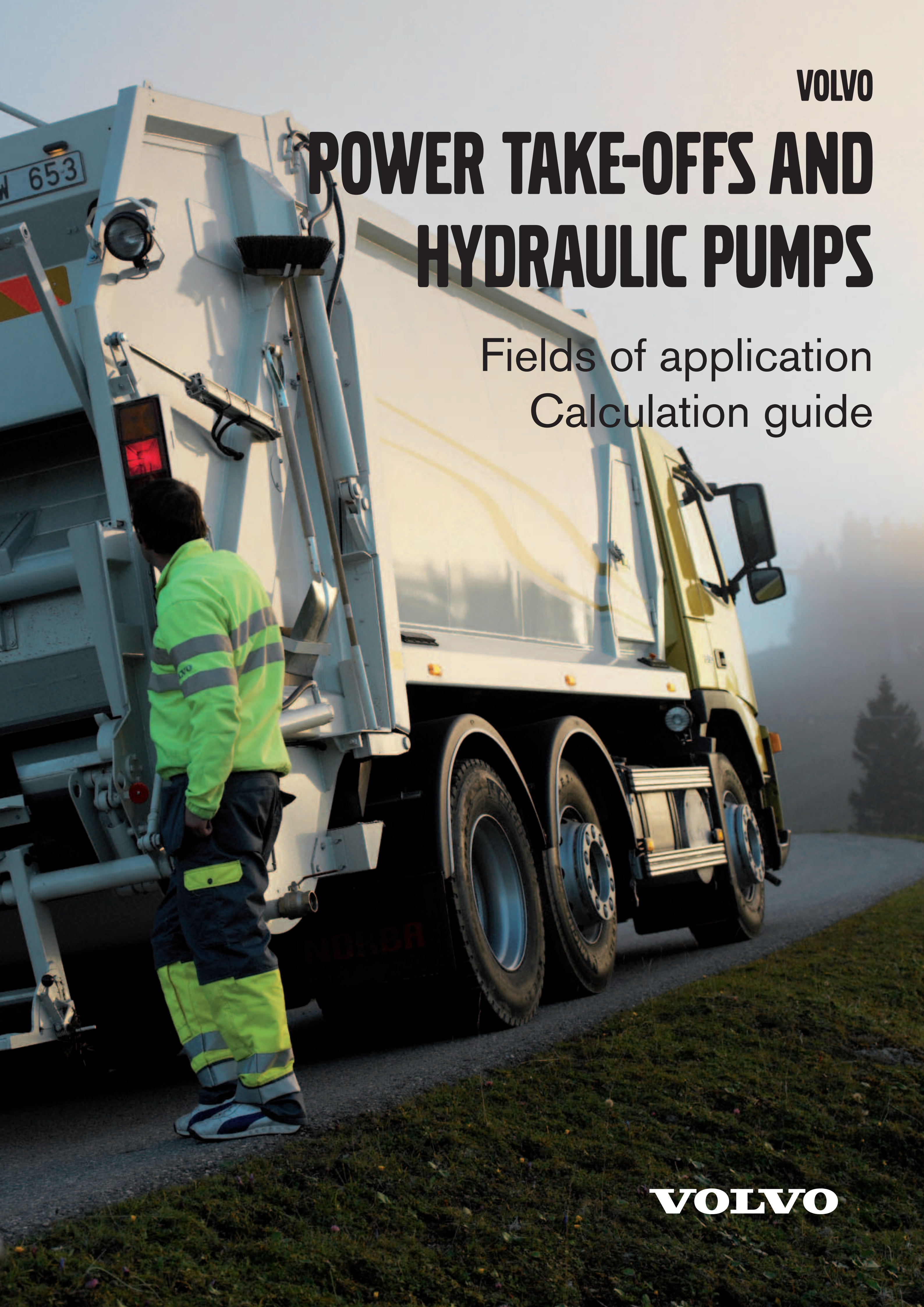
VOLVO

POWER TAKE-OFFS AND HYDRAULIC PUMPS

Fields of application
Calculation guide



VOLVO

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VOLVO POWER TAKE-OFFS AND HYDRAULIC PUMPS

For a truck to be capable of doing its job efficiently and profitably, its load handling equipment must be suited to the task.

To power the load handling equipment, the vehicle must be fitted with an extra means of power supply, a power take-off. One or more power take-offs transfer power from the engine to drive attachments or load handling equipment. The power take-off is the vital link between the power source and the function.

EXTRA EQUIPMENT IS CRUCIAL

There are many reasons why it is important to specify and order the correct power take-off with the chassis from the factory. The four most important ones are optimal operation, higher quality, simpler fitting and lower overall cost.

Depending on the field of application of the vehicle, different types of extra drive equipment are coupled to the power take-off to transfer power to the function to be driven. The factor that determines which power take-off is the most suitable one is the performance requirements of the extra equipment.

Volvo's own in-house manufactured power take-offs are produced to guarantee the highest possible quality and perfect matching to the severe demands of the transport sector. Since the interaction between power take-off and driveline is crucial for quality, Volvo power take-offs are designed specifically for Volvo engines and gearboxes. In addition to reliability, this brings many advantages, such as low weight and simpler maintenance.

PREPARED FOR POWER TAKE-OFFS

All trucks are fitted at the factory with a control system for a power take-off. Where vehicles need to drive two pumps or to have some other form of advanced power take-off control, special electrical outlets can be ordered for vehicle superstructures. Wiring for extra switches is necessary for most vehicles with a power take-off. Your dealer will help you specify the truck with the right control system.

COMPLETE HYDRAULIC SYSTEMS

There are also complete hydraulic systems for the power take-offs, with hydraulic pumps, tanks, pipes, connections and suspension parts suitable for Volvo chassis.

Installing a complete hydraulic system from Volvo means high availability, thanks to Volvo's comprehensive service network, with access to spare parts and competent service personnel.

