



# Installation guidelines for high-pressure pumps in industrial applications

Cat Pumps high-pressure pumps are designed and manufactured to exceptionally high quality standards and have an unequalled reputation for reliability and long life. But the most common cause of pump failure is not the pump itself, it is poor installation. A good pump will not perform well if it is badly installed. This simple guide will help you to get the maximum benefit from your choice of high-pressure pump. If in doubt, always ask for advice. This document does not over-rule specific instructions provided elsewhere.

**⚠ CAUTION** – Take care to work safely in accordance with good practice. Ensure all installations meet all relevant safety rules, laws, directives, standards, regulations and codes of practice. All work must be carried out by competent people who are appropriately trained and qualified.

## 1) Pump Selection

It is essential to always use the right pump for your job. Cat Pumps sales offices are happy to assist with selection of the best pump for each application. You must provide us with as much information as possible about the liquid to be pumped, its temperature, the application, duty cycle, running conditions and the location & environment especially if the pump will be used in a hazardous e.g. ATEX zone-classified area.

## 2) Drive motor & Transmission

Cat pumps are usually driven by an **electric motor** but can also be driven by a diesel or petrol **engine, air motor or hydraulic motor**. Pumps can be purchased from Cat Pumps sales offices already assembled with a suitable motor but if you are providing your own driver, take care of the following:

**Power** - drive motor or engine must be sized to provide sufficient power to drive the pump and to start it, under load if necessary. Refer to pump data sheet or ask any Cat Pumps sales office for advice on motor power & selection. This document refers primarily to electric motor-driven installations. Contact your IC engine and hydraulic motor supplier for advice on engine size, power & configuration. Follow the manufacturer's instructions when installing, commissioning, operating and servicing their equipment.

**Transmission** – if the pump is to run at the same speed as the motor, a suitable **flexible coupling** can be used to direct drive the pump. Some smaller sizes of pump can be mounted directly onto the end face of the motor using a **bell-housing**. Ask for data sheet on Cat Pumps bell-housings.

Many pumps need to run slower than the motor speed to provide the correct flow to operate reliably; the pump must be driven through a **speed-reducing** gearbox or via belts and pulleys of the correct reduction ratio. Alternatively the motor can be controlled by a **Variable Speed Drive (VSD)** e.g. an Inverter. The output flow from the pump and the power required to drive it are proportional to the pump speed of rotation.

### Gearbox drive –

- An in-line helical gearbox is compact and needs no adjustment
- Lubricating oil needs to be added then checked and changed periodically
- Gear ratio must be chosen to give correct pump speed and cannot easily be changed later
- Most gearboxes are available in only a limited range of ratios

### Pulley drive –

- Either vee-belts or a toothed (timing) belt can be used.
- Belts are inexpensive and simple to install and are available in a wide range of ratios.
- Note that vee-belts can be shed dust into the atmosphere.
- Belts need to be checked for adjustment periodically and changed when worn.
- The Cat pump drive shaft is designed to accept a belt-pull (i.e. side-load); use a large diameter driven pulley and do not over-tension the belt(s).

Consult your transmission supplier for information on correct gearbox/belt size, load factor, installation, alignment, tension, adjustment, operation and lubrication.

Pumps with a double-ended crankshaft can be driven from **either end**. Fit a Cat Pumps **Shaft Protector** over the unused shaft end. Do not drive a second pump or any other load through the 'spare' end of the crankshaft without consulting Cat Pumps sales office first. Preferred direction of rotation is anticlockwise looking on end of pump shaft when pump head is to the left.

**Guards** – All moving parts e.g. belts & couplings must be guarded to meet all applicable safety regulations, standards and guidelines to prevent personal injury. Do not operate equipment with guards removed or damaged.

**Mounting** – The pump, drive motor and transmission should be mounted horizontally on a strong, rigid baseplate or frame that will resist twisting and distortion under load. The base can be rigidly bolted to the floor or to a machine taking care not to distort it. Pump must only be mounted horizontally.

A Cat Pump is a reciprocating pump and therefore creates mechanical oscillations. To prevent these being transmitted to other equipment, the complete pump base unit or motor, pump & bellhousing assembly can be mounted on a suitable anti-vibration mounts (AVM's). Consult your AVM supplier for suitable components. Do not mount the pump alone on AVMs.

