 l oil contents (first filling) | - | - | 15000 |
| | | | | > 19 l oil contents (first filling) | - | - | 30000 |
| | | | | Euro III | - | - | 30000 |
| | | | BF4M2012C | > 95 kW from Euro II | - | - | 30000 |
| | | | BF6M2012C | > 143 kW from Euro II at cylinder bore 101 mm with or 98 mm with MV system | - | - | 30000 |
| | | | | > 135 kW from Euro II at cylinder bore 98 mm with mechanical injection system | - | - | 30000 |
| | | | BF4M2013C | > 90 kW | - | - | 30000 |
| | | | BF6M2013C | >120 kW | - | - | 30000 |
| | | **1015** | | Euro I, außer: | - | 20000 | 30000 |
| | | | 1015CP | Euro II | - | - | 30000 |
| | | **2015** | | Euro III | - | - | 30000 |
| Long distance traffic | 60 | **226/413/513/912/913/914** | | Naturally aspirated engines | 30000 | 30000 | 40000 |
| | | | | Turbocharged engines | 20000 | 30000 | 40000 |
| | | **1012/1013/2012/2013** | | Euro I | 20000 | 30000 | 40000 |
| | | | | Euro II and Euro III, except for: | - | 30000 | 40000 |
| | | | BF4M1013FC | Euro II ≤ 14 l oil contents (first filling) | - | - | 20000 |
| | | | | > 14 l oil contents (first filling) | - | - | 40000 |
| | | | | Euro III | - | - | 40000 |
| | | | BF6M1013FC | Euro II ≤ 19 l oil contents (first filling) | - | - | 20000 |
| | | | | > 19 l oil contents (first filling) | - | - | 40000 |
| | | | | Euro III | - | - | 40000 |
| | | | BF4M2012C | > 95 kW from Euro II | - | - | 40000 |
| | | | BF6M2012C | > 143 kW from Euro II at cylinder bore 101 mm with or 98 mm with MV system | - | - | 40000 |
| | | | | > 135 kW from Euro II at cylinder bore 98 mm with mechanical injection system | - | - | 40000 |
| | | | BF4M2013C | > 90 kW | - | - | 40000 |
| | | | BF6M2013C | >120 kW | - | - | 40000 |
| | | **1015** | | Euro I, except for: | - | 50000 | 40000 |
| | | | 1015CP | Euro II | - | - | 60000 |
| | | **2015** | | Euro III | - | - | 60000 |

If, for vehicle engines, lube oil change intervals are determined by operating hours, the lube oil change intervals indicated in table 4.1. for "Oil use under normal duty" will apply.

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 Page 5 of 8

## 5 Lube oil filter servicing

The filter cartridges must be changed upon every lube oil change or the filter be cleaned.

For engine series 226/413/513/912/913/1008, the first filter cartridge change or first filter cleaning must be made after about 50 op. hours after initial commissioning or restarting after major repairs (general overhaul).

All intervals also apply to the bypass filters (e.g. centrifugal filters in the fan).

Additional lube oil processing via bypass filters is not necessary. When using bypass filters, an extension of the lube oil change intervals is not admissible.

## 6 Specific lube oil definitions

For the following engines or applications

- 1013FC / 1015CP / 2015C / 2015CP
- all engines in block-type thermal power stations
- all engines in gensets operating in parallel with the mains / with each other
- engines in harvesting machines
- engines 1012C with increased power (precise definition, see table 4.1 and 4.2)

**DEUTZ OIL TLX-10W40FE** must be used. Alternatively, oils as per DEUTZ lube oil quality class DQC III can be used (ACEA E4-99 or oils indicated in Enclosure 1).

These are high-grade oils. In addition, most of these oils are partly synthetic, some even fully synthetic (5W-40), and thus achieve the thermal stability required for the relevant application and are distinguished by a low tendency to cause deposits in the turbocharger and in the charge air pipes with closed-circuit crankcase breather (according to the data of the lube oil producers for the MTU lab test MTV 5040).

## 7 Further notes on the use of lube oils in high-speed DEUTZ engines

### Biodegradable lube oils

Biodegradable lube oils may only be used in DEUTZ engines if they meet the requirements laid down in this Technical Circular.

### Synthetic lube oils

Synthetic lube oils are used to an ever increasing extent. As already described under section 6, synthetic lube oils feature an improved temperature and oxidation stability as well as a relatively low viscosity at cold temperatures. That is why they are suitable for use at arctic temperatures (>-25°C), see table in section 3.

As some phenomena which are of relevance for the determination of oil change intervals are not essentially dependent on the oil grade (e.g. ingress of soot and other contaminations), the oil change interval must not be extended beyond the data given in section 4, even when using synthetic oils.

### Lube oil additives

The lube oils described in this Technical Circular contain for all functions within the engine constituents which are carefully matched to each other and are subjected to a thorough final test as finished product. The effect of these additives is usually not tested with the same diligence and care so that unforeseeable effects cannot be excluded. DEUTZ therefore does not recommend the use of additives.

**Tractor universal oils**

Tractor universal oils which are destined both for the hydraulics and the engine may be used for the engine if the specifications stipulated in this Technical Circular are met.

## 8 Standard lubricants specified by the German building industry

To simplify the selection of lube oils for construction equipment and nonroad vehicles, the 'Hauptverband der Deutschen Bauindustrie' (Main Association of the German Building Industry) and the 'Zentralverband des Deutschen Baugewerbes' (Central Association of the German Building Industry) have specified standard lubricants. An abstract may be taken from enclosure 2; the adaptation to the new ACEA classification by the German building industry will follow.

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| | Lube oils for engines with uprated power and engines with high loading | Enclosure 1<br>TR 0199-99-3002<br>5th Exchange<br>04/2002 |
|---|---|---|

| Producer | Type of lube oil | SAE class | Availability |
|---|---|---|---|
| **DEUTZ** | **DEUTZ ÖITLX-10W40FE** | **10W-40** | **Europe** |
| ADDINOL | ADDINOL Super Truck MD 1048 | 10W-40 | Europe, Asia |
| | ADDINOL Ultra Truck MD 0538 | 5W-30 | Europe, Asia |
| AGIP | Agip Sigma Ultra TFE | 10W-40 | worldwide |
| | Autol Valve Ultra FE | 10W-40 | Germany |
| ARAL | Aral MegaTurboral | 10W-40 | worldwide |
| | Aral SuperTurboral | 5W-30 | worldwide |
| AVIA | TURBOSYNTH HT-E | 10W-40 | Germany |
| BAYWA | BayWa Super Truck 1040 MC | 10W-40 | South Germany |
| | BayWa Turbo 4000 | 10W-40 | South Germany |
| BP OIL International | BP Vanellus E7 Plus | 10W-40 | Europe |
| | BP Vanellus E7 Supreme | 5W-40 | Europe |
| Castrol | Castrol SYNTRUCK | 5W-40 | Europa, North America, Brazil Argentina, Australia, South Africa |
| | Castrol DYNAMAX | 7,5W-40 | Europe, North America, Brazil Argentina, Australia, South Africa |
| CEPSA | EUROTRANS SHPD | 10W-40 | Spain, Portugal |
| CHEVRON | Chevron Delo 400 Synthtic | 5W-40 | North America |
| DEA | DEA Cronos Synth | 5W-30 | Germany, Europe |
| | DEA Cronos Premium LD | 10W-40 | Germany, Europe |
| | DEA Cronos Premium FX | 10W-40 | Europe |
| ESSO | Essolube XTS 501 | 10W-40 | Europe |
| FUCHS EUROPE | Fuchs Titan Cargo MC | 10W-40 | worldwide |
| | Fuchs Titan Cargo SL | 5W-30 | worldwide |
| | Fuchs Titan Unic Plus MC | 10W-40 | worldwide |
| MOBIL OIL | Mobil Delvac 1 SHC | 5W-40 | Europe, SE Asia, Africa |
| | Mobil Delvac 1 | 5W-40 | worldwide |
| | Mobil Delvac XHP Extra | 10W-40 | Europe, SE-Asia |
| Schmierölraffinerie Salzbergen | Wintershall TFG | 10W-40 | Europe |
| Shell International | Shell Myrina TX / Shell Rimula Ultra | 5W-30 | Europe, different description in some country |
| | Shell Myrina TX / Shell Rimula Ultra | 10W-40 | Europe, different description in some country |
| Texaco | Ursa Super TDX 10W-40 | 10W-40 | Europe |
| | Ursa Premium FE 5W-30 | 5W-30 | Europe |
| TOTAL FINA ELF | TOTAL RUBIA TIR 8600 | 10W-40 | worldwide |
| | ELF PERFORMANCE EXPERTY MX 1010 | 10W-40 | worldwide |
| | ELF PERFORMANCE EXPERTY MX 1012 | 10W-40 | Germany, Benelux, Scandinavia, Austria |
| | FINA KAPPA FIRST | 5W-30 | Europe |
| | FINA KAPPA ULTRA | 10W-40 | Europe |

The table will be extended as and when required.

## 18.4 Fuel

Technical Circular 0199 – 3005

DEUTZ

DEUTZ AG
Deutz-Mülheimer Straße 147-149
51057 Köln

# Technical Circular

## 0199 - 3005 en

## 1st Exchange

Product :
**DEUTZ**

TR

Date : 27.03.1998

This Circular supersedes TC : TR0199-3005, 2.4.91
TR0199-99-1113, 20.9.94

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Note : The part numbers stated in this documentation are not subject to the modifikation service.
For identifying spare parts, the spare part documentation has to be referred to.

## Fuels

The first exchange is being issued because of

- new standards, specifications
- exclusion of spindle-oil fuels
- editorial revision

This Technical Circular is valid for all air-cooled and liquid-cooled DEUTZ engines. It applies analogously for engines of the DEUTZ and DEUTZ MWM brand (small-size diesels) which are no longer included in the build program.