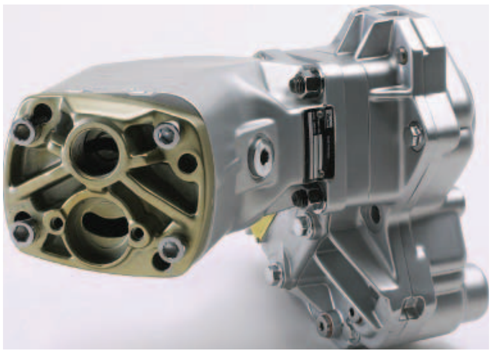
CLUTCHED POWER TAKE-OFFS

Clutched power take-offs are fitted on manual gearboxes, including I-Shift. They can only be used when the vehicle is stationary. Installation is simple, and the PTO is a lightweight unit.

The power take-off is driven via the gearbox layshaft and is fitted on the rear end of the gearbox. Rotation speed and power output are determined by the engine's revs and the gearbox ratio. Clutched power take-offs can only be used when the vehicle is stationary, and the PTO is engaged via a pneumatic system.

SEVERAL ADVANTAGES

A clutched power take-off is light compared with a direct-drive one. In addition, it does not drain engine power, since hydraulic oil is not being constantly pumped round as it is in a direct-drive system. The design is simple and robust, requiring a minimum of maintenance, and the cost of installation can be kept low. The fact that the power take-off cannot be engaged when the vehicle is moving may be an advantage from a safety point of view.
Clutched power take-offs are the obvious choice where the vehicle has a manual gearbox and there is no need to use the power take-off when the vehicle is in motion.



Clutched power take-off with hydraulic pump fitted.

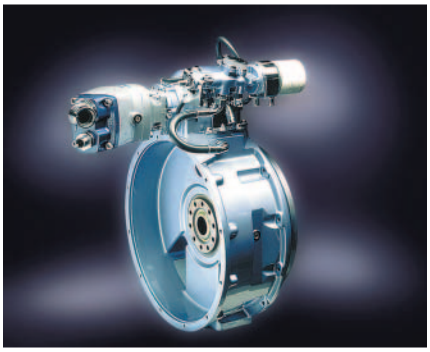
DIRECT-DRIVE POWER TAKE-OFFS

There are several variants of direct-drive power take-offs. They can be fitted to vehicles with any type of driveline. The power take-offs can be used both in driving and when the vehicle is stationary. Direct-drive power take-offs are also suitable for engagement and disengagement from outside the vehicle. For vehicles that require constant access to power take-offs, direct-drive is the only option.

DIRECT-DRIVE POWER TAKE-OFFS FOR MANUAL GEARBOXES

The power take-off is driven via the flywheel of the engine and is fitted between the engine and the gearbox. Speed and power are governed only by the engine.

The power take-offs have an electro-pneumatic/hydraulic engagement system in the form of a disc clutch.



Direct-drive power take-off for manual gearbox.

DIRECT-DRIVE POWER TAKE-OFFS FOR AUTOMATIC GEARBOXES

The power take-off is mounted on the front upper part of the gearbox. It is driven from the flywheel of the engine via the torque converter housing which, with the support of a sturdy pinion, transfers the power to the power take-off. This means that it is only affected by the speed of the engine, not by the speed of the torque converter.

The power take-off is engaged by means of an electrical and hydraulic system, which allows it to be engaged when the vehicle is moving.

Driect-drive power take-off mounted on a Powertronic gearbox.

ENGINE MOUNTED DIRECT-DRIVE POWER TAKE-OFFS

The power take-off is mounted on the engine. It is powered by the transmission of the engine. This means that the PTO is always activated when the engine is running, irrespective of whether the vehicle is moving or stationary.

Activation of the hydraulic circuit takes place via a relief valve mounted on the hydraulic pump. The power take-off is mounted at the rear of the engine, except in the case of the D12 engine where it is side mounted. Installation on the D9, D13 and D16 can be specified with either a DIN output or connecting flange.

Engine-mounted power take-off with hydraulic pump, here on the D13.

POWER TAKE-OFFS FOR DIFFERENT APPLICATIONS AND POWER DEMANDS

The length of time for which a power take-off is used varies depending on the application, and the power demand for every application varies within wide limits. The schematic on the next page gives an approximate idea of how often the power take-off is used depending on the application and shows the power demands of the various applications.

For example, a bulk truck uses the power take-off for between 1000 and 4000 hours over a five-year period and requires a relatively high power output. A tipper truck, on the other hand uses the power take-off for about 600 hours over the same period and requires far less power.

The pages that follow present some brief facts about the most common fields of application in which Volvo power take-offs form the trusty link between power source and function. The power and torque figures given are for guidance only. Different applications impose different demands on the hydraulic system. Your Volvo dealer can provide data sheets with further information about each power take-off.

When choosing a power take-off it is important to be aware of the following points:

• The use of higher hydraulic system pressures means that smaller pipes and pumps can be used. These occupy less space and are lighter.

• Connecting the hydraulic pump directly to the power take-off reduces the cost of the installation.

• A higher ratio at the power take-off allows a lower engine speed to be used, lowering the noise level and reducing fuel consumption.

