



TECHNICAL GUIDE

Engine Valve Train & Adjustment Shim: Faults, Replacement, Care

Technical guide to the heavy-duty engine valve train and adjustment shims: how they fail, compression and leak-down diagnosis, replacement steps, clearances and torque values.

On heavy commercial vehicles, the cylinder head is where the engine breathes; the mechanism that measures, opens and closes that breath is the valve train. Out in the field, complaints like "the engine lost power," "it shakes at idle" or "compression dropped" often trace back to a worn valve, a seat that no longer seals, or a valve clearance that has drifted. When you consider that a tractor unit works well past 500,000 km with the engine constantly turning at high temperature and rpm, the valve train and adjustment shims are the quiet but decisive components of engine health. This guide explains, in field language, what the valve train does, how it fails, how it is diagnosed and replaced, and how to extend its service life.

💡 **TIP — E-E-A-T note:** This guide was prepared by the VADEN technical team, experienced in heavy commercial vehicle engine repair and spare parts engineering. The values given here are typical reference ranges; for the **exact valve clearance, torque and tolerance values of a specific engine, always refer to the relevant vehicle's OE service manual.** Last updated: July 2026.

What Is the Engine Valve Train (+ Adjustment Shim)? Function and Working Principle

The engine valve train is the mechanism that opens and closes the intake and exhaust ports in the cylinder head at the correct time, controlling the flow of air/fuel into the combustion chamber and the expulsion of burnt gases; it consists of the valves together with the springs, guides, seals, retainers and adjustment shims that support them.

The working principle is based on timing. The camshaft, driven from the crankshaft by a timing chain or gear set, rotates; the cam lobes push down on the valve stem — either directly or through a tappet/rocker arm — driving the valve off its seat and opening the port. Once the cam lobe passes, the valve spring returns the valve to its seat, closing the port tightly. The intake valve draws in fresh air, and the exhaust valve expels the burnt gas. Heavy commercial diesel engines typically have 4 valves per cylinder (2 intake + 2 exhaust); so a 6-cylinder engine runs with 24 valves.

In this system, **valve clearance (valve lash)** is a critical parameter. As the engine warms up, the metal expands; if no clearance is left, the hot valve does not close fully, gas leaks past the seat and the valve burns. If the clearance is excessive, you get ticking, delayed opening and power loss. This is exactly why **adjustment shims (valve shims)** are used to set that clearance precisely: these steel discs of varying thickness sit between the cam and the valve, adjusting the clearance to micron precision.

- **Valve (intake/exhaust):** Made of heat- and wear-resistant alloy; exhaust valves usually have a stellite-coated seating face.
- **Valve spring:** Holds the valve closed and prevents valve float at high rpm.
- **Valve guide:** Centres the valve stem and limits oil leakage and lateral sway.
- **Valve seal (stem seal):** Stops oil from leaking down the guide into the combustion chamber.
- **Valve retainer and collets (keepers/locks):** Lock the spring onto the stem.
- **Adjustment shim / hydraulic lifter:** Sets the valve clearance; by selecting a thickness in shim systems, automatically in hydraulic systems.

- **Valve seat (insert):** The sealing ring pressed into the cylinder head on which the valve sits.

Shim (Mechanical) and Hydraulic-Lifter Systems

Heavy commercial engines use two basic approaches to clearance management. In **mechanical shim systems**, the clearance is measured periodically and adjusted by hand by fitting an adjustment shim of the correct thickness; this is a durable structure that is reliable under heavy load and is preferred in many European-built heavy diesel engines. In **hydraulic lifter (HLA) systems**, the clearance is reset automatically by engine oil pressure; it requires no periodic adjustment but is sensitive to oil quality and pressure.

Difference Between Intake and Exhaust Valves

The intake valve is larger in diameter and runs relatively cooler; the exhaust valve, constantly exposed to hot burnt gas, is smaller, made of a more heat-resistant alloy and, in some engines, produced with a sodium-filled (heat-conducting) stem. For this reason, exhaust valves and seats typically wear faster and are the priority inspection point in diagnosis.

Vehicle / Engine Matching (general reference)

Engine family (type/equivalent)	Typical application	Valves per cylinder	Clearance management
Mercedes OM457 / OM471 type	Actros, Travego, bus/tractor	4	Mechanical (shim/rocker adjusted)
MAN D20 / D26 type	TGA, TGX tractor	4	Mechanical adjustment
Volvo D13 type	FH, FM tractor	4	Mechanical adjustment
Scania DC13 type	R/S series tractor	4	Mechanical adjustment
DAF MX-13 type	XF tractor	4	Mechanical adjustment
Cummins ISX / ISL type	Heavy commercial, construction machinery	4	Mechanical / OHV rocker

⚠ CAUTION — Part number verification is essential: Even within the same engine family, the intake/exhaust valve diameter, stem length, guide dimension and shim series vary by model year and variant. The table above is general guidance only. Before ordering, always verify the OE reference from the vehicle's chassis/engine number and the VADEN cross-reference catalogue; the wrong diameter or stem length causes the valve to seat improperly and leads to engine damage.

Failure Symptoms and Diagnosis

Valve train failures usually develop slowly and show themselves first as performance loss, then noise, and finally serious mechanical damage. The table below links the field complaint to the likely cause and the correct check method.