## General

The following fuels are approved for engines of the DEUTZ brand:

1 Diesel fuels

2 MDF distillates

3 Light burner fuels

4 Jet fuels

5 Bio diesel fuel

Distillate fuels with oil residues or intermediate residual fuels may not be used for DEUTZ engines.

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.../2

DEUTZ engines are designed for diesel fuels with a cetane number of 49 according to DIN EN 590. In the case of standard engines running on a fuel with a cetane number <49 unpleasant white smoke development and misfiring may have to be expected.

In the case of engines in accordance with EPA regulation (US EPA REGULATIONS FOR LARGE NONROAD COMPRESSION-IGNITION ENGINES), an unpleasant white smoke development can only occur with a cetane number <42, as specific engine versions have been developed to comply with such conditions.
If the white smoke development is not acceptable when fuel with a very low cetane number is used, the use of ignition improvers can be recommended as subsequent remedy. If it is known in advance that fuels with very low cetane number will be used, we recommend that engines of EPA configuration will be ordered.

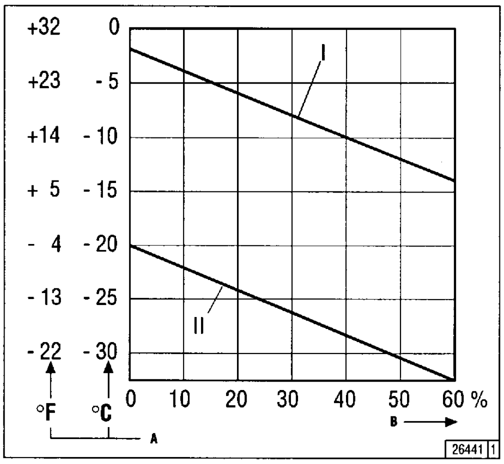
General information on the fuel characteristics may be taken from enclosure 1.

## 1 Diesel fuels

Diesel fuels according to the following specifications are approved and may be used:

| Fuel | Specification |
|---|---|
| **EN 590** | Enclosure 2 |
| **ASTM Designation: D 975 Grade-No. 1-D** | Enclosure 3 |
| **ASTM Designation: D 975 Grade-No. 2-D** | Enclosure 3 |
| **BS 2869 Class A 2** | Enclosure 4 |
| **ISO 8217 DMX** | Enclosure 5 |

- The European Standard EN 590 has in most European countries the status of a national standard with national annex, e.g. DIN EN 590.
- Low-sulphur diesel fuels according to EN 590 with a sulphur content < 0.05% may be used. Adequate lubricating capability must be ensured, however, by admixing additives.
- In the case of diesel fuel according to ISO-8217 DMX, oil change intervals must be halved because of the high sulphur content of max. 1%, see Technical Circular 0199-3002.
- Winter operation with diesel fuel
  For winter operation particularly high demands are placed on the low-temperature characteristics (temperature limit value of filtrability). Appropriate fuels are available at the service stations during that time.




I = Summer diesel fuel
II = Winter diesel fuel
A = Ambient temperature
B = Percentage of kerosene

At lower temperatures or if only summer diesel fuel is available, we recommend - in order to ensure flowability - to admix kerosine to the diesel fuel according to the percentages given in the diagram above. Admix only in the tank: First fill in the required quantity of keresone, then top up diesel fuel.

.../3

Admixture of standard petroleum is not permissible for safety reasons.

For arctic climate there are available diesel fuels down to -44°C.

Admixture of flow-improving additives is permissible. The fuel supplier should be consulted for effectiveness and compatibility.

- Fuel ISO 8217 DMX has also been included in Specification BS MA 100: 1996.

## 2 MDF distillate fuels

(Marine distillate fuels)

These include distillates mainly used for marine application. Only those MDF distillates may be used which do not contain any residues (residues from the distillation process).

The following distillates may be used:

| Fuel | Specification |
|---|---|
| **ISO 8217 DMA** | Enclosure 6 |

- The cetane number must be at least 40, as otherwise starting problems, extreme white smoke development or increased HC emission may occur.
- Due to the higher density the injection pump must be derated (to be carried out only by DEUTZ-authorized personnel).
- The possibly high sulfphur content requires shorter oil change intervals. In the case of distillates with a sulphur content > 1.0 % by mass, it is necessary to consult your DEUTZ Service. See Technical Circular 0199-3002 and the applicable operation manual.
- Owing to the possibly higher degree of contamination, the fuel has to be cleaned with special care; it may be necessary to install an additional fuel filter with water separator.

## 3 Light burner fuels

Light burner fuels are basically to be treated like diesel fuels. Light burner fuels enjoy customs and tax privileges and require specific authorization when used in diesel engines.

The following light burner fuels may be used:

| Fuel | Specification |
|---|---|
| **DIN 51603** | Enclosure 7 |
| **ASTM D 396 Grade-No. 1** | Enclosure 8 |
| **ASTM D 396 Grade-No. 2** | Enclosure 8 |
| **BS 2869 Class D** | Enclosure 9 |

- The cetane number must be at least 40, as otherwise starting problems, extreme white smoke development or increased HC emission may occur.

.../4

- A power loss up to 5% may be involved depending on the engine power.
  **Uprating of the injection pump is not permissible.**

- The lube oil grade must be at least API-CD or ACEA E1-96.

- The oil change intervals must be halved as compared to operation with diesel fuel according to EN 590.

- Long downtimes with bio diesel fuel must be avoided. Otherwise the engine must be started and stopped with diesel fuel.

- In the case of series-production engines, the fuel hoses and the diaphragm fuel feed pump are not resistant to bio diesel fuel and must be renewed annually.

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Enclosures

| DEUTZ | Explanation of Major Fuel Characteristics | Enclosure 1 to TC 0199-3005 en 1st Exchange |
|---|---|---|

**Density**
The density is mostly quoted in g/cm3 at 15°C and is of importance for converting the fuel consumption from volume to mass units. The higher the density, the grater the mass of the injected fuel. With identical fuel rack position, the engine power increases with higher density.

**Boiling curve**
The boiling curve indicates the % by volume of fuel recovered at a given temperature. The greater the boiling residues (residues remaining after evaporation), the greater can be the combustion residues in the engine, particularly under low-load conditions.

**Viscosity**
The kinematic viscosity is quoted in mm2/s at a reference temperature (1 mm2/s = 1 cSt = 1 Centistoke). For engine operation the viscosity must stay within specific limits. If the viscosity is too high, preheating will be required.

**Flash point**
The flash point is of no significance for engine operation. It serves as parameter for fire hazards and is important for classification of the fuel in one of the dangerous materials classes (decisive for storage, transport and insurance).

**Sulphur**
A high sulphur content and low component temperatures may cause increased wear due to corrosion. The sulphur content influences the oil change intervals.

**Carbon residue**
The carbon residue serves as a reference value regarding the tendency to build up residues in the combustion chamber.

**Water**
An inadmissably high water content causes corrosion and sludge when combined with corrosion products and sediments, thus leading to troubles in the fuel and injection system.

**Sediments**
Sediments are solid matter (dust, rust, scale) which cause wear in the injection system and combustion chamber as well as valve leakage.

**Ash**
Ash is a combustion residue free from carbon which may cause wear through deposits in the engine and exhaust turbocharger.

**Low-temperature characteristics**
The following characterisics indicate operability of the fuel at low temperatures.

- The setting point indicates the fuel temperature at which the gravity of the fuel alone is no longer sufficient to cause the fuel to flow.
- The pour point is about 3°C higher than the setting point.
- The cloud point indicates at which temperature solid-particle fall-out (paraffin wax) becomes visible.
- The filtrability limit indicates the temperature at which clogging of the filter and piping may occur.

**Cetane number**
The cetane number indicates the ignition quality of the fuel. If the cetane number is too low, it may cause starting problems, white smoke development, increased HC emissions and possibly thermal and mechanical overloading of the engine. The cetane number is measured on a test engine.

**Net calorific value**
The net calorific value ($H_u$) indicates the thermal energy released upon complete combustion of 1 kg of fuel.

| DEUTZ | **Fuel Specification**<br>(Minimum Requirement)<br><br>Diesel Fuel to<br>**EN 590 : 1993** | **Enclosure 2 to TC 0199-3005 en 1st Exchange** |
|---|---|---|

| Characteristics | Units | **Diesel Fuel EN 590** | Testing method |
|---|---|---|---|
| Flash point | °C | min. 55 | ISO 2719 |
| Carbon residue<br>(of 10% distillation residue) | % by mass | max. 0,30 | ISO 10370 |
| Ash | % by mass | max. 0,01 | EN 26245 |
| Water | mg/kg | max. 200 | ASTM D 1744 |
| Total contamination | mg/kg | max. 24 | DIN 51419 |
| Corrosion effect on copper<br>(3 h at 50°C) | Degree of corrosion | 1 | ISO 2160 |
| Oxidation stability | g/m³ | max. 25 | ASTM D 2274 |
| Sulphur | % by mass | max.0,20 | ISO 8754<br>EN 24260 |
| Filtrability limit (CFPP) [1)]<br>15.04. to 30.09.<br>01.10. to 15.11.<br>16.11. to 28.02.<br>01.03. to 14.04. | <br>°C<br>°C<br>°C<br>°C | <br>max. 0 °C<br>max. - 10 °C<br>max. - 20 °C<br>max. - 10 °C | EN 116 |
| Density at 15°C | kg/m³ | 820 - 860 | ISO 3675<br>ASTM D 4052 |
| Viscosity at 40°C | mm²/s | 2,00 - 4,50 | ISO 3104 |
| Cetane number | | min. 49 | ISO 5165 |
| Cetane index | | min. 46 | ISO 4264 |
| Distillation<br>recovered at 250 °C<br>recovered at 350 °C<br>recovered at 370 °C | <br>% by vol.<br>% by vol.<br>% by vol. | <br>max. 65<br>min. 85<br>min. 95 | ISO 3405 |