HEAT FROM EXHAUST SYSTEM

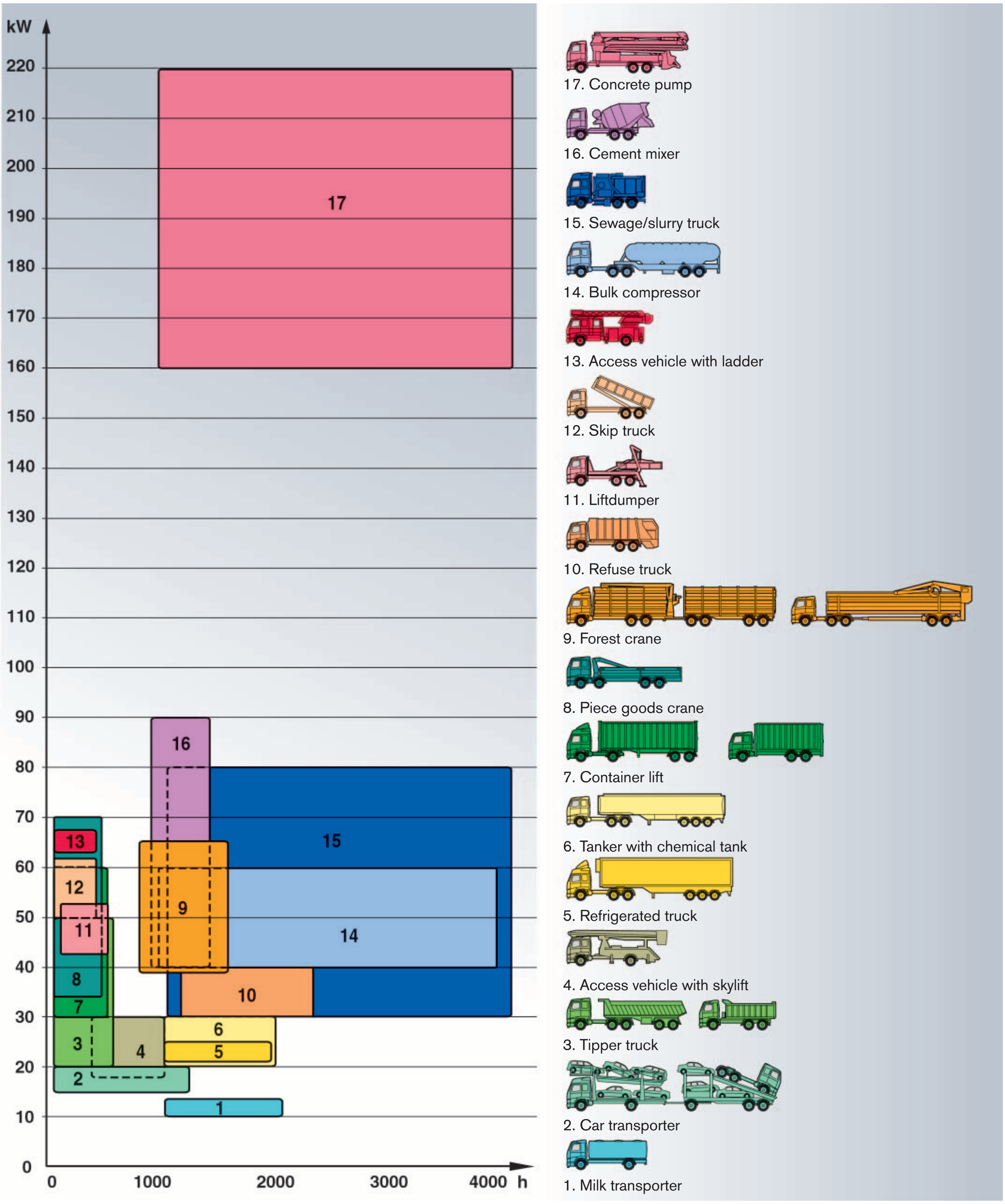
The heat from the exhaust gases and exhaust systems will be high when the engine is working with high load.
Stationary operations with engaged PTO will warm up both the vehicle and the ground under the vehicle. There is no major difference between Euro 3 (ordinary muffler) or Euro 4/5 (catalytic muffler) except that the last one keeps the heat a little longer due to the bigger mass.

Different exhaust pipe directions are available as options. For vehicles using heavy PTO load, exhaust pipe outlet guidelines in table below should be used (green colour). For exhaust direction and PTO effect outside these guidelines, extra attention on the heat to the ground is needed if PTO max. effect is used.

<table>
<tr><th></th><th>60 kW</th><th>80 kW</th><th>100 kW</th><th>120 kW</th><th>160 kW</th><th>>160 kW</th></tr>
<tr><td rowspan="5">CHH-STD
CHH-MED</td><td colspan="6">ESH-VERT / ESV-VERT</td></tr>
<tr><td colspan="5">ESH-LEFT</td><td></td></tr>
<tr><td colspan="4">ESH-REAR</td><td colspan="2"></td></tr>
<tr><td colspan="2">ADR1/-2, ESH-LEFT/REAR</td><td colspan="4"></td></tr>
<tr><td colspan="2">ESH-RIGH</td><td colspan="4"></td></tr>
<tr><td rowspan="3">CHH-LOW
CHH-XLOW</td><td colspan="6">ESH-VERT / ESV-VERT</td></tr>
<tr><td colspan="2">ESH-LEFT</td><td colspan="4"></td></tr>
<tr><td colspan="2">ESH-REAR</td><td colspan="4"></td></tr>
</table>

At 600 rpm idling no critical temperature occurs. This independent of PTO effect or chassis height.
At 1000 rpm idling the temperature can be to too high if the PTO installation is outside of the guidelines above.

UTILIZATION AND POWER DEMAND



The diagram shows roughly how often the power take-off is used and how much power the application needs.
kW = power output, h = approximate usage time in hours over five years.

MILK TANKER

Milk tanker applications may involve a low flow rate since the milk is pumped slowly. The power demand for milk tankers is about **10 kW**. The hydraulic system is usually driven by a clutched power take-off but there also applications with direct-drive power take-offs.

CAR TRANSPORTERS

The power needed for car transporter applications is relatively low, **15–20 kW**. The hydraulic system is driven by a clutched power take-off, as the power take-off is only needed when the vehicle is stationary.

TIPPERS

Tipper trucks are the most common application for power take-offs. The tipping application accounts for 60 % of all applications in Europe. The hydraulic system has a single-acting hydraulic cylinder which is filled by means of the hydraulic pump and emptied by the weight of the vehicle body. The power take-off is used for short periods and the system requires **20–60 kW** of power.

For plant vehicles with tipping body, a power take-off with a directly-mounted hydraulic pump is used. Where a tipper truck is combined with a snowplough or salt/sand spreader, a direct-drive power take-off is needed, since it must be possible to drive this application when the vehicle is moving.

ACCESS VEHICLE WITH SKYLIFT OR LADDER

The power needed for medium-heavy vehicle variants is relatively low, **18–30 kW**. Ladder applications need relatively high power outputs, 65 kW for short intervals.

The hydraulic system is driven by a clutched power take-off, since the application requires the vehicle to be stationary, but a direct-drive power take-off is often used. On the heavy vehicle variants, the skylift application is used on firefighting vehicles.