### 3) Location

As with any pump, the installed position of a Cat pump should be chosen carefully. If the pump is to be fed directly from a header tank (see 'Feed' below) the pump should be mounted as low as possible to maximize the positive head i.e. inlet pressure to the pump. Wherever possible, position the pump so you can easily:

- Check the crankcase (and gearbox) oil level.
- Drain and replenish crankcase (and gearbox) oil.
- Remove pump head in situ to service seal & valves.
- Remove guards to check and service the transmission.

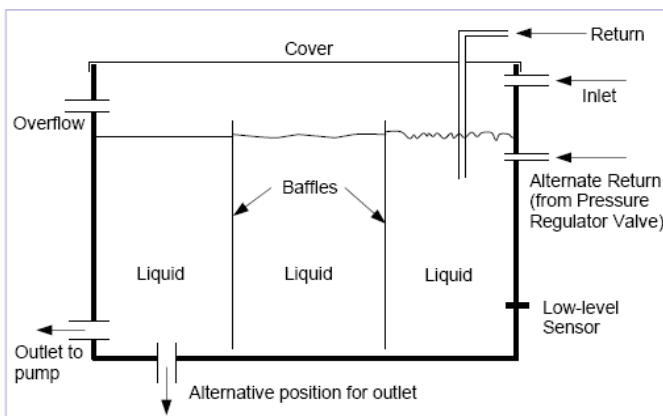
Pumps should not be installed outdoors or in excessively hot, humid, dirty or dusty environments. If this is unavoidable, protect pump with a suitable cover or ventilated enclosure. In potentially cold climates, pumps must be protected from frost as freezing will cause serious irreparable damage.

### 4) Liquid Feed

Adequate supply of liquid to any pump is essential for its reliable operation. Insufficient pressure or flow at the inlet is the most common cause of pump failure due to cavitation. Supply of liquid will normally be either gravity (positive head) or pumped (pressurized):

#### 4a) Gravity feed from a raised header tank:

The tank should have a working capacity (volume) of at least 6 x the flow rate per minute e.g. if the pump flow is 15 l/min the tank capacity needs to be more than 90 liters. See drawing below of a well-designed tank including baffles to prevent surging, turbulence, aeration and a vortex at the outlet to the pump. Note positions of inlet, overflow and return connections.



The tank outlet should be at least 1 x its own diameter above the bottom of the tank.

The tank should be covered to prevent contamination.

Tank should be mounted as high as possible. Ideally the liquid level (even when the tank is nearly empty) should be 2 metres higher than the pump. (2m static head); Applications closer to the liquid vapour pressure e.g. hot water or volatile solvents require a higher static head.

Install a low-level switch or an Inlet Pressure Sensor to stop the Cat pump if the tank level falls too low.

Cat Pumps will not tolerate large particles nor high concentrations of abrasives. Contact any Cat Pumps sales office for advice if unsure. If a filter is required, it is preferable to filter the liquid going into the tank. A filter in the tank outlet pipe will restrict the flow to the Cat pump especially when it becomes blocked.

If the tank must be below the pump (i.e. suction lift, suitable for piston pumps only), remember that the Cat pump is not self-priming. Fit a non-return foot-valve at the bottom of the inlet feed pipe (take care not to restrict the flow) and manually prime the Cat pump before first start-up.

A Captive Acceleration Tube (see section 5) cannot be used with low inlet pressures e.g. suction lift.

#### 4b) Pressurized feed from a booster pump:

If the liquid to be pumped is close to its vapour pressure or it is not possible to provide an adequate positive head, feed the Cat pump from a booster pump. A simple centrifugal pump is often suitable; a discharge head of 20 metres at the desired flow rate and a stall head of 35 m is recommended. Refer to Cat pump data sheet for maximum permitted inlet pressure.

Always use a Captive Acceleration Tube in conjunction with a booster pump feed (see section 5); ask for the appropriate data sheet and note the maximum inlet pressure specified.

It is advisable to interlock the Cat pump and the boost pump so the Cat pump cannot run if the boost pump has stopped, failed or is blocked.

A low-pressure switch at the inlet to the Cat pump is recommended, set to 1.5 bar g and wired to the Cat pump's starter. This is also advisable where an inlet filter is fitted, to protect the pump when the filter becomes blocked.

### 5) Inlet Pipework feeding liquid to the Cat pump

The inlet pipe can be connected to:

Either side of a plunger pump inlet manifold. If inlet supply is very poor, consult any Cat Pumps sales office first as it may be advisable to connect to both sides of the pump.