[1)] Data applies to the Federal Republic of Germany.
National regulations may deviate.

| DEUTZ | **Fuel Specification**<br>(Minimum Requirement<br><br>Diesel Fuel to<br>**ASTM Designation: D 975-96** | **Enclosure 3 to TC 0199-3005 en 1st Exchange** |
|---|---|---|

| Characteristics | Units | **ASTM D 975 Grade No. 1-D** | **ASTM D 975 Grade No. 2-D** | Testing method |
|---|---|---|---|---|
| Density at 15°C | $kg/m^3$ | max. 860 [1] | max. 860 [1] | |
| Flash point | °C | min. 38 | min. 52 | ASTM D 93 |
| Water and sediments | % by vol. | max. 0,05 | max. 0,05 | ASTM D 2709 |
| Distillation Temperature, 90% Recovered | °C<br>°C | ...<br>max. 288 | min. 282<br>max. 338 | ASTM D 86 |
| Kinematic viscosity at 40°C | $mm^2/s$<br>$mm^2/s$ | min. 1,3<br>max. 2,4 | min. 1,9<br>max. 4,1 | ASTM D 445 |
| Ash | % by mass | max. 0,01 | max. 0,01 | ASTM D 482 |
| Sulphur | % by mass | max. 0,5 | max. 0,5 | ASTM D 129 |
| Copper strip corrosion (max. 3 h at 50°C) | Degree of corrosion | No. 3 | No. 3 | ASTM D 130 |
| Cetane number | | min. 40 | min. 40 | ASTM D 613 |
| Ramsbottom carbon residue on 10% distillation residue | % by mass | 0,15 | 0,35 | ASTM D 524 |
| Filtrability limit | °C | [2] | [2] | |

[1] DEUTZ min. requirement
[2] depending on season and region

DEUTZ

**Fuel Specification**
(Minimum Requirement)

Diesel Fuel to
**British Standard 2869 : Part 2 : 1988**

**Enclosure 4 to TC 0199-3005 en 1st Exchange**

| Characteristic | Units | **BS 2869 Class A 2** | Testing method |
|---|---|---|---|
| Density at 15°C | kg/m³ | max. 860 [1] | |
| Flash point (Pensky-Martens) | °C | min. 56 | BS 2000: Part 34 |
| Water content | % by vol. | max. 0,05 | BS 4385 |
| Sediment | % by mass | max. 0,01 | BS 4382 |
| Siedeverlauf bei 85 %, min. | °C | 350 | |
| Kinematic viscosity at 40°C | mm²/s<br>mm²/s | min. 1,5<br>max. 5,5 | BS 2000: Part 71 |
| Ash | % by mass | max. 0,01 | BS 4382 |
| Sulphur content | % by mass | max. 0,5 | IP 336 |
| Copper corrosion (3 h at 100 °C) | Degree of corrosion | 1 | BS 2000: Part 154 |
| Cetanzahl | | min. 45 | BS 5580 |
| Koksrückstand nach Ramsbottom von 10 % Destillatrückstand | % by mass | max. 0,20 | BS 4451 |
| Filtrability limit<br>summer (16.03. - 30.09.)<br>winter (01.10. - 15.03.) | <br>°C<br>°C | <br>- 4<br>- 12 | BS 6188<br>(EN 116) |

[1] DEUTZ min. requirement

| DEUTZ | **Fuel Specification**<br>(Minimum Requirement)<br><br>Diese Fuel to<br>**ISO 8217 : 1996** | **Enclosure 5 to TC 0199-3005 en 1st Exchange** |
|---|---|---|

| Characteristic | Units | **Category ISO - F - DMX** | Testing method |
|---|---|---|---|
| Density at 15°C | kg/m³ | max. 860 [1] | ISO 3675 or ISO 12185 |
| Viscosity at 40°C | mm²/s<br>mm²/s | min. 1,4<br>max. 5,5 | ISO 3104 |
| Flash point | °C | min. 43 | ISO 2719 |
| Cloud Point | °C | max. - 16 [2] | ISO 3015 |
| Sulfur | % by mass | max. 1,0 [3] | ISO 8754 |
| Cetan number | | min. 45 | ISO 5165 |
| Carbon residue of 10% distillation bottoms | % by mass | max. 0,30 | ISO 10370 |
| Ash | % by mass | max. 0,01 | ISO 6245 |

[1] DEUTZ min. requirement
[2] This fuel can be used without preheating down to -15°C
[3] Please note shortened oil change interval

| DEUTZ | **Fuel Specification**<br>(Minimum Requirement)<br><br>MDF- Distillate nach<br>**ISO-8217 : 1996** | **Enclosure 6 to**<br>**TC 0199-3005 en**<br>**1st Exchange** |
|---|---|---|

| Characteristic | Units | **Category ISO - F - DMA** | Testing method |
|---|---|---|---|
| Density at 15°C | kg/m³ | max. 890 | ISO 3675 or ISO 12185 |
| Viscosity at 40°C | mm²/s<br>mm²/s | min. 1,5<br>max. 6,0 | ISO 3104 |
| Flash point | °C | min. 60 | ISO 2719 |
| Pour Point<br>winter<br>summer | <br>°C<br>°C | <br>max. - 6<br>max. 0 | ISO 3016 |
| Sulphur | % by mass | max. 1,5 [1)] | ISO 8754 |
| Cetane number | | min. 40 | ISO 5165 |
| Koksrückstand<br>of 10% distillation bottoms | % by mass | max. 0,30 | ISO 10370 |
| Ash | % by mass | max. 0,01 | ISO 6245 |

1) Please note shortened oil change interval

| | Fuel Specification<br>(Minimum Requirement)<br><br>Light Burner Fuel to<br>**DIN 51603-1 : 1995** | **Enclosure 7 to TC 0199-3005 en 1st Exchange** |
|---|---|---|
| DEUTZ | | |

| Characteristic | Units | **Heizöl DIN 51603-EL-1** | Testing method |
|---|---|---|---|
| Density at 15°C | kg/m³ | max. 860 | DIN 51757 |
| Calorific value | MJ/kg | min. 42,6 | DIN 51900-1 and<br>DIN 51900-2 or<br>DIN 51900-3 or<br>calculation |
| Flash point in closed cup to Pensky-Martens | °C | min. 55 | DIN EN 22719 |
| Kinematic viscosity at 20°C | mm²/s | max. 6,0 | DIN 51562-1 |
| Distillation range<br>total of evaporated volume<br>up to 250 °C<br>up to 350 °C. | <br><br>%<br>% | <br><br>max. 65<br>min. 85 | DIN 51751 or<br>ASTM D 86 |
| Pour Point | °C | max. - 9 | DIN ISO 3016 |
| Carbon residue, Conradson of 10% distillation residue | % by mass | max. 0,5 | DIN 51551 |
| Sulphur | % by mass | max. 0,2 | DIN EN 24260 or<br>DIN 51400-1 and<br>DIN 51400-2 or<br>DIN 51400-6 |
| Water | mg/kg | max. 200 | DIN 51777-1 |
| Total contamination | mg/kg | max.30 | DIN 51419 |
| Ash | % by mass | max. 0,01 | DIN EN 7 or ISO 6245 |

| DEUTZ | **Fuel Specification**<br>(Minimum Requirement)<br><br>Light Burner Fuel to<br>**British Standard 2869 : Part 2 : 1988** | **Enclosure 8 to TC 0199-3005 en 1st Exchange** |
|---|---|---|

| Characteristic | Units | **BS 2869 Class D** | Testing method |
|---|---|---|---|
| Density at 15°C | kg/m³ | max. 900 [1] | |
| Flash point (Pensky-Martens) | °C | min. 56 | BS 2000: Part 34 |
| Water | % by vol | max. 0,05 | BS 4385 |
| Sediments | % by mass | max. 0,01 | BS 4382 |
| Distillation by 85 % vol. recoverey | °C | min. 350 | BS 2000: Part 123 |
| Kinematic viscosity at 40°C | mm²/s<br>mm²/s | min. 1,5<br>max. 5,5 | BS 2000: Part 71 |
| Ash | % by mass | max. 0,01 | BS 4450 |
| Sulphur | % by mass | max. 0,5 | IP 336 |
| Cetane number | | min. 40 [1] | |
| Carbon residue, Ramsbottom on 10% residue | % by mass | max. 0,2 | BS 4451 |
| Cold filter plugging point<br>summer (16.03. - 30.09.)<br>winter (01.10 - 15.03) | <br>°C<br>°C | <br>max. - 4<br>max. - 12 | BS 6188<br>(EN 116) |
| Copper corrosion<br>(3h at 100 °C) | Degree of corrosion | 1 | BS 2000: Part 154 |

[1] DEUTZ min. requirement

| DEUTZ | **Fuel Specification**<br>(Minimum Requirement)<br><br>Light Burner Fuel<br>**ASTM Designation: D 396-96** | **Enclosure 9 to TC 0199-3005 en 1st Exchange** |
|---|---|---|

| Characteristic | Units | **ASTM D 396 No. 1** | **ASTM D 396 No.2** | Testing method |
|---|---|---|---|---|
| Density at 15°C | kg/m³ | max. 850 | max. 876 | ASTM D 1298 |
| Flash point | °C | min. 38 | min. 38 | ASTM D 93 |
| Water and sediments | % by vol. | max. 0,05 | max. 0,05 | ASTM 2709 |
| Distillation temperature<br>90 % vol. recovered<br>10 % vol. recovered<br>90 % vol. recovered | <br>°C<br>°C<br>°C | <br>--<br>max. 215<br>max. 288 | <br>min. 282<br>--<br>max. 338 | ASTM D 86 |
| Kinematic viscosity at 40°C | mm²/s<br>mm²/s | min. 1,3<br>max. 2,1 | min. 1,9<br>max. 3,4 | ASTM D 445 |
| Sulphur | % by mass | max. 0,5 | max. 0,5 | ASTM D 129 |
| Copper strip corrosion rating ( 3 h at 50 °C) | Degree of corrosion | No. 3 | No. 3 | ASTM D 130 |
| Cetan number | | min. 40 [1] | min. 40 [1] | |
| Carbon residue to Ramsbottom on 10% of distillate residue | % by mass | max. 0,15 | max. 0,35 | ASTM D 524 |
| Pour Point | °C | max. - 18 | max. - 6 | ASTM D 97 |