REFRIGERATED TRUCK

The load space of the vehicle is refrigerated by a refrigeration unit powered by a 380 volt alternator or a separate engine. The alternator is driven from the transmission of the engine, either directly or via a variable hydraulic pump.

The power demand for this application is just over **20 kW**. The hydraulic system is usually driven by a direct-drive engine power take-off.

CHEMICAL TANKER

Tanker trucks have varying needs depending on the density of the liquid. It may be oil, petrol, kerosone or other liquids.

The power demand for a chemical tanker is **20–30 kW**. The hydraulic system can be driven by either a clutched or a direct-drive power take-off.

CONTAINER LIFTING

A medium to high hydraulic flow is needed for container applications. The power take-off, which drives four large rams, is used for short periods and the system requires **30–60 kW** of power. The hydraulic system is usually driven by a clutched power take-off.

PIECE GOODS CRANES

Crane applications for piece goods usually operate with a two-circuit system in order to increase manoeuvrability. This requires a split displacement hydraulic pump or dual variable displacement hydraulic pumps. Vehicles with a piece goods crane are usually fitted with a single power take-off and a split-displacement hydraulic pump. This combination of power take-off and pump is used when a piece goods crane is combined with a tipper. The power demand for piece goods cranes is **35–70 kW**. The hydraulic system is usually driven by a clutched power take-off, but direct-drive power take-offs are also used.

FOREST CRANES

Forest cranes impose big demands on the power take-off equipment, since the load varies greatly. The crane application for forest cranes usually operates with a fixed or variable flow single-circuit system.

The power demand for forest cranes is **40–65 kW**. The hydraulic system is usually driven by a clutched power take-off.

REFUSE TRUCKS

Refuse collection applications have a high degree of utilisation and are equipped with complex hydraulic circuits. This makes big demands on the reliability of the power take-off and requires the power take-off and the hydraulic system to run quietly.

Since some markets allow refuse trucks to use the hydraulic system while the vehicle is moving, a direct-drive power take-off is required. The power demand for a refuse trucks is **30–40 kW**.

LIFT DUMPERS

Liftdumper applications require a high hydraulic flow rate and a power output of about **45–55 kW**. It is becoming increasingly common for vehicles to be built so that they can switch between the liftdumper and skip truck system. In these cases the power take-off is designed for the skip truck system, since it requires more power. The hydraulic system is usually driven by a direct-drive power take-off.

SKIP TRUCKS

The hydraulic system for skip trucks requires a high pump flow rate and a power take-off with an output of **50–65 kW**. Since most skip truck systems need to be able to move the pick-up hook when reversing, a direct-drive power take-off is required.

BULK

High-speed compressors driven via transmission shafts are used for bulk applications. These require a power take-off with a high ratio and output. To avoid impact loads on the gearbox when pumping bulk products, belt drive is used, in combination with a direct-mounted pump for tipping the bulk container. The compressor can be driven via a transmission shaft from the high-speed backward-facing output, and the tipping function can be driven via the corresponding forward-facing output with a direct-mounted hydraulic pump.

The power demand for a bulk applications is **40–60 kW**. The hydraulic system is usually driven by a clutched power take-off.

SEWAGE/SLURRY TRUCK

The power take-off output levels required for these applications vary. They depend on whether the truck is equipped only with a sewage/slurry pumping unit, or whether it also has a high-pressure jetwashing unit. Sometimes extra power take-off output is needed to be able to tip the tank and to operate heavy covers and hose reels. The power demand for the slurry pump unit is **30–80 kW** whilst the jetwashing unit requires about **110 kW**.

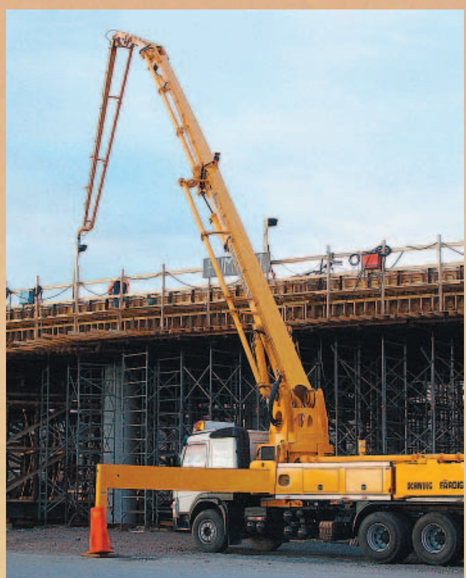
In most cases, Volvo power take-offs can meet the power demand, but where vehicles are fitted with units that require a great deal of power, they must be driven via a distribution gearbox with outputs for the pumping and jetwashing units. The most commonly used power take-offs for jetwashing and slurry pumping applications are clutched dual power take-offs.

CEMENT MIXER

Cement mixer sizes range from 4 to 10 m^3. The power demand is **40–90 kW**. A cement mixer operates with two power levels, a higher one when discharging and a lower one for rotation while on the move.

The power demand for rotating the drum while travelling is **15–20 kW**, whilst the beginning of the discharging phase – when the drum changes direction – needs **40–90 kW** depending on the size of the mixer, falling to **15–20 kW** for the rest of the discharging phase. This means that full power output is only needed for short periods. Sometimes extra power take-off output is needed to be able to drive and control conveyor belts. The most common type of power take-off for cement mixers is the direct-drive power take-off, since the hydraulic system needs to be able to operate when the vehicle is travelling.

CONCRETE PUMPS



Concrete pumps need lots of power, up to **160 kW**, in extreme cases as much as **220 kW**. A distribution gearbox is needed for power outputs above **100 kW**. The hydraulic system is usually driven by a clutched power take-off, since the application requires the vehicle to be stationary, but a direct-drive power take-off is sometimes used.

SPECIFYING A POWER TAKE-OFF

THE RIGHT POWER TAKE-OFF

There are many reasons why it is important to specify and order the correct power take-off with the chassis from the factory. The most important ones are:

- Optimal operation can be guaranteed, above all in terms of noise level, fuel consumption, emission levels and function.
- Better scope for quality assurance, since there is no need for work to be done on the gearbox at a later time.
  Sealing and cleanliness can be guaranteed.
- Reduced lead time, since the chassis is better prepared for the superstructure.
- Reduced total cost, since the power take-off, hoses and wiring can be installed during production.