To the bottom of a Cat Pumps piston pump, or to the top – ask for pump to be supplied with an Inverted Inlet Manifold.

The inlet pipe should be of an adequate diameter to allow unrestricted flow into the pump.

Use a few fittings and changes of direction as possible.

Use full-bore fittings (not high pressure thick-wall e.g. hydraulic fittings).

Use large-radius swept bends or reinforced flexible hose at changes of direction, not tight-radius or drilled elbows.

If possible, fit a straight pipe immediately before the pump inlet connection; its length should ideally be at least 20 x its bore diameter.

**Support** all rigid inlet pipework to prevent excessive loads being transmitted to the pump head and causing distortion & seal leaks.

As a **simple check**, if you disconnect the feed pipe at Cat pump, the liquid should flow freely at **twice the flow rate of the pump**, even when the tank is nearly empty. Caution: take care when dealing with harmful liquids. Example: if the desired Cat pump flow rate is 15 l/min the liquid should flow freely from the open end of the disconnected feed pipe at a minimum rate of 30 l/min.

To absorb and allow for vibrations, fit a length of **flexible hose** between any rigid pipework and the Cat pump, especially if the pump set is mounted on AVMs.

Fit a Cat Pumps **Captive Acceleration Tube** in all installations with long inlet pipe runs or pressurized/booster pump feed. Ask for the appropriate data sheet.

Fit a full-bore valve in the inlet pipe so the pump can be **isolated** from the liquid supply for servicing. Cat Pumps advise that valves are electrically interlocked so the pump cannot run unless all valves are in their correct position.

If more than one pump will be supplied from the same tank, provide **separate inlet pipes** from the tank to each pump. Where this is not possible, use a **Y-piece or swept tee** to branch off a single feed pipe to multiple pumps. Ensure main feed pipe is **adequate diameter** to feed all the pumps simultaneously.

## 6) Discharge pipework

Due to the high pressure capabilities of a Cat pump, pipe restriction is less important on the discharge side of the pump compared to the inlet side. However, **safety** is a major consideration. Caution: a Cat pump delivers a fixed flow rate of liquid at any given speed, irrespective of pressure. Remember, if the outlet of the pump is excessively restricted or closed completely this liquid flow must go *somewhere*.

**Never dead-head a Cat pump.**

Fit a **Pressure Regulator** valve or an **Unloader** valve on the discharge side of the Cat pump, depending on the application. Ask for the appropriate data sheet. Cat Pumps recommended that you also fit a **pressure safety relief device** immediately adjacent to the pump, upstream of any other valves. The Safety Device should be set at a pressure 15 to 20% above the maximum operating (duty) pressure.

Failure to fit such relief devices could result in **personal injury** or damage to the pump or to system components and will **void the pump warranty**. Carry out a **hazard analysis** to assess the risks and select a suitable device e.g. a Safety Valve. Note, a pressure switch may not act quickly enough to protect the pump and personnel. Bursting discs can fatigue due to the slight pulsation from a Cat pump.

Outlet (discharge) pipes can be connected to either side of the discharge manifold of a Cat Pumps plunger pump or to any of the 3 connections on the discharge manifold of a Cat Pumps piston pump. Valves and other accessories e.g. pulsation dampener, pressure gauge can be fitted to **unused connections**.

Use high-pressure pipes, accessories, components & fittings **suitably rated** for the pressure in the system, taking account of the highest set/rated pressure of any safety device.

**Support** all rigid discharge pipework to prevent excessive loads being transmitted to the pump head and causing distortion & seal leaks.

By-pass the flow from any Pressure Regulator, Unloader or Diverter valves **back to tank/source** or to a suitable waste or drain. If it is possible, connect each by-pass into the inlet pipe well upstream of the Cat pump (at least 10 x the inlet pipe bore diameter) via a Y-piece or swept tee. Fit a device e.g. a sensor or Cat Pumps Thermo Valve to protect the Cat pump against excessive **heat build-up** due to closed-circuit recirculation e.g. closed trigger-gun or downstream valve.

Fit an **adequate diameter** by-pass pipe/hose to all Pressure Regulator, Unloader or Diverter valves to prevent restriction.

**Do not fit any other valve** or restriction in the by-pass pipe/hose as this may prevent the Pressure Regulator or Unloader valve from operating safely.