[1] DEUTZ min. requirement

**Fuel Specification** (Minimum Requirement)

Jet-Fuels

**Enclosure 10 to TC 0199-3005 en 1st Exchange**

| Characteristic | Units | NATO Code F-34 / F-35 | NATO Code F-54 | Testing method | NATO - Code F-44 | NATO - Code XF-63 | Testing method |
|---|---|---|---|---|---|---|---|
| | | Specification (Country-specific)<br>D = TL 9130-0012<br>USA = MIL-T-83133<br>F = AIR 3405/D<br>GB = DEF-STAN 91-87<br>= DEF-STAN 91-91 | D = TL 9140-0001<br>USA = A-A-52557<br>F = DCSEA 105<br>GB = DEF-STAN 91-09 | (only applicable Bfor Federal Rep. of German) | Specification (Country-specific)<br>F = AIR 3404/C | F = AIR 3405/D | |
| Density at 15°C | kg/m³ | 775 - 840 | 820 - 860 | DIN 51757/ | 788 - 845 | 797 | ASTM-D 1298 |
| Boiling curve<br>with 10% by vol. distillate quant.<br>Boiling end point<br>Distillation residue<br>Distillation loss | °C<br>°C<br>% by vol.<br>% by vol. | max. 205<br>max. 300<br>max. 1,5<br>max. 1,5 | --<br>max. 370<br>max. 3,0<br>-- | DIN 51751 | max. 205<br>max. 290<br>max. 1,5<br>max. 1,5 | | ASTM-D 86 |
| Kinematic viscosity | mm²/s | max. 8,0 at -20°C | 2,0 - 4,5 at 40 °C | DIN 51562-1 | max. 8,5 at -20 °C | Limit values | ASTM-D 445 |
| Flash point | °C | min. 38 | min. 56 | DIN EN 22719/IP 170 | min. 60 | like | ASTM-D 93 |
| Sulphur | % by mass | max. 0,20 | max. 0,05 | DIN 51400-1and 6 | max. 0,4 | Jet fuel | ASTM-D 1266/2622 |
| Ash | % by vol. | -- | max. 0,01 | DIN EN ISO 6245 | -- | F-34/F-35 | |
| Water | mg/kg | -- | max. 200 | DIN 51777-1 | -- | | |
| Sediments | mg/dm³ | -- | max. 10 | ASTM D 2276 App. A2 | -- | | |
| Net calorific value Hu | MJ/kg | min. 42,8 | -- | DIN 51900-1and -2 | min. 42,6 | | ASTM-D 240/2382 |
| Cloude Point | °C | -- | max. - 13 | DIN EN 23015 | -- | | |
| Pour Point | °C | -- | max. - 18 | DIN ISO 3016 | -- | | |
| Cetan number | | min. 40 [1] | min. 49 | DIN 51773 | min. 40 [1] | min. 48 | |
| Copper corrosion | Degrees of corrosion | 1<br>(2 h at 100 °C) | 1<br>(3 h at 100 °C) | DIN EN ISO 2160 | 1<br>(2 h at 100 °C) | Limit values like Jet fuel F-34/F-35 | ASTM-D 130 |

[1] DEUTZ min. requirement

| DEUTZ | **Fuel Specification**<br>(Minimum Requirement)<br><br>**DieselFuel to**<br>(Bio Fuel)<br>**DIN 51606 : 1997** | **Enclosure 11 to TC 0199-3005 en 1st Exchange** |
|---|---|---|

| Characteristic | Units | **Dieselfuel DIN 51606-FAME** | Testing method |
|---|---|---|---|
| Density at 15°C | g/ml | min. 0,875<br>max. 0,900 | DIN EN ISO 3675 |
| Kinematic viscosity at 40°C | mm²/s | min. 3,5<br>max. 5,0 | DIN EN ISO 3104 |
| Flashpoint in closed cup to Pensky-Martens | °C | min. 110 | DIN EN ISO 22719 |
| Filtrability limit (CFPP) 1)<br>15.04. to 30.09.<br>01.10. to 15.11.<br>16.11. to 28.02.<br>01.03. to 14.04. | <br>°C<br>°C<br>°C<br>°C | <br>max. 0<br>max. -10<br>max. -20<br>max. -10 | DIN EN 116 |
| Sulphur | % by mass | max. 0,01 | DIN EN 2460 or<br>DIN EN ISO 14596 |
| Carbon residue | % by mass | max. 0,05 | DIN EN ISO 10370 |
| Cetane number | | min. 49 | ISO/DIS 5165 : 1996 or<br>DIN 51773 |
| Ash | % by mass | max. 0,03 | DIN 51575 |
| Water | mg/kg | max. 300 | ISO/DIS 12937 : 1996 or<br>DIN 51777-1 |
| Total contamination | mg/kg | max. 20 | DIN 51419 |
| Corrosion effect on copper (3 h at 50 °C) | Degree of corrosion | 1 | DIN EN ISO 2160 |
| Oxidation stability, induction time | h | ist anzugeben | IP 306 |
| Neutralization value | mg KOH/g | max. 0,5 | DIN 51558-1 |
| Methanol | % by mass | max. 0,3 | E DIN 51608 |
| Monoglyceride | % by mass | max. 0,8 | E DIN 51609 |
| Diglyceride | % by mass | max. 0,4 | |
| Triglyceride | % by mass | max. 0,4 | |
| Free glycine | % by mass | max. 0,02 | |
| Total glycine | % by mass | max. 0,25 | |
| Iod number | | max. 115 | DIN 53241-1 |
| Phosphorus content | mg/kg | max. 10 | DIN 51440-1 |
| Alkali content (NA + K) | mg/kg | max. 5 | iin adaptation to DIN 51797-1 supplemented by potassium |

1) Data applicable for Federal Republic of Germany
National regulations may deviate.

## 18.5 Starting lock relay

Technical Product Information 0199 – 99 – 0217

# Technical Product Information
# 0199-99-0217b /1st Supplement

Responsible for the contents: DEUTZ AG | Department: VV-TQ | Cologne, 21.6.2001

## STARTING – LOCK – RELAY

Officedaten-TPI0217bEngl1Sup.doc

**This TPI supplements the Technical Circular 0199-05-1127 dated 23.6.2000.**

**The starting lock relay serves for protecting the stator, the pinion and the engine girth gear.**

The **use of a starting lock relay is mandatory** for all applications where the starting procedure of the engine (or the engines for multiple-engine systems) cannot be properly observed by the operator (visually, acoustically). Starting again by mistake with the engine already running or still slowing down is avoided in this way.

The starting lock relay is an electronic component directly switching the starter and immediately blocking the starting procedure, if the generator is supplying voltage. Then, a repetition of starting is avoided for 10 ± 2 seconds.
If the starting procedure is interrupted, new starting can be initiated only after a release time of 10 ± 2 seconds.

How to connect a starting lock relay of that kind can be taken from the circuit diagram, Enclosure 1.

The starting lock relay of Messrs. Bader is available in a 12 V and a 24 V version.
The relay can stand ambient temperatures of –30°C up to +70°C. However, it must not be fastened to the engine direct.

The contact load is momentarily (1 sec.) 80 A upon connection or 34 A upon disconnection. Admissible permanent current load 15 A.

If higher currents must be expected at terminal 50 due to inductive loads as it is generally the case with Bosch DW-, EV-, IF- starters, an **additional relay** is always required.

In the case of the bigger KB- and QB-starters (see BFM1015 series) no additional relay is needed because the starting lock relay is able to contact the lower currents.

How to connect an additional relay ( for instance Bosch part 0 332 002 150) can be taken from the circuit diagram, Enclosure 2.