THE FUNCTION OF THE SUPERSTRUCTURE

The power take-off is often used to drive a hydraulic pump which is part of the hydraulic system for the function of the superstructure. The specification of the power take-off therefore depends on the design of the vehicle superstructure. The function of the superstructure is determined by the customer's needs for the envisaged application. This means that many superstructures are unique to a particular customer. The builder of the superstructure must therefore design the superstructure so that these needs can be efficiently met. Superstructures to meet the same needs may be designed in different ways, depending on which company built them.

TECHNICAL VARIABLES

When specifying power take-offs it is important to optimise the combination of engine, gearbox, power take-off and hydraulic pump. A well-optimised system brings benefits in terms of performance, noise level, weight and cost. If the technical variables for the hydraulic system are not known, it is impossible to specify a power take-off correctly.

Examples of important variables are:

- Required hydraulic flow
- Maximum hydraulic system pressures in different circuits
- Requirements for clutched power take-offs
- Location of the power take-off
- Working speed of the engine

The design of the superstructure must be known before some of these variables can be determined. Knowing what application the superstructure is designed for is not enough; different companies have different superstructure designs for the same purpose. So when specifying power take-offs it is very important to obtain information from the company supplying the superstructure.

PROCEDURE FOR SPECIFYING A POWER TAKE-OFF

Two proposed ways of specifying power take-offs are described below. The first is based on the assumption that the power take-off will be driving a hydraulic pump. In the second, the power take-off will be driving a compressor, pump or similar unit via a transmission shaft. Examples of calculations are given on page 17.

DIRECT MOUNTED HYDRAULIC PUMP DRIVE

The procedure is based on the assumption that the power take-off will be driving a hydraulic pump. A power take-off should always be specified in combination with a hydraulic pump, either one chosen by the body builder or one chosen by the dealer.

1. Establish the operating conditions through discussions with the body builder and customer, with regard to:

- Hydraulic flow, Q (l/min) and, when the hydraulic pump is chosen by the body builder, the hydraulic pump's displacement, D (cm^3/rev).
- Maximum system pressure, p (bar).
- The diesel engine's revs (should be as low as possible), n_{eng} (rpm).
- Demand concerning direct-drive format or not.
- Other requirements such as location, dual power take-off installation, dual hydraulic pumps or variable hydraulic pumps etc.
- Type of gearbox and engine.

2. Choose a suitable power take-off with the aid of item 1 above and the power take-off fact sheets.

The points should give enough data to reduce greatly the choice of possible power take-offs. The ratio of the power take-off depends on the engine rpm and the required pump flow rate. As a guide, choose the highest power take-off ratio that does not exceed the limits of the hydraulic pump.

3. Read off ratio z for the selected power take-off, see the tables entitled "power take-off ratios (z)" on pages 18 and 19.

4. Select the pump by calculating the required displacement, $D_{req,}$ using the following formula:

$$D_{req} = \frac{Q \times 1000}{z \times n_{eng}} \iff Q = D_{req} \times z \times n_{eng} / 1000$$

Refer to the hydraulic pump fact sheets to select the smallest pump with a displacement of $D > D_{req}$.

5. Check that the maximum permitted speed n (rpm) of the hydraulic pump is not exceeded, using the formula:

$$n_{eng} \times z < n$$

When specifying engine power take-offs, it is important to bear in mind that the power take-off and the pump coupled directly to it cannot be disengaged. This means that the hydraulic pump must also be capable of running at the speed it reaches when the vehicle is travelling.

6. Check that the maximum permitted torque M_{perm} (Nm) of the power take-off is not exceeded, by using the following formula:

$$M = \frac{Dp \times p}{63} < M_{perm}$$

If the torque is exceeded, a different power take-off must be chosen, either one with a higher ratio or a higher permitted torque. Start again at 2.

7. It is important that the engine can handle the relevant torque at the selected engine revs.

Check that the engine can provide torque M (Nm) multiplied by the PTO's ratio z at revs n_{eng} (rpm). If several power take-offs are used simultaneously, the engine must be able to provide the total torque required. It is particularly important to check the engine's torque capacity when small engines are used for power-intensive applications.

8. Check that the maximum permitted power P_{perm} (kW) of the power take-off is not exceeded, by using the following formula:

$$P = \frac{M \times z \times n_{eng} \times 3.14}{30000} < P_{perm}$$

If the power P (kW) is greater than P_{perm} (kW) a different power take-off capable of handling the power obtained must be chosen. Start again at 2.

9. When the power take-off has been chosen, contact the body builder concerned. Let them know the characteristics of the power take-off and which hydraulic pump the choice of power take-off is based on.

PROPELLER SHAFT DRIVE

This procedure is based on the assumption that the power take-off is to drive a propeller shaft.

1. Determine the operating conditions by discussion with the body builder and customer, with regard to:

- The power requirement P (kW) of the application.
- The working speed of the diesel engine n_{eng} (rpm).
- Whether or not direct drive is required.
- Other requirements such as positioning, dual power take-off, dual hydraulic pumps or variable hydraulic pumps, etc.
- Type of gearbox and engine.

2. Choose a likely power take-off with the aid of item 1 above and the power take-off fact sheets.

Above items should give enough data to greatly reduce the number of suitable power take-offs.

3. Check that the power take-off's maximum permitted torque M_{perm} (Nm) is not exceeded as per the following formula:

$$M = \frac{P \times 9550}{(z \times n_{eng})} < M_{perm}$$

z is the power take-off's ratio. See the "Power take-off ratio (z)" tables on pages 18-19.

4. It is important that the engine can provide the required torque at the selected revs.

Check that the engine can provide torque M (Nm) multiplied by the power take-off's ratio z at revs n_{eng} (rpm). If several power take-offs are used simultaneously, the engine must be able to provide the total torque required. It is particularly important to check the engine's torque capacity when small engines are used for power-intensive applications.

5. Check that the power take-off's maximum permitted output P_{perm} (kW) is not exceeded.
If the power output P (kW) is greater than P_{perm} (kW) another PTO that can handle the required power output should be selected. If so, begin according to point 2 above.