Symptom	Likely Cause	Check / Verification
Metallic ticking when cold, easing as it warms up	Excessive valve clearance, worn shim/rocker	Clearance measurement with a feeler gauge; shim thickness check
Power loss, poor pull, struggling on hills	Burnt/unseated valve, compression leak	Cylinder compression test + leak-down test
Rough running at idle, vibration	Valve leakage in one cylinder	Per-cylinder compression; listening for air escape from the exhaust port
Bluish exhaust smoke, oil consumption	Hardened/torn valve stem seal, worn guide	Stem seal and guide clearance inspection; oil consumption monitoring
Irregular cranking, "banging" kickback	Spring breakage, valve sticking/binding	Visual inspection with cover off; spring free length / vertical measurement
Slow start, low vacuum, popping sound	Timing slip + valve seating fault	Timing mark alignment + compression comparison
Continuous hissing/blowing sound from the exhaust	Exhaust valve burn, seat erosion	Air escaping from the exhaust in the leak-down test; valve face inspection

Compression and Leak-Down Test

These two tests are the backbone of valve diagnosis. The **compression test** gives each cylinder's pressure in bar; a large difference between cylinders points to the problem cylinder. The **leak-down test** lets you feed compressed air into the cylinder and listen for where it escapes: if the air comes from the intake manifold it is the intake valve, from the exhaust it is the exhaust valve, and from the crankcase/dipstick it is a ring/cylinder problem. This distinction pins the fault to the right place without removing the head.

Valve Clearance Measurement

In mechanical systems, the clearance is measured with a feeler gauge at the temperature specified by the engine manufacturer (usually a cold engine) and at the correct crank angle. If the measured value is out of tolerance, it is corrected by changing the shim. Before measuring, make sure the relevant valve is fully closed (cam heel up); a measurement taken in the wrong position throws off the entire adjustment.

Visual and Dimensional Inspection

Once the cover is removed, the valve face is checked for burning/erosion, the stem for scoring or discolouration (overheating), the spring for cracks or loss of tension, and the guide for ovality. The clearance between the valve stem and the guide is measured with a dial indicator; exceeding the tolerance means both oil leakage and a seating fault.

Replacement / Installation Steps

⚠ CAUTION — Personal Protective Equipment (PPE) and safety: The engine must be completely cold. Disconnect the battery and make sure there is no residual pressure in the fuel/injector lines. Wear gloves and safety goggles. Valve springs are under high pressure; never work on removing/fitting the collets without a proper valve spring compressor — a flying collet or spring can cause serious injury. If you hold the cylinder with compressed air, the piston must be positioned near top dead centre.

- 1 Preparation and timing mark:** Bring cylinder 1 to top dead centre, note and photograph the timing/camshaft alignment marks.
- 2 Upper assembly removal:** Remove the air filter connections, injector/glow lines, valve cover and, if fitted, the upper intake manifold. Label the bolts.
- 3 Camshaft/rocker shaft removal:** Loosen the rocker or cam shaft bearings gradually, in the sequence specified by the manufacturer; release the spring preload evenly.
- 4 Clearance/shim record:** Before removal, write the existing shim thicknesses and measured clearances onto a cylinder-valve map; this becomes the starting reference for the new adjustment.
- 5 Valve spring compression:** Compress the spring with a proper valve spring compressor, carefully remove the collets (lock keepers); place the parts in separate trays by cylinder order.
- 6 Valve and seal removal:** Remove the valve from the combustion chamber side. Remove the stem seal; do not damage the guide mouth or the stem surface.
- 7 Inspection and surface work:** Check the valve seat and valve face; if necessary, have the valve seat cut/lapped at a competent workshop. Verify the new valve's seating contact with marker/dye.
- 8 New part installation:** Seat the new valve seal squarely onto the guide (use the fitting sleeve/cap), lubricate and insert the valve, fit the spring and retainer and seat the collets. Verify the collets are fully locked with a light tap.
- 9 Cam/rocker assembly and torque:** Tighten the cam shaft/rocker bearings gradually according to the manufacturer's torque and sequence values. Re-align the timing marks.
- 10 Valve clearance adjustment:** Measure each valve's clearance; where out of tolerance, select and fit an adjustment shim of the correct thickness and re-measure to confirm.
- 11 Closing and test:** Fit the valve cover with a new gasket and connect all lines. Start and warm the engine, check for leaks/noise; after a short road test, re-confirm the clearances.

Points to Watch (Common Mistakes)

⚠ CAUTION — The most critical mistake — wrong shim / wrong clearance: A clearance left "roughly" adjusted causes the exhaust valve to burn or excessive ticking in a hot engine. The adjustment must always be measured and verified; guesswork must never be accepted.

⚠ CAUTION — Fitting the stem seal incorrectly: Seating the seal onto the guide at an angle or forcing it without a fitting sleeve tears the seal lip and causes oil consumption/blue smoke right after assembly. The seal must always be fitted with the manufacturer's fitting cap.

- **Disassembly without recording the timing marks:** If the cam/timing alignment slips, valve-to-piston contact (engine damage) becomes a risk.
- **Collets not fully seated:** A half-locked collet flies off in operation; the valve drops into the combustion chamber and causes severe damage.
- **Fitting the old valve mixed with a new one without lapping the seat:** A new valve does not seat fully on an unprepared seat; the compression leak continues.
- **Not following torque and sequence:** If the cam shaft bearing is tightened unevenly, the shaft binds/bends and the valve timing is disrupted.
- **Dirty assembly:** If swarf or gasket residue gets into the combustion chamber, the valve face is scored at first start.
- **Not verifying diameter/stem length on an equivalent part:** The wrong dimension causes the valve not to close and leads to engine damage.

Technical Values and Check Points

The values below are **typical/general reference** ranges for heavy commercial diesel engines. The exact value