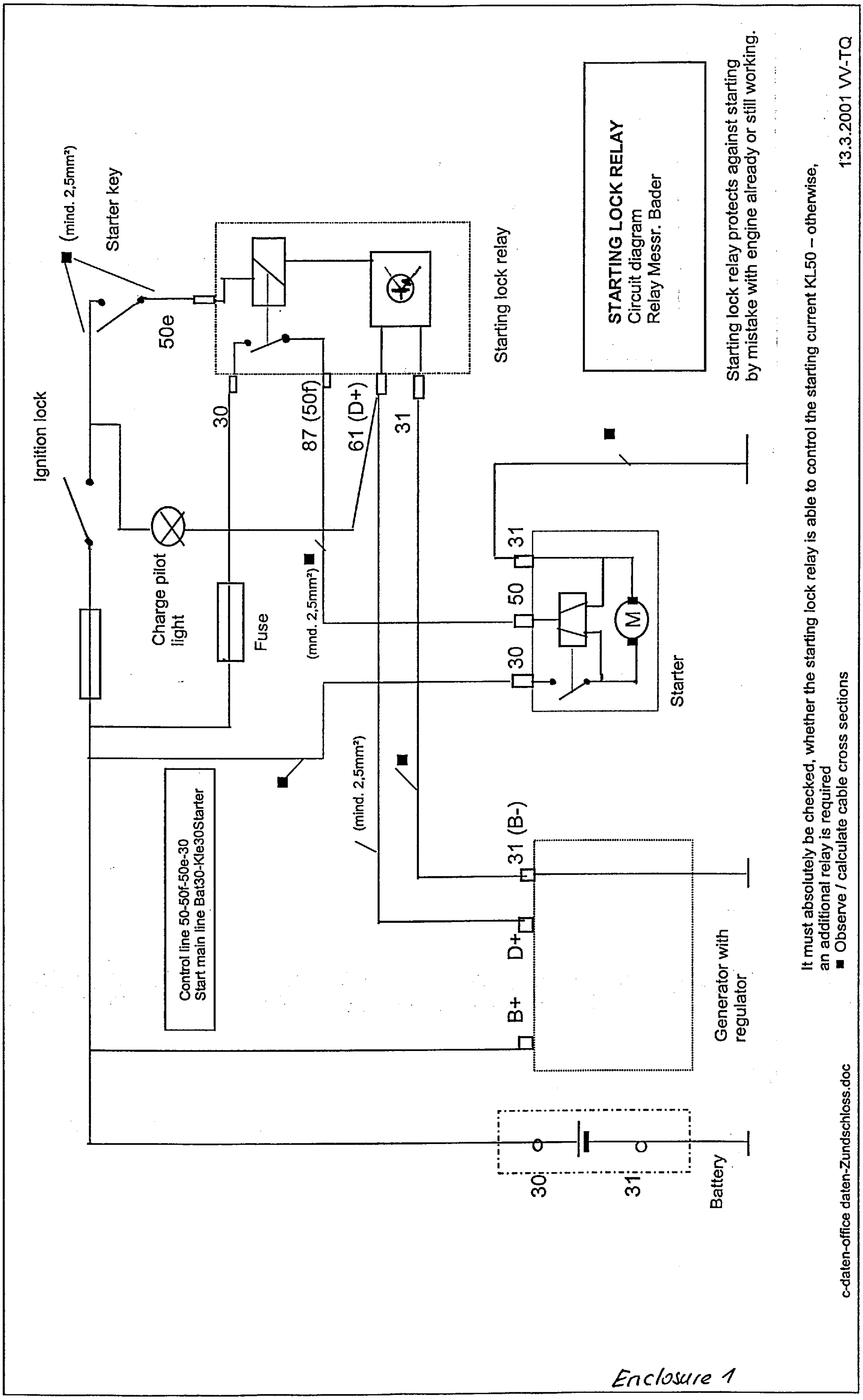
For the additional relay, the installation conditions described above will also apply.

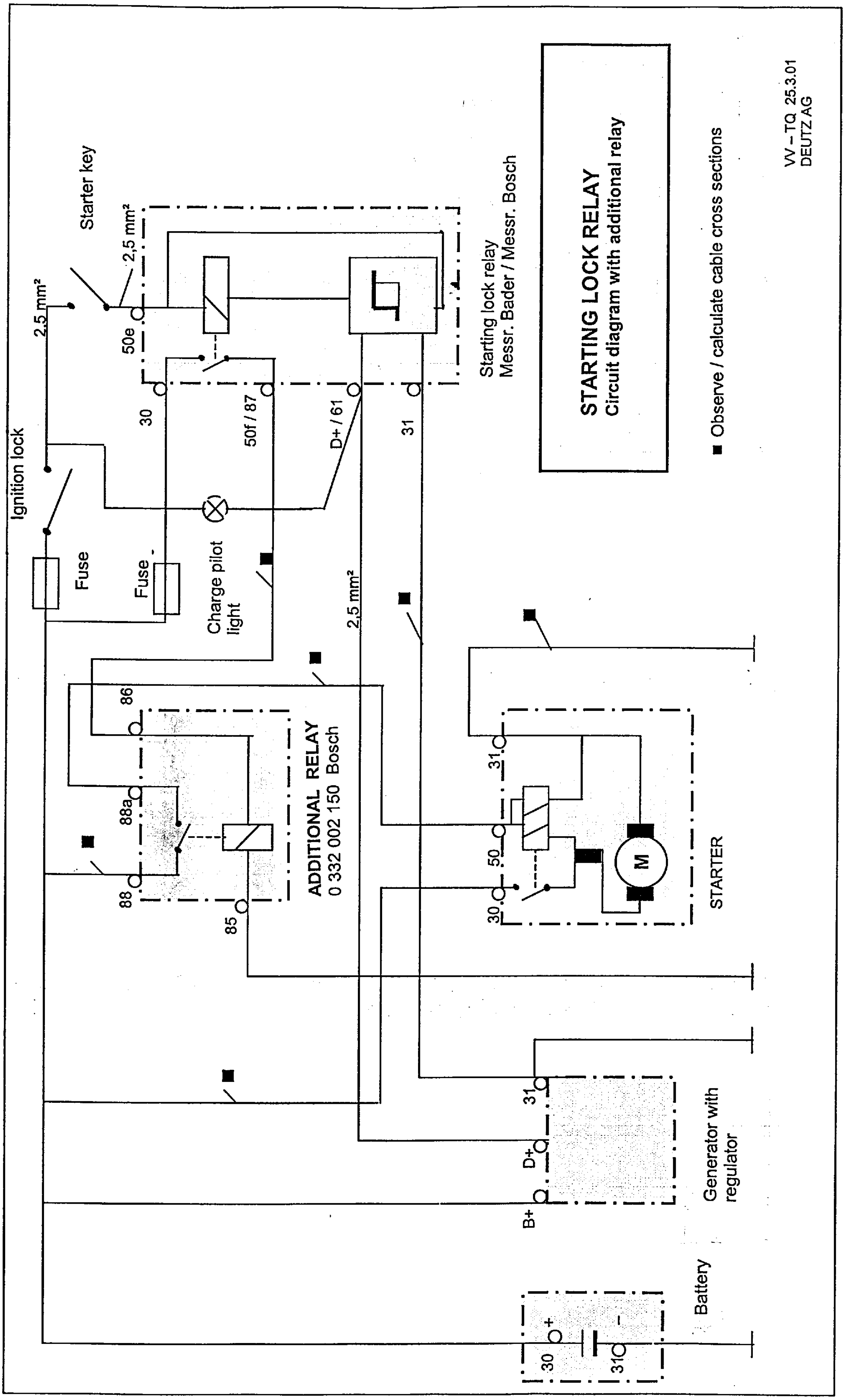
Please observe the cable cross sections as regards admissible resistance values – see TPI 0199-99-0198.

Information:
Messrs. Bosch in co-operation with Messrs. Bader will include the Bader starting lock relay into their own range of products with some detail modifications. At the moment, the Bader relay has not yet been released by Bosch.

VV-T | VV-TQ

Pape | Kramp | Enclosures 1 +2


STARTING LOCK RELAY
Circuit diagram
Relay Messr. Bader
Starting lock relay protects against starting by mistake with engine already or still working.
13.3.2001 VV-TQ
It must absolutely be checked, whether the starting lock relay is able to control the starting current KL50 – otherwise, an additional relay is required
■ Observe / calculate cable cross sections
c-daten-office daten-Zundschloss.doc
Ignition lock
Starter key
(mind. 2,5mm²)
50e
Starting lock relay
30
87 (50f)
61 (D+)
31
Charge pilot light
Fuse
(mnd. 2,5mm²)
31
50
30
M
Starter
Control line 50-50f-50e-30
Start main line Bat30-Kle30Starter
(mind. 2,5mm²)
31 (B-)
D+
B+
Generator with regulator
30
31
Battery
Enclosure 1


Ignition lock
Starter key
2,5 mm²
2,5 mm²
50e
30
50f / 87
D+ / 61
31
Starting lock relay
Messr. Bader / Messr. Bosch
STARTING LOCK RELAY
Circuit diagram with additional relay
■ Observe / calculate cable cross sections
VV – TQ 25.3.01
DEUTZ AG
Fuse
Fuse
Charge pilot light
2,5 mm²
86
88a
88
85
ADDITIONAL RELAY
0 332 002 150 Bosch
31
50
30
M
STARTER
31
D+
B+
Generator with regulator
+
-
30
31
Battery

Enclosure 2

## 18.7 Heating flange

Technical Product Information 0199 – 63 – 0206

The recipients of TPIs are asked to ensure, that these are copied to all appropriate persons in their area!



**Herewith, the TPI 0198-63-0206 including the first supplement becomes invalid**

# Heating Flange for Engine Series 1013, 2012 and 2013

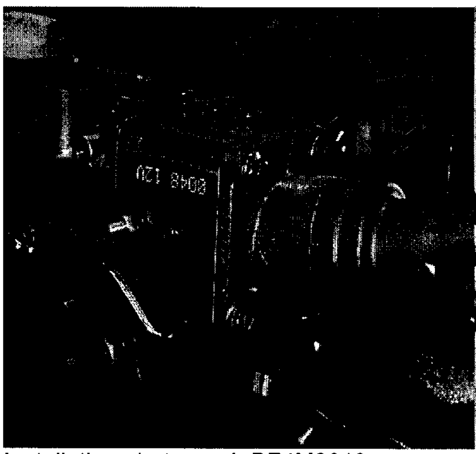
c-daten-tpi 0206-2-mit Nachtrag3.doc + Ergä 18.2.03.+.Ergä 2.4.03

## 1.) Introduction :

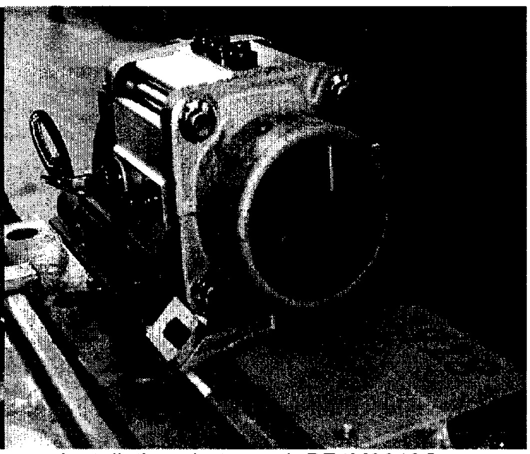
The heating flange is a component for heating the combustion air via an electrically operated heating wire with high energy density. Due to the high heating-up level of the combustion air, the cold-start performance and the resulting emissions of a diesel engine are drastically improved. The "component" heating flange is installed in the clean air pipe (engine without charge air cooler) or in the cold charge air pipe (engine with charge air cooler) at the engine inlet. The heating flange "cold-start facility" is a system consisting of the following:

- Heating flange
- Temperature sensor
- Control unit with cable harness (separate control unit or integrated in EMR 2)
- The heating function can be manually started with the aid of an additional pushbutton
- Supply line with fuses
- Switching relay
- Battery

The dimensions of a heating flange as well as an installation drawing of a heating flange are attached (Enclosures 1 and 2). Enclosure 3 shows the circuit diagram of the heating flange cold-start facility.