6. When the power take-off has been chosen, contact the body builder concerned. Let them know the characteristics and location of the power take-off.

CHOOSING A HYDRAULIC PUMP

If the power take-off is the heart of a truck's load handling system, the hydraulic system is the circulation of the blood. Without the right pump, tanks and hoses, peak efficiency cannot be achieved.

It is very important that the body builder and the salesman together have the correct tools to specify a correctly dimensioned hydraulic system adapted to each unique operation.
On the Volvo Body Builder Instructions (VBI) home page a "Truck pump/PTO system calculator" is available.

Internet address: http://vbi.truck.volvo.com/ (password required)

Click on "Introduction / Software requirement / Parker Truck diesel engine speed calculator". Please always use this calculator to have a correctly dimensioned hydraulic system. The calculator indicates the maximum allowed engine speed when the hydraulic pump is in service.

Vehicles specified with a PTO and pump (variable pumps excluded) will always have a maximum engine speed (rpm) pre set from factory, i.e. when the PTO is in service the max. engine speed cannot be overridden by pressing the throttle:

- **Settings for vehicles specified with variant UELCEPK, without BBM (Body Builder Module):***

Hydraulic pump	**Max. engine revs during pump operation**
HPE-F41 /-F51/-F61/-F81	2000 r/min
HPE-F101	1700 r/min
HPE-T53 /-T70	1700 r/min
HPE-V45	2000 r/min
HPE-V75 /-V120	1700 r/min
PTO incl. hydraulic pump	
PTES-F41 /-F51 /-F61 /-F81	2000 r/min
PTES-F10	1700 r/min

* For gearbox-mounted PTO with DIN output (PTR-D, PTR-DM, PTRD-D1 etc.), No max. engine revs set.

- **Setting for vehicles specified with variant ELCE-CK, with BBM (Body Builder Module):**

PTO incl. hydraulic pump	**Max. engine revs during PTO/pump operation**
All PTOs & pumps (apart from variable pumps)	2500 r/min

The VCADS Pro tool can be used to alter the preset maximum engine revs.

Hydraulic system dimension data, operating instructions and service instructions are always delivered with the vehicle. A final body building delivery inspection must always be carried out according to Volvo Truck Corporation directives.

The following type of pumps occur:

- **Fixed displacement single-flow pump**
- **Fixed displacement double-flow pump**
- **Variable displacement pump**

The following pump drives occur:

- **Direct-driven pump**
- **Single pump with transmission shaft**
- **Double pump with transmission shaft**

SINGLE-FLOW PUMPS

This type of hydraulic pump is suitable for single-circuit systems with fixed displacement. The single-flow pump comprises a single circuit from the pressure port to the suction port of the pump. Hydraulic pump F1 Plus is a single-flow pump.

TWIN-FLOW PUMP

This type of hydraulic pump is suited to a twin-circuit system with a fixed volume. The twin-flow pump consists of two entirely independent circuits that are regulated entirely separately. The pump has a single suction port and two separate pressure ports. Hydraulic pump F2 Plus is a twin-flow pump.

VARIABLE DISPLACEMENT PUMPS

This type of hydraulic pump is suitable for single-circuit systems with variable volume. Just like single-flow pumps, pumps for variable flow have only one circuit as seen from the pressure side to the suction side; the difference is that the flow rate can be varied. With a variable flow pump, the flow rate can be kept constant even if the engine speed varies. Hydraulic pump VP1 is a variable flow pump.

DIRECT-DRIVEN PUMPS

Direct-driven pumps can be mounted directly on the power take-off in accordance with the DIN 5462/ISO 7653 standard. All pumps can be mounted directly on the power take-off.

SINGLE PUMPS WITH TRANSMISSION SHAFT

Hydraulic pumps can also be driven via a transmission shaft connected to the power take-off. A flange conforming to the SAE 1300 standard is used. All pumps can be driven via a transmission shaft from the power take-off.

DUAL PUMP WITH PROPELLER SHAFT

Hydraulic pumps can also be driven in pairs via a transfer gear and a propeller shaft that is connected to the power take-off. Connection is via a flange according to SAE 1400 standard. Hydraulic pumps VP1-45 and VP1-75 can also be installed for tandem drive with just one propeller shaft since it has a through-shaft. All pumps can be driven in pairs via a propeller shaft from the power take-off.

APPLICATION AREAS

Each pump model has several different sizes with various displacements and pressure ratings to suit the widest possible variety of application areas.

The following pages provide a brief description of the various pump models.

HYDRAULIC PUMPS

F1 PLUS SINGLE-FLOW PUMP

F1 Plus is a further development of the F1 pump. The pistons' operating angle has been increased to 45° and the pump has a new bearing housing. The pumps in the F1 Plus series have high operating reliability and their compact format make them easy to install at low cost.
The F1 Plus series consists of five different pumps. All five sizes have the same installation dimensions on the connecting flange and axle and conform to the current ISO standard.

Single-flow pump F1 Plus with relief valve for engine mounting.

F2 PLUS DOUBLE-FLOW PUMPS

The F2 Plus is the double-flow variant of the F1 Plus. A double-flow pump can provide two totally independent flows. The advantage of a double-flow pump is that, for a given design of the hydraulic system, it is possible to have three different flows for the same truck engine speed. With a double-flow pump, the hydraulic system can be better optimised, giving reduced energy consumption and lower risk of overheating, less weight, simpler installation and standardised system solutions. With the double-flow pump, two flows can be driven independently, giving a higher speed and better operating precision. There may be a requirement for a high flow rate at the same time as a low flow rate, or two equal flow rates. Every alternative is possible with a double-flow pump. One of the pump's flows can be used in combination with high system pressure, and later, when the pressure level in the system has fallen, both flows can be used. This eliminates the risk of the power take-off overheating and gives more optimal running. The shaft journal and flange conform to the ISO standard and are designed for direct mounting on the power take-off. F2 Plus is suitable for large piece goods cranes, forest cranes, skip trucks, tippers with crane, and refuse collection trucks.

Twin-flow pump F2 for engine mounting.