The following accessories are **recommended** but are not essential for all applications:

If required, fit a **Pulsation Dampener** of the correct size. Ask for the appropriate data sheet. This will smooth the outlet flow & pressure delivery and will help to:

- protect the down-stream system e.g. sensitive separation membranes
- protect the pump from back-pressure spikes
- minimize pipework vibration
- provide an even spray pattern from nozzles

Cat Pumps Pulsation Dampeners are supplied pre-charged to suit each individual system

If the pump will continue to run whilst not required to deliver high pressure liquid, fit a 3-way **diverter valve** to off-load pump when flow is not required.

Fit a **bleed valve**, to vent trapped air before starting.

Fit a manual pressure off-loading valve or easy start valve to reduce the motor load when starting against a pressurized system. Caution – take care when opening this valve. This valve may also serve as a rain-down point for servicing.

In multi-pump installations or when starting against a pressurized system, fit a high-pressure **check-valve** (non-return valve) to each pump downstream of all safety devices, and all drain, bleed, off-loading and vent valves.

Fit a full-bore valve, downstream of all safety devices, so that the pump can be **isolated** for servicing.

Cat Pumps advise that valves be electrically **interlocked** so the pump cannot run unless all valves are in their correct position.

Fit a suitable **pressure gauge** upstream of all valves, to monitor pump operation. This is essential in order to set a Pressure Regulating valve or Unloader valve in situ.

To absorb and allow for vibrations, fit a length of high-pressure **flexible hose** between any rigid pipework and the Cat pump, especially if the pump set is mounted on AVMs.



### WARNING

All systems require both a primary pressure regulating device (i.e. regulator or unloader) and a secondary pressure safety relief device (e.g. safety valve, pop-off valve etc.). Failure to install such relief devices could result in personal injury or damage to the pump or to system components. Cat Pumps does not assume any liability or responsibility for the operation of a customer's high pressure system.

## 7) Seal flushing

Cat pumps with model numbers ending in K or C (e.g. 2831K, 3821K.111 or 2520C) are fitted with flushed or cooled seals.

This facility may have been provided to:

- keep the pump head cool when pumping hot liquids
- prevent flashing-off from pump seals when pumping hot liquids
- limit the escape of harmful fluids
- flush away any seal leakage
- allow seal condition to be monitored (e.g. by monitoring flush liquid level, pH, colour etc.)
- prevent drying or crystallizing of liquid deposits on pump seals
- prevent air being drawn into the pump
- lubricate pump seals when pumping non-lubricating liquids
- allow the pump to run dry indefinitely

A suitable flushing/cooling system must be provided on installation which may consist of a once-through (total loss) system or a recirculation (closed) system with or without a circulation pump. Consult the Cat Pumps sales office for more information or refer to the instructions provided with the pump.

## 8) Commissioning

More damage is done to pumps when they are first started than at any other time during their working life. Careful commissioning and start-up will extend pump life.

### Before starting:

- Fill pump crankcase, and gearbox if fitted, with correct quantities and grades of lubricating oil.
- Check adjustment and alignment of belts & couplings in case they have been disturbed during transport & installation.

- Check that all pipe connections are correctly sealed & tightened to prevent air and liquid leaks.
- Flood pump and system with liquid and where possible vent air from pump & pipework.
- Open all vent and bleed valves if appropriate
- Back off the pressure adjustment of any Pressure Regulating or Unloader valves.
- Open all valves e.g. isolation valves
- Ensure feed tank contains sufficient liquid or that booster pump (if fitted) is operating

### On first start-up and when re-commissioning:

- Start the pump against an open (unrestricted) discharge.
- Do not run the pump dry i.e. with no liquid supply.
- Observe that the inlet pressure is always adequate, to ensure that the Captive Acceleration Tube (if fitted) does not collapse.
- Listen for unexplained noises.
- Watch for leaks.
- Run the pump at open flow until all air is purged from system
- Gradually adjust all valves to correct working pressure.
- Observe pump for first few hours running to ensure everything is working correctly.

Once the pump is installed and operating correctly, follow the recommended operation, maintenance and repair instructions contained in the appropriate Cat Pumps Service Manual. Also:

- If pumping aggressive, corrosive or viscous liquids, flush pump & system with a clean compatible liquid periodically and whenever pump will be left idle.
- Take care to protect pump from freezing e.g. by filling system with a suitable anti-freeze.

**If you require any additional information or advice, please call your supplier or your local Cat Pumps sales.**

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