Installation photograph BF4M2012
Heating flange with plug-in pipe flange



Installation photograph BF4M2012C
Heating flange with hose socket

## 2.) Function :

The heating flange function comprises a preheating and a reheating time.
The preheating time is started only below a coolant temperature of +5°C, while the reheating time is already activated below a coolant temperature of +25°C. This means, that between +5°C and +25°C, only reheating takes place.

The coolant temperature is determined upon activating of the heating flange and serves as reference value up to the end of the preheating and reheating function. The temperature is then measured in the coolant via NTC-thermistor.

The heating function is automatically activated after the connection of the voltage supply. Via an additional pushbutton, this function can be manually started once.

It is differentiated between preheating to ensure the cold-start capacity of the engine and reheating. Both functions serve to reduce white smoke. The reheating function is triggered temperature-dependent, when activating the heating flange control unit via voltage application to the starter (terminal 50).

The heating flange control unit is suitable for 12V and 24V. If preheating does not take place, a functional check (signalising of the readiness for being started) is carried out with lighting up of the pilot light for 0.5 to 1.0 s. During the preheating phase, the pilot light is permanently lighted. Upon a failure at the coolant inlet or at the control outlet, the light is lighted.

| Failure code | Defective component | Failure type | Description |
|---|---|---|---|
| A | Control outlet | Short circuit or cable rupture | Light flashing with 2.5 Hz for the entire heating time. |
| B | NTC - inlet | | Light flashing with 1 Hz for the preheating time. |

### Supplementary information on activating of the heating flange (see circuit diagram in Enclosures 4 and 5):

**Pushbutton S5 is installed (Enclosure 4, manual activation):**

a1) By activating the pushbutton, the heating flange control is triggered (ignition on).
a2) If the pushbutton is not activated, the heating flange is not triggered, i.e. no preheating and no reheating takes place.
a3) If the pushbutton is activated only after having started the engine, only reheating takes place.

**Pushbutton S5 is not existing (Enclosure 5, automatic activation):**

b1) If it is intended to trigger the heating flange without pushbutton S5, at the control unit, terminal 2 or S must be short-circuited with terminal 7 or 15. When switching on the ignition, the heating flange is automatically controlled (see Enclosure 5).
b2) If terminal 7 or 15 is no more connected with terminal 2 or S at the control unit, the heating flange is not triggered – i.e. nor more functioning of the heating flange.

If EMR 2 is used, the heating flange control is integrated – see Enclosure 3.
EMR2 is different in the following respects:

- The diagnosis takes place via the pilot light as well as via SERDIA
- Upon manual operation, the reheating time can also be activated via the pushbutton after having started the engine.

**Attention: Activation of the heating flange for equipment operated in the field**
If, upon the automatic activation of the heating flange, the engine is not properly started, since – due to malfunctions in the electric control of the equipment or of the customer's equipment – the starter is not energised and, thus, the engine is not properly turning, the starting procedure must be completely interrupted (set ignition switch to OFF, voltage supply to heating flange interrupted).
To avoid overheating damage at the heating flange or at the charge air hoses, a further engine start must be avoided and trouble-shooting immediately started.

For product liability reasons, the equipment manufacturer should include an according reference in the operating instructions for his equipment.

**Attention: Activation of the heating flange upon the production of the equipment**
During the production of the equipment, repeated engine starts following each other at short intervals will lead to a repeated activation of the heating flange without sufficient heat discharge, so that defects due to overheating can result.
Moreover, the repeated activation of the heating flange control leads to a discharge of the starter batteries.
To avoid these failures, it is recommended to shortly withdraw the plug K6 (load relay – control connection, see Enclosures 4,5) up to the final starting of the engine.

## 3.) Thermal stability of the control unit :

The control unit is suitable for an ambient temperature range of –40 to 80 °C (permanently) and 85 °C (temporarily). In view of the high heat radiation of the engine, the installation of the control unit directly at the engine is not permissible.

## 4.) Protective system of the control unit :

The control unit is provided with protective system IP54. The installation position must ensure the discharge of moisture, i.e. the plug must point downwards. Generally, however, a splash water-proof position is recommended.

## 5.) Shock and vibration test of the control unit :

For installation of the control unit remote of the engine and mounting of the heating flange on the engine, the function components are suitably vibration-proof. Considering the engine vibrations, it is not permissible to mount the control unit directly on the engine.

## 6.) Heating capacity :

12 V : 2000 W
24 V : 3600 W

## 7.) Heating times :

a) Preheating

| | | Control unit | | EMR2 |
|---|---|---|---|---|
| max. 52 s | ....... | at -30°C | ....... | at –30°C |
| min. 38 s | ....... | at + 5°C | ....... | at + 5°C |

b) Reheating

| | | Control unit | | EMR2 |
|---|---|---|---|---|
| max. 180 s | ........ | at -30°C | ....... | at –30°C |
| min. 35 s | ....... | at +25°C | ....... | at +25°C |

## 8.) Battery capacity and charging balance :

From today's point of view, it is not absolutely necessary to use a battery with increased capacity, as there remains sufficient energy in the battery for further engine starts.
Here, a calculation example:
According to P = U x I, with a power of 2000 W and a 12 V-system, an operating current of 167 A is resulting. If the preheating procedure takes 52 s at a max., 2.5 Ah are discharged from the battery. At a battery capacity of 110 Ah, these are only abt. 2 % of the capacity of a new battery or abt. 4 % of a used battery (semi-charged).

During the reheating phase which may take in the worst case 180 s, a capacity of approx.
8 Ah is again discharged from the battery, which corresponds to 8% of the capacity of a new battery or abt. 16% of a used one (semi-charged). Upon starting of the reheating phase, however, this continued energy discharge is compensated by generator operation.

To ensure the electric energy supply, when using a starting aid between battery and generator, the charging situation must always be balanced. It depends on various influencing factors, in how far the charging situation is really balanced:

- Duration of engine operation and engine standstill
- Engine operation cycle and engine speed
- Generator capacity

Under adverse influencing factors, the battery capacity may be too small in the individual case. If necessary, this must be confirmed under in-service conditions.

## 9.) Cable dimensioning :

When using the heating flange, the following cable dimensions between battery and heating flange must be observed which, on the basis of laboratory examinations, were determined considering the admissible cable heating up. As the current flow for the heat flange capacities used here is comparable at 12V and 24V, for both operating voltages, the same cable lengths result.

| 12V- and 24V-system | Cable cross section | | Cable length range |
|---|---|---|---|
| | 25 mm² | - | 0 to 5.0 m |
| | 35 mm² | - | 0 to 7.5 m |
| | 50 mm² | - | 0 to 10.0 m |

**Reference:**
If the heating flange control is realised via the engine control unit EMR2, upon cabling, it must **absolutely** be made sure that the voltage input for the pulling winding of the load relay is always connected only with the same terminal 15 (to which EMR is connected) – otherwise, there is the risk of an unintended connection of the heating flange.

## 10.) Earthing connection :

A cross section of at least 25 mm$^2$ is used for the earthing cable both for a 12V- and 24V-system - **also see reference under Item 11.**
The earthing cable must be connected to the heating flange at the correct screw. The attached installation drawing (Enclosure 2) may serve as connection reference basis.

**Reference:**
With Service Bulletin 0199-63-9371 ( see Enclosure 6), the heating flange was converted to metal seal, so that the earthing line can be omitted.

## 11.) Electric fusing :

**Electric fusing is absolutely required.**

The electric supply line to the heating flange has no integrated fusable cutout. The following values may be taken as suggestion for the necessary fusing by a strip fuse:

| Cable cross section | | Fuse size |
|---|---|---|
| 25 mm2 | - | 125 A * |
| 35 mm2 | - | 125 A |
| 50 mm2 | - | 125 A |

*We recommend as fuse supplier:
Messrs. Pudenz GmbH, 27243 Duensen, Klosterserseelter Str.5-17, Phone:04244 8190
e.g. for 125 A fuse, the version: Type CF8 or BF1

In view of the nearly identical current loads for the specified heating flange capacities, the same fuse sizes are admissible for 12V and 24V systems.

The direct environment of the fuse is a recommended installation place for the battery.

**REFERENCE:**

Older, already used heating flange coils with a cable cross section of 16mm² and a 100A fuse must not necessarily be converted, if no negative experience in practice was made.

**This TPI must absolutely be observed for new systems or new installations.**

**Supplement:**
From the results of the short-circuit tests (e.g. defective heating flange or permanent energisation due to defective control), the following consequences can arise:

a. The peak current lines to the heating flange must not be integrated in the cable harness considering the excessive heating up of the lines.

b. It must be made sure that the insulation is not in contact with metallic parts (the insulation becomes softer with increasing heating up).

c. Therefore, the peak current lines should not be laid with strong bends.

d. After a short-circuit failure (e.g. defective heating flange), the load relay must be replaced.