VP1 PUMP WITH VARIABLE FLOW

The VP1 pump can be mounted directly on a power take-off on the gearbox or on a direct driven power take-off on the engine flywheel or the transmission of the engine. The variable flow of the VP1 pump is particularly suitable for applications requiring a load-sensitive hydraulic system, such as truck mounted cranes. The pump supplies the hydraulic system with the appropriate flow at the right time, thus both reducing energy requirement and cutting heat production. This in turn means a quieter system with lower energy consumption. The VP1 pump is characterised by a high efficiency rating, compact installation dimensions and light weight. It is reliable, economical and simple to install. The pump's construction permits an angle of 20° between the piston and swashplate, making the pump compact.
The VP1-45 and VP1-75 feature a through-shaft that permits tandem connection of an additional pump, for example an F1 pump with a fixed displacement.
All three pump sizes have compact installation dimensions. The axles and connecting flanges conform to the ISO standard.

Pump VP1-120 with variable flow.

CALCULATION EXAMPLE – FOREST CRANE

The example below illustrates the procedure for specifying a power take-off with hydraulic pump for a Volvo FH fitted with a forest crane.

OPERATING CONDITIONS

1. The following operating conditions are arrived at in discussions with the customer and the body builder:

- The crane requires a hydraulic flow rate Q = 95 l/min.
- The maximum pressure of the hydraulic system is p = 250 bar.
- The customer and the body builder consider that a suitable engine speed is neng = 900 rpm .
- The forest crane is always used when the vehicle is stationary, so there is no need for a direct-drive power take-off.
- The body builder recommends a direct-mounted hydraulic pump.
- A single variable displacement pump is recommended for the vehicle.
- The engine is the D13 and the gearbox is the V2514.

2. The above operating conditions provide the basis for selecting a suitable power take-off.

No direct-drive power take-off is required, so a gearbox-mounted power take-off can be selected. Furthermore, the PTO should be suitable for a direct-mounted hydraulic pump. The rule of thumb says that a power take-off with a high ratio should preferably be selected. Examination of the PTO fact sheets reveals that PTR-DH can be chosen as a suitable power take-off.

3. The table "Power take-off ratio (z)" on the next page shows that the ratio for gearbox V2514 on high split and power take-off PTR-DH is z =1.53.

4. Select the pump by first calculating the required displacement:

$$D_{req} = \frac{Q \times 1000}{z \times n_{eng}} \quad \frac{95 \times 1000}{1.53 \times 900} = 69 \text{ cm}^3\text{/rev.}$$

Refer to the hydraulic pump fact sheets to select the smallest pump with sufficient displacement, $D > D_{req}$. The fact sheets indicate that VP1-75 is the smallest variable pump that meets this criterion, D = 75. The engine rev rating of 900 rpm is also the lowest possible for this application.

5. Check that the maximum permitted speed n (rpm) of the hydraulic pump is not exceeded.

Using the formula:

$$n_{eng} \times z = 900 \times 1.53 = 1377 \text{ rpm}$$

shows that the speed is less than the maximum speed n =1700 rpm of the pump (see pump data). This means that the maximum speed of the hydraulic pump is not exceeded.

6. Check that the maximum permitted torque M_{perm} (Nm) of the power take-off is not exceeded.

$$M = \frac{D \times p}{63} = \frac{75 \times 250}{63} = 298 \text{ Nm}$$

M =298 Nm is less than the maximum permitted torque M_{perm} = 400 Nm of the power-take-off (see power take-off data sheet). This means that the chosen power take-off can meet the torque requirements of the application. It is also important that the engine is capable of delivering the required torque at the chosen speed (rpm). In other words: Can the engine deliver the torque M (Nm) multiplied by the ratio z of the power take-off at the speed n_{eng} (rpm)? In this case the engine must be able to deliver:

298 × 1.53 =456 Nm, at 900 rpm.

7. Check that the maximum permitted power P_{perm} (kW) of the power take-off is not exceeded.

$$P = \frac{M \times z \times n_{eng} \times 3.14}{30000} = \frac{298 \times 1.53 \times 900 \times 3.14}{30000} = 43 \text{ kW}$$

For PTR-DH, the maximum permitted power is 65 kW (see data sheet). This means that the power take-off can handle the power requirement of the application.

8. Conclusion: The calculations above show that power take-off PTR-DH is suitable, in conjunction with variable pump VP1-75. Inform the superstructure builder which power take-off the truck will be specified with and which hydraulic pump the specification is based on.

POWER TAKE-OFF RATIOS (Z) FOR VOLVO FH AND FM

GEARBOX-DRIVEN POWER TAKE-OFFS FOR VOLVO FH AND FM

		PTR-					PTRD-			
		D	FL	FH	DH	DM	F	D / D1	D2	
							1 outer	2 inner	2 outer	1 inner
V2009		0.70	0.73	1.23	1.23	1.06	1.30	1.30	1.30	0.60
V2214	Low split	0.70	0.73	1.23	1.23	1.06	1.30	1.30	1.30	0.60
	High split	0.88	0.91	1.53	1.53	1.32	1.62	1.62	1.62	0.75
VO2214	Low split	0.88	0.91	1.53	1.53	1.32	1.62	1.62	1.62	0.75
	High split	1.10	1.14	1.91	1.91	1.65	2.02	2.02	2.02	0.94
V2514	Low split	0.70	0.73	1.23	1.23	1.06	1.30	1.30	1.30	0.60
	High split	0.88	0.91	1.53	1.53	1.32	1.62	1.62	1.62	0.75
VO2514	Low split	0.88	0.91	1.53	1.53	1.32	1.62	1.62	1.62	0.75
	High split	1.10	1.14	1.91	1.91	1.65	2.02	2.02	2.02	0.94
V2814	Low split	0.70	0.73	1.23	1.23	1.06	1.30	1.30	1.30	0.60
	High split	0.88	0.91	1.53	1.53	1.32	1.62	1.62	1.62	0.75
VO2814	Low split	0.89	0.92	1.56	1.56	1.34	1.64	1.64	1.64	0.76
	High split	1.12	1.16	1.96	1.96	1.68	2.06	2.06	2.06	0.95
V2412IS / V2412AT / V2512AT / V2812AT	Low split	0.70	0.73	1.23	1.23	1.06	1.30	1.30	1.30	0.60
	High split	0.90	0.93	1.57	1.57	1.35	1.65	1.65	1.65	0.77
VO2512AT / VO3112AT	Low split	0.90	0.93	1.57	1.57	1.35	1.65	1.65	1.65	0.77
	High split	1.15	1.18	2.00	2.00	1.72	2.10	2.10	2.10	0.98

