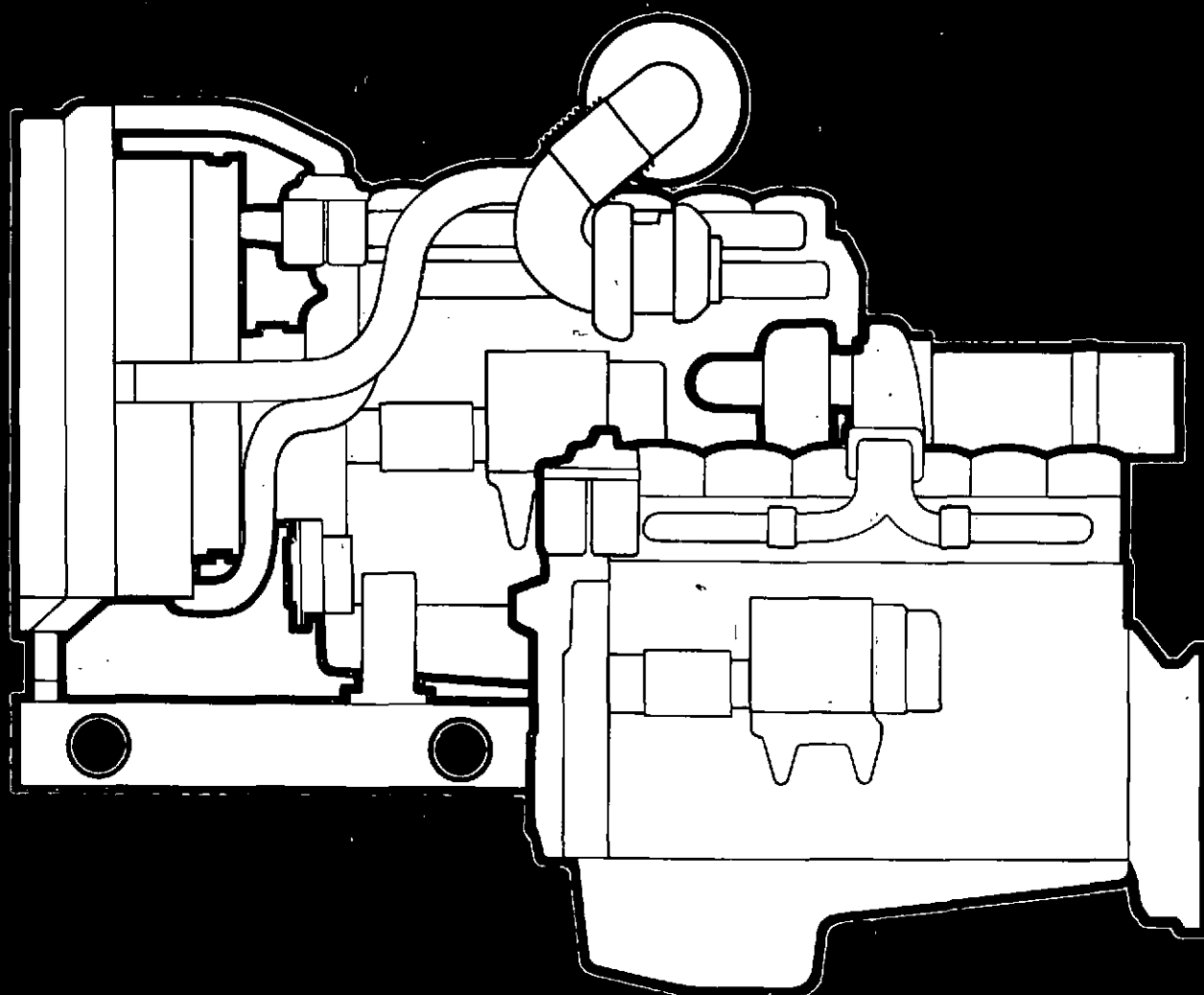


# INSTALLATION

General instructions

Industrial diesel engines



Outputs

## Foreword

For a power plant to function satisfactorily it is essential for an engine of adequate power to be chosen. The choice of engine must therefore be preceded by careful calculations. The instructions in this booklet are intended as a guide to the correct choice.

The instructions are general, but detailed information about the different engines will be found in the product information files.

Please contact Volvo Penta for information concerning any matters not included here.

**AB VOLVO PENTA**  
**Technical Publications**

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## Power standards

Standard methods must be used when taking power measurements of internal combustion engines if the results obtained are to be of any real value. There are several such standards for industrial and marine diesel engines, those most widely used being:

DIN 6270  
BS 649 and BS 5514  
SAE J618 and J270  
ISO 3046

For Volvo Penta industrial diesel engines the power is stated in accordance with DIN standard 6270, which for practical purposes is normally comparable with standard BS 649:1958.

## Power diagrams

There are three types of power diagram for the engines: one for mobile engines, one for stationary engines intended for pump or compressor operation or similar, and one for generator engines.

The power is measured at the flywheel, at an air temperature of 20°C, an atmospheric pressure of 736 mm Hg and a relative air humidity of 60% (the normal condition according to the DIN standard). Engines intended for driving generators give the stated power as soon as they are delivered from Volvo Penta. For other engines, the stated power is available only when the engine has been run in. The power of new engines may be up to 3% lower.

## Mobile engines

Curve 1. Intermittent gross power. The power requirement for a fan and a fully loaded charging alternator is NOT deducted.

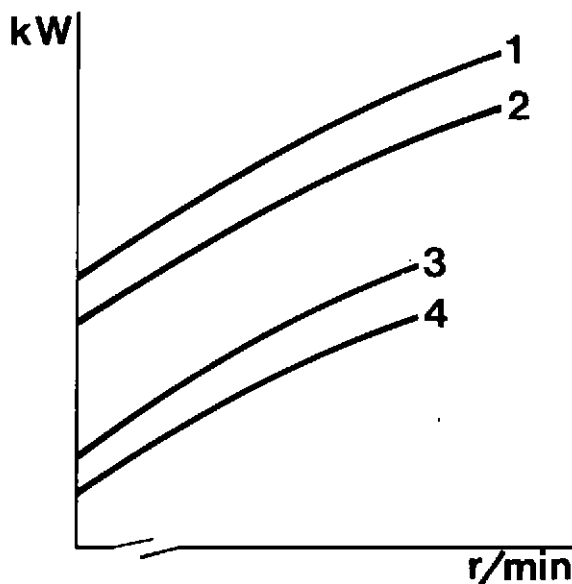


Fig. 1

Curve 2. Intermittent net power. The curve corresponds to DIN 6270, Leistung B, 1 hour per 12-hour period (for practical purposes 1 hour's overload per 12-hour period in accordance with BS 649: 1958 and SAE J270).

Curve 3. Continuous gross power. The power requirement for a fan and a fully loaded charging alternator is NOT deducted.

Curve 4. Continuous net power. The curve corresponds to DIN 6270, Dauerleistung A (for practical purposes continuous power in accordance with BS 649: 1958 and SAE J270).

## Stationary engines

(for driving pumps, compressors etc.)

Fig. 2 shows a power diagram for classifiable engines with radiators or heat exchangers. In the diagram for the power packs (PP in the engine coding), only one curve is shown, corresponding to curve 4 in fig. 2.

The setting has been chosen to prevent the power from being exceeded, and no overloading of these engines is possible.

Curve 3. Continuous gross power. The power requirement for a fan is NOT deducted.

Curve 4. Continuous net power. The net power for a fan is deducted. The curve corresponds to DIN 6270, Leistung B für Dauerbetrieb, for practical purposes continuous power in accordance with BS 649: 1958 no overload, and SAE J270.

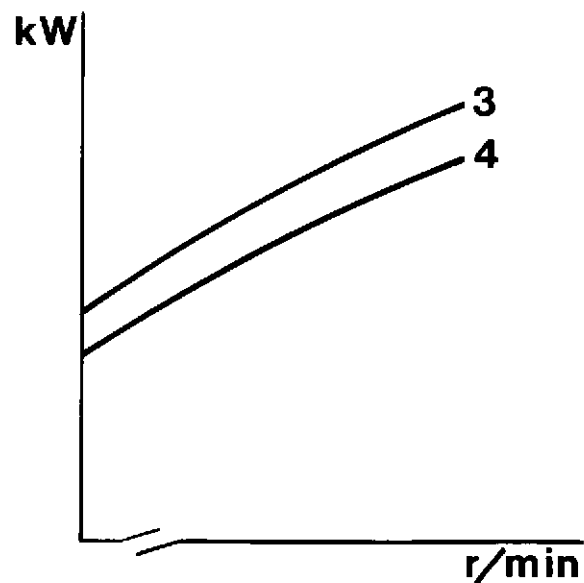


Fig. 2

## Engines for generator drive (fixed speed setting)

Engines with a fixed speed setting do not perform to the normal curve (fig. 2), but to a power cut-off curve, see fig. 3. The gradient of the power cut-off curve is determined by the setting of the governor.

An engine for driving a generator must have stable fuel regulation, with no hunting around the set speed. The power cut-off curve should have as steep a gradient as possible.

Engines are delivered from Volvo Penta in the standard version with a governor setting which gives a droop of 4% when full continuous load is applied. See the difference between B and C, fig. 3.

Because the upper end of the power cut-off curve (A) curves downward, see fig. 3, the intermittent gross power for these engines has been placed where the bend in the power cut-off curve begins (point 2).

### DROOP CHARACTERISTIC

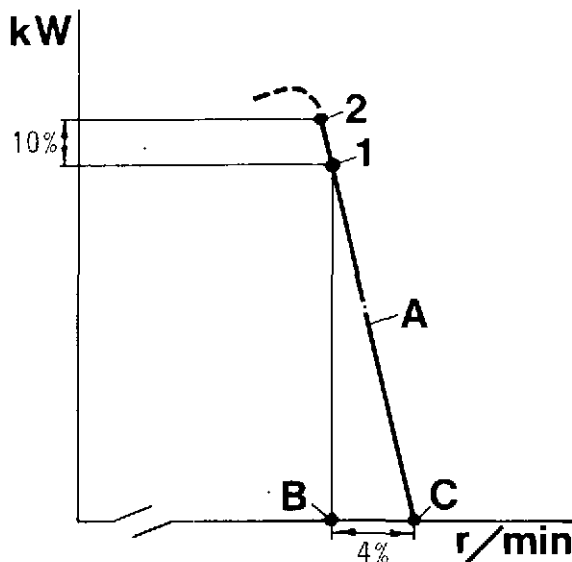


Fig. 3

- |  |  |
|--|--|
| A. Power cut-off curve                 | C. Runaway speed (1560 or 1870 r.p.m.) |
| B. Nominal speed (1500 or 1800 r.p.m.) | 1. Continuous power                    |
|  | 2. 10% overload                        |

## Engines for generator sets intended for continuous operation

(e.g. for power station units)

Point 1 (fig. 3) represents continuous power. The gross power is stated without deduction for a fan. The net power is reduced by the power requirement for a standard fan.

Point 1 corresponds to DIN 6270, Dauerleistung A (for practical purposes continuous power according to BS 649: 1958 and SAE J270).

Point 2 represents 10% overload. The gross power is stated without deduction for a fan. The net power is reduced by the power requirement for a standard fan.

Point 2 corresponds to DIN 6270, Überleistung NÜ (for practical purposes overload in accordance with BS 649: 1958 and intermittent power in accordance with SAE J270). Power in accordance with point 2 is 110% of power in accordance with point 1. Power in accordance with point 2 may be taken out intermittently for 1 hour per 12-hour period.

N.B. Power in accordance with point 2 is not available until the engine has run under load for about 1 minute.

## Engines for generator sets intended for stand-by operation

(short annual operating time, e.g. stand-by units for power failure)

Point 3 represents stand-by power. The gross power is stated without deduction for a fan. The net power is reduced by the power requirement for a standard fan.

Point 3 corresponds to DIN 6270, Leistung B (for practical purposes equivalent to BS 649: 1958 and SAE J270). Power in accordance with point 3 may be taken out for 1 hour per consecutive 6-hour period provided that the average value does not exceed the power in accordance with point 2.

For engines being run with an output in accordance with point 3, shorter service intervals are prescribed.

N.B. Power in accordance with point 3 is not available until the engine has run under load for about 1 minutes.

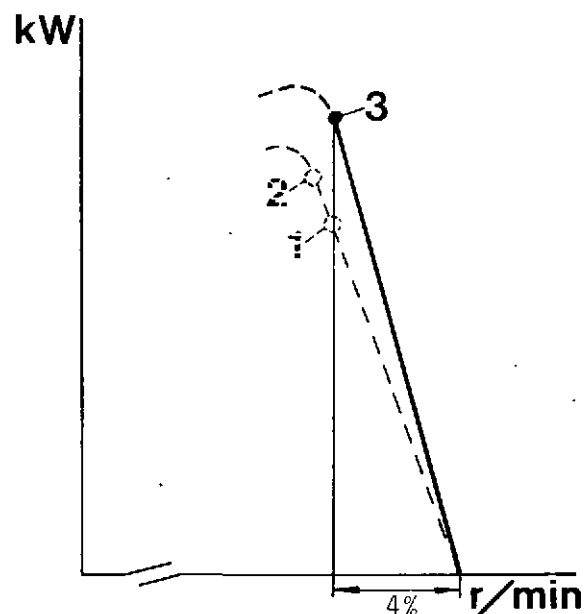


Fig. 4

# Engines for generator sets intended for intermittent operation

(e.g. portable sets for road work)

For this type of operation the same points apply as for continuous operation (see fig. 3), with the difference that the power in accordance with point 2 can be taken out for 1 hour per consecutive 6-hour period provided that the average value does not exceed the power in accordance with point 1.

## Instantaneous load

Figs. 5 and 6 are two different curves in diagrammatic form showing the transient response upon application of load X kW.

The continuous curves show how the engine speed drops from point A to point B upon application of the load and then rises to point C before finally stopping at point D.

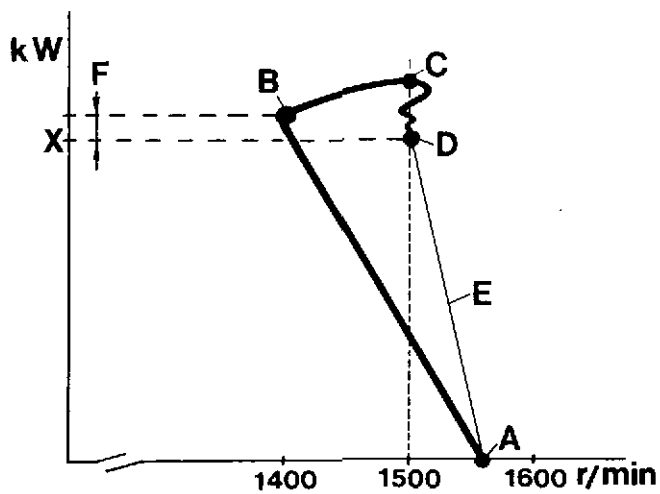


Fig. 5. Change in speed upon instantaneous application of load.

E. Power cut-off curve

The part of the curve between the points A and B in fig. 6 is the transient droop, and the difference between A and D is the steady state droop.

The drop in speed between the points A and B (fig. 5) is dependent upon the surplus power F, i.e. the difference between engine power at point B and the applied load X. The recovery time for increasing the speed from point B to point C also depends on the surplus power of the engine. The greater the surplus power, the less the change in speed and the shorter the recovery time.

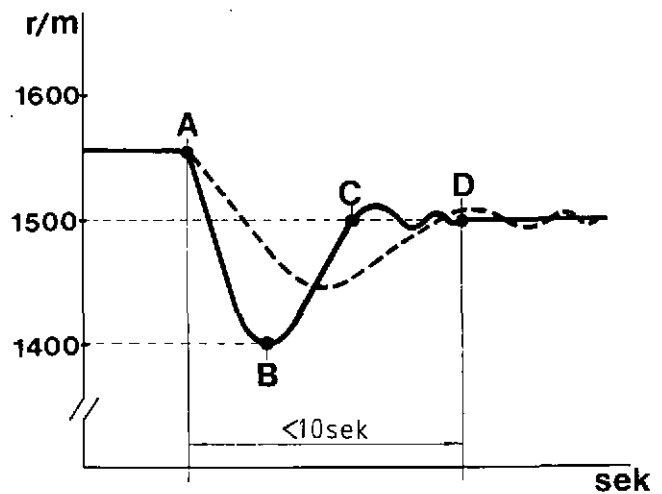


Fig. 6. Lapse of time for change in speed

Dotted curve: Unit with higher inertia

The change in speed may also be reduced by an increase in the total inertia of the engine and the unit being driven (see dotted curve in fig. 6). In this case, however, the recovery time is longer due to the higher inertia.

When closer governing is required, an electric governor may be used. This gives more precise regulation of the quantity of fuel, which in turn implies a smaller change in speed when a load is applied, adjustable gradient for the power cut-off curve and the possibility of automatic synchronization, phasing and load distribution.

This system can allow isosynchrom governing which offers zero steady state droop and a faster transient response time.

When a generator is being driven, there is often the requirement that the engine should be able to cope with an instantaneous switching on of a certain stated "electrical" output.

If such a set is designed so that this instantaneous power output is equal to or near the continuous output of the engine, there is a considerable risk of speed dropping so much that point B, at which the injection pump gives full volume of fuel, will be lower than the output, causing the engine to stall.

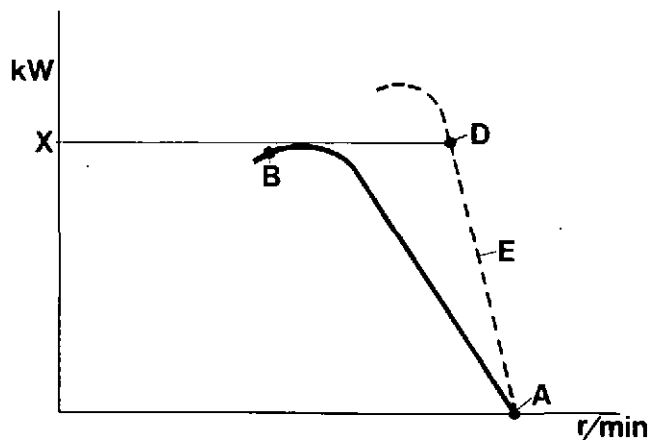


Fig. 7

In this case, the type of voltage regulation used is of great importance, as is the size of the total flywheel capacities. If a frequency-dependent voltage regulator is chosen (so that the voltage drops as the frequency falls), the load on the engine is reduced and a steeper power cut-off curve – point B moving towards higher speed and power – is obtained than if a frequency-independent voltage regulator, giving “constant” voltage, is used. It is therefore understandable if differing values for the instantaneous output have to be stated for generator sets with the same type of engine but different electrical equipment.

For sets with “stiff” electrical systems the max. instantaneous output may be as low as 70 % of the specified continuous power.

Engines intended for driving generators give the intermittent power stated on the data sheet when they are delivered from Volvo Penta. One precondition is, however, that the engine has run with at least 75 % load for about 1 minute.