## 12.) Load relay :

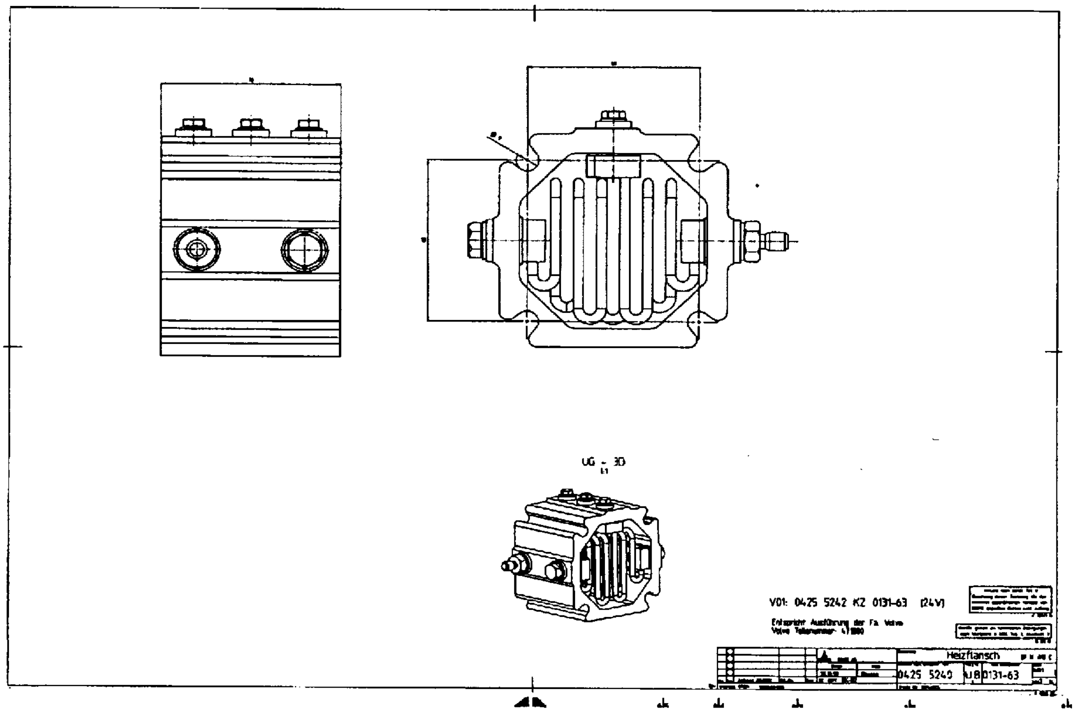
The DEUTZ scope of supply comprises a load relay (PN 04194081 for 12V and PN 04194093 for 24V).
This relay should be installed at a splash-water proof location.
For reasons of vibrations, it is not permissible to fasten the relay directly on the engine.
Moreover, the max. permissible ambient temperature near the relay of 85°C must not be exceeded.

## 13.) Pushbutton :

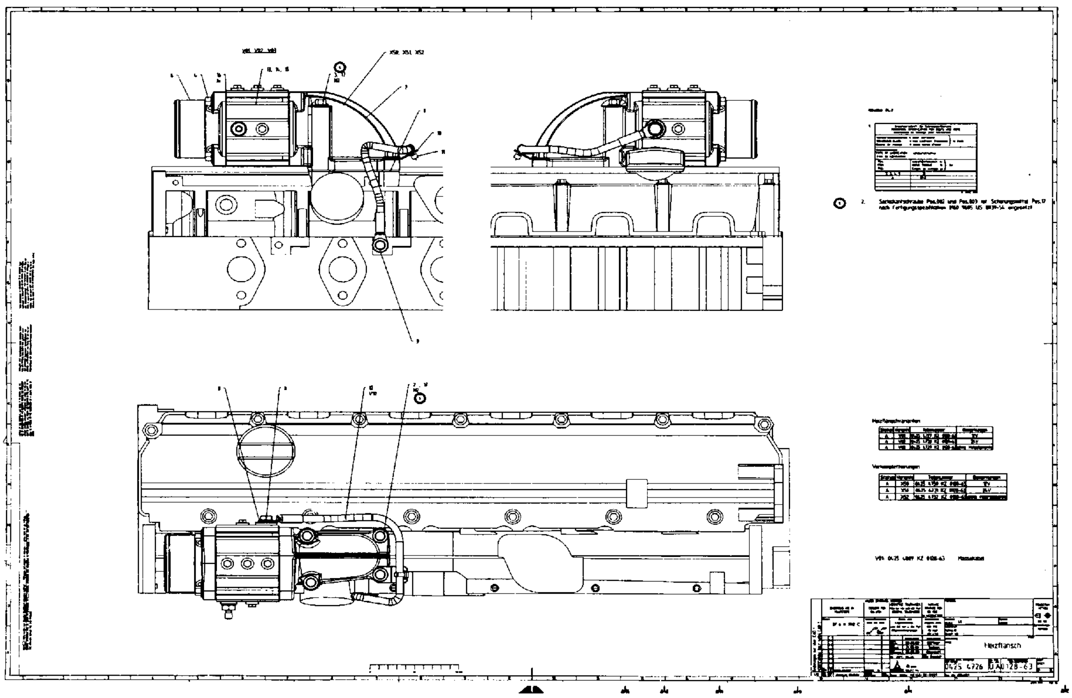
Installation of the pushbutton always near the seat for the machine operator (dashboard).

| | |
|---|---|
| VV-TQ | VV-TS |
| Kramp | Akbarian |

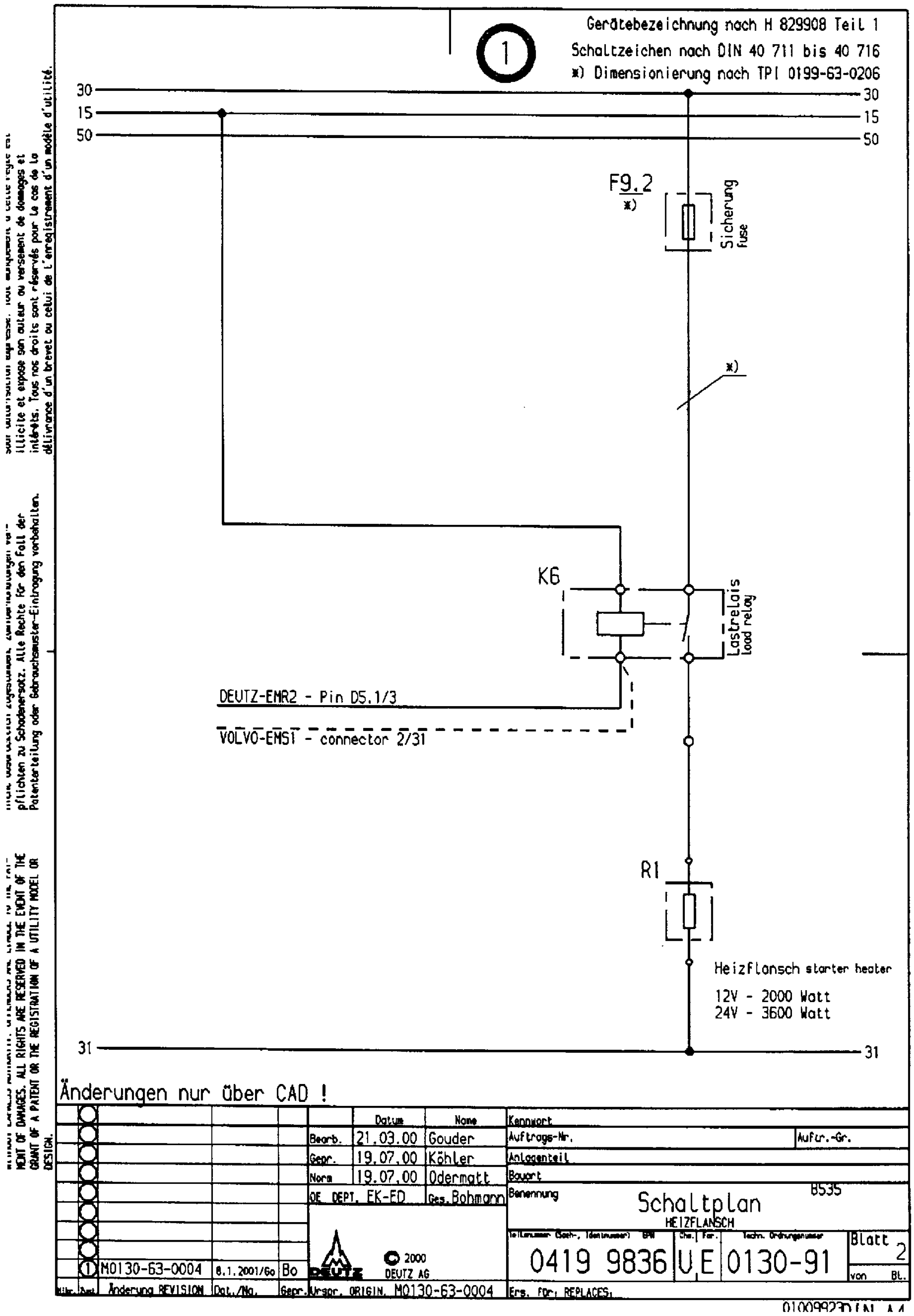
## Enclosure 1: Dimensions of a heating flange