ENGINE-DRIVEN POWER-TAKE-OFFS

	D9A	D9B	D12D	D12F	D13A	D16C	D16E
Rear-mounted:							
PTER-DIN / PTER1400	1.08	1.08	-	-	1.26	1.26	1.26
PTER1300	1.08	1.08	-	-	-	1.26	-
Side-mounted:							
PTES-xxx (F41 / F51 / F61 / F81 / F10)	-	-	0.97	0.97	-	-	-

DIRECT-DRIVE POWER-TAKE-OFFS FOR MANUAL GEARBOXES

PTOF-DIF	1.0
PTOF-DIH	1.0

DRIECT-DRIVE POWER TAKE-OFFS FOR POWERTRONIC

PTPT-D	1.0
PTPT-F	1.0

POWER TAKE-OFF RATIOS (Z) FOR VOLVO FL

GEARBOX-DRIVEN POWER TAKE-OFFS FOR FL, MANUAL GEARBOXES

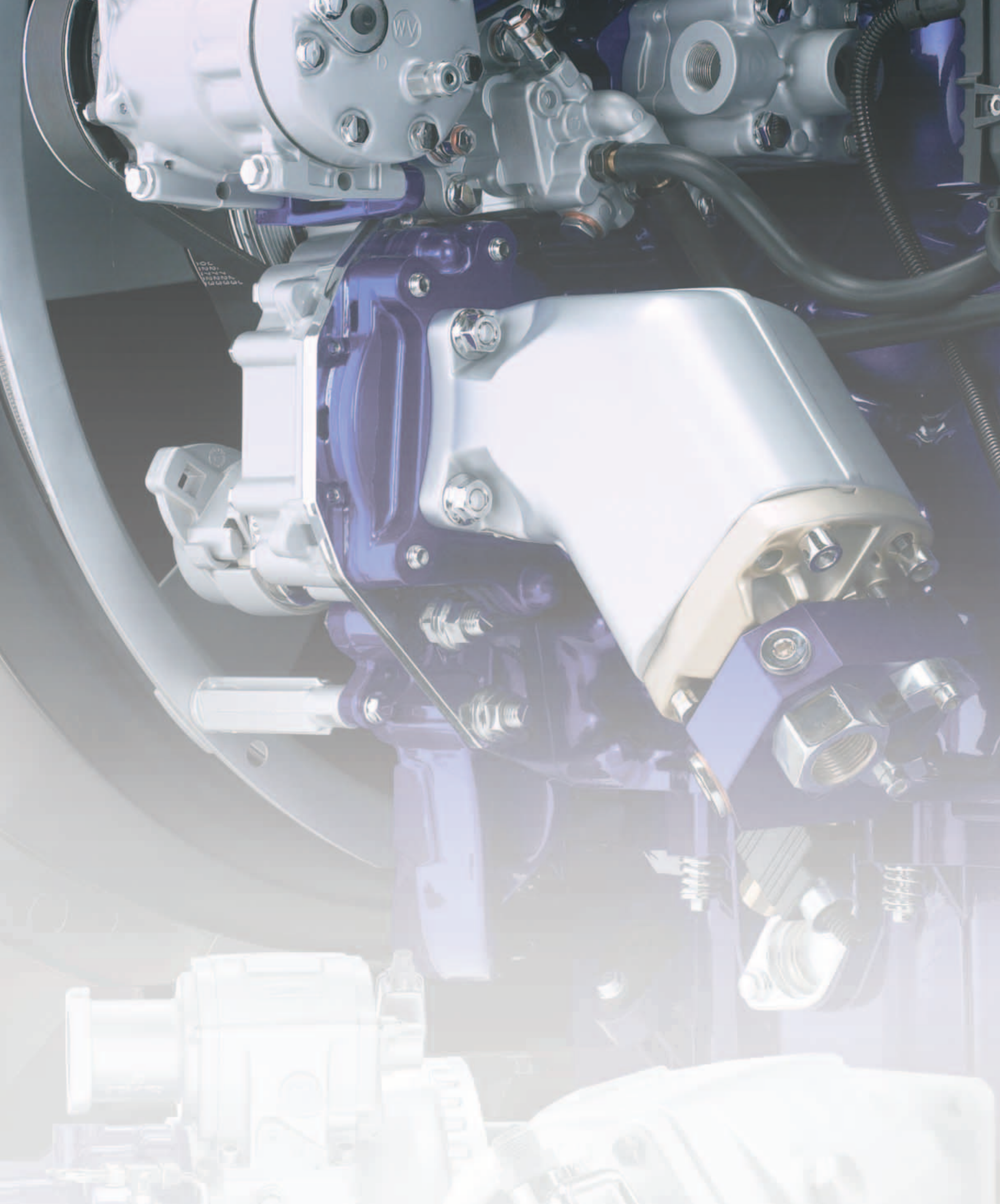
	BKT6057	BKHT6057	BKT6091	BKHT6091	BKR8061	BKR8081	BKHR8081	BKR8121	BKHR8121
T600A	0.57	0.57	0.84	0.84					
T600B	0.68	0.68	1.00	1.00					
T700A	0.57	0.57	0.84	0.84					
T700B	0.68	0.68	1.00	1.00					
TO800	0.84	0.84	1.25	1.25					
R800					0.61	0.81	0.81	1.21	1.21

DIRECT-DRIVEN POWER TAKE-OFF FOR AUTOMATIC GEARBOXES.

	SKMD100	SKMDH100	SKMD140
MD3060P5	0.93	0.93	1.4
MD3560P5	0.93	0.93	1.4

DIRECT-DRIVE POWER TAKE-OFFS FOR FL

	KOBL85	KOBLH85
T600B	0.85	0.85
T700A	0.85	0.85
R800	0.85	0.85



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