### Parallel running

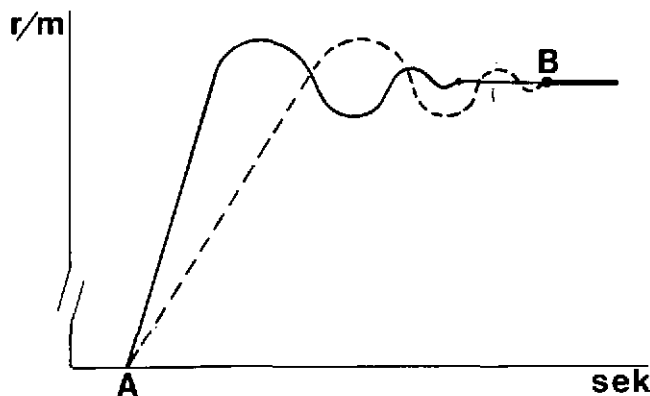


Fig. 8

Parallel running of two engines

The fact the engines do not deliver full power until they have run under load for a few minutes should be particularly borne in mind when engines are running parallel, i.e. when an engine which has just been started is synchronized with one which is already under load. Initially the engine most recently started cannot carry its full share of the load. If this is compensated for by increasing the speed of this engine, there will be an uneven load when the second engine has become warm.

When sets which are running parallel are started simultaneously and synchronized, and then after synchronization

allowed to run under no load for shorter or longer periods, considerable reverse power may develop if the engines are synchronized before they have reached a stable speed (point B, fig. 8).

N.B. If possible it should be stated when ordering whether the engines are to be used for parallel running. For such running the governor requires fine adjustment with the complete set when a test run is carried out.

## Power requirement

When choosing a suitable engine for an installation it must be borne in mind that it may not always be possible to obtain the power stated by the manufacturer. Atmospheric conditions (temperature, atmospheric pressure) where the engine is working may differ from the norm as assumed by the power standard, or perhaps a non-standard version of the engine is being used (larger fan, higher fan speed etc.). In such cases, reduced power must always be expected.

Do not be excessively optimistic in estimating the efficiency of the unit being driven. Do not forget power losses in transmissions and other equipment, e.g. belt transmissions and couplings, or control equipment, hoses and pipes in hydraulic systems. Remember also the idling power for any hydraulic pumps.

Remember that the engine will not supply full power until it has run under load for about 1 mins.

## Power reduction

When the engine is run at a high ambient temperature or at high altitude above sea level, the output should be reduced in accordance with the values given below.

If the output is not reduced, the result will be that

1. The temperature of the exhaust gases will rise (greater strain on valves and turbocompressor).
2. Exhaust smoke will increase.
3. The speed of the turbocompressor will increase.

This may necessitate more frequent overhaul of the engine. In extreme cases, failures may occur. Operating conditions are of great importance in this connection, however. Somewhat

higher stresses are permissible in the case of intermittent running with short-term power peaks.

For example, it may be mentioned that if the ambient temperature rises by 20°C, the temperature of the exhaust gases rises by 2-2 1/2 times as much, i.e. by 40-50°C.

When engines are provided with an intercooler, the exhaust gas temperature rises by 1 1/2-2 times as much (30-40°C).

**Power reduction caused by high altitude above sea level (low atmospheric pressure)**

1000 m	1500 m	2000 m	2500 m	3000 m	3500 m	4000 m
3,5%	6,5%	9,5%	13,0%	17,0%	20,5%	24,0%

**Power reduction caused by high ambient air temperature**

Engine	Power reduction begins at	Power reduction for each 5°C rise in air temperature
TD60B	45°C	3%
TD60BG	40°C	3%
TD70G	30°C	3%
TD70GG	40°C	3%
TD100A	30°C	3%
TD100AG	30°C	3%
TD120C	30°C	3%
TD120G	30°C	3%
TD120GG	40°C	3%
TID120FG	40°C	1,75%

Publ.no. 3995  
12-1981 E

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S-405 08 GÖTEBORG, SWEDEN