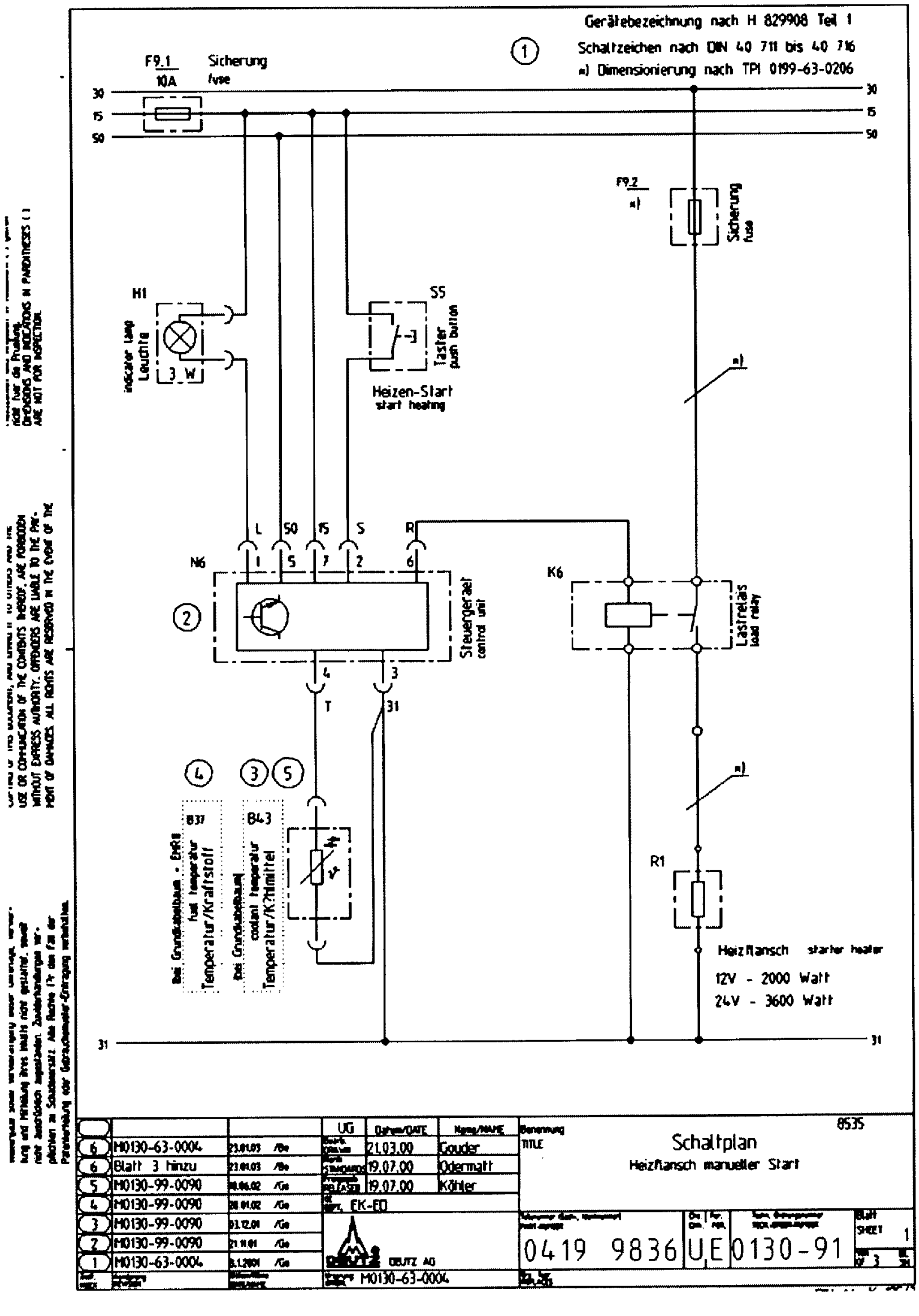

## Enclosure 2 : Installation drawing of a heating flange



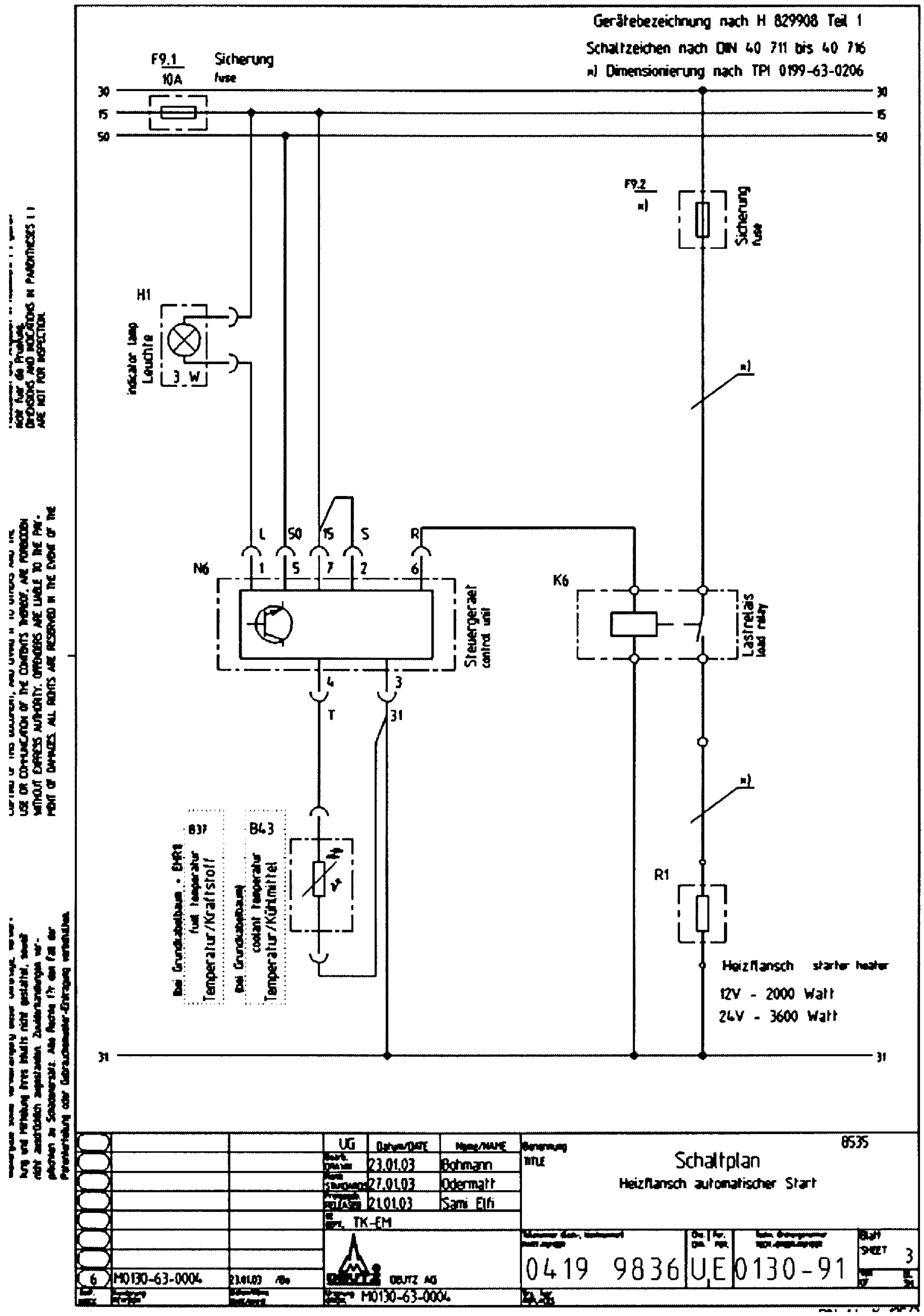
## Enclosure 3 : Circuit diagram heating flange for EMR 2 and VOLVO EMS1



## Enclosure 4 : Circuit diagram heating flange with activation via pushbutton



## Enclosure 5 : Circuit diagram heating flange upon automatic activation



# Technical Product Information
# 0199-26-0206 / 1st Exchange

The recipients of TPIs are asked to ensure, that these are copied to all appropriate persons in their area!

Responsible for the contents: DEUTZ AG Department: VV-TQ Cologne, 2.4.2003

**Enclosure 6 : Service-Bulletin**

## Service - Bulletin
### 0199 - 63 - 9371 en

DEUTZ AG
Deutz-Mülheimer Straße 147-149
51057 Köln

Product:
1012/1013/2012/2013

Date: 14.01.2003 | This Circular supersedes SB:

SM

Copies to : 0019

- **Service Partners At Home and Abroad** (subsidiaries, agencies, dealers)
- **Service Centers At Home**
- **Company Departments (02)**
- **Pocket Book Holders**

Address :

Drawn up by: VS-TII 3 Phone: +49 (0) 221 822-3635
Fax: +49 (0) 221 822-2752

Note : The part numbers indicated in this document serve technical explanation purposes. **Exclusively** the spare parts documentation is binding for the definition of spare parts. Reproduction and / or publication of this document is subject to our approval.

### 1012/1013/2012/2013 - Sealing-heat flange

The seals on the heat flange (between heat flange elbow and charge air pipe) for series 1012/1013/2012 have been changed to metal seals with silicon sealing lip. When changing the **"former"** seals to the **"current"** seals the earth line is not necessary, as the earth contact is established by the metal seal.

☞ Exception, series 2013:
For series 2013 the charge air pipe has a flexible coupling.
The earth line must be used, otherwise the heat flange will not work!

| Series | | Former | Current |
|---|---|---|---|
| | Seal | 0419 8835 | 0428 2753 |
| BF 4M 1012 | Seal set | | 0293 1276 |
| BF 6M 1012 | Seal set | | 0293 1277 |
| | Seal | 0420 3649 | 0428 2488 |
| BF 4M 1013 | Seal set | | 0293 1278 |
| BF 6M 1013 | Seal set | | 0293 1279 |
| | Seal | 0425 8722 | 0425 8906 |
| BF 4M 2012 | Seal set | | 0293 1431 |
| BF 6M 2012 | Seal set | | 0293 1432 |
| | | | |

DEUTZ AG
Service-Engineering

i.V. Sonntag i.A. Rendenbach

- Sonntag - - Rendenbach -

SM_de_07/2002 VS-TII3

Printed in Germany  Page 1 of 1 ÄM 0130-63-0012 / 23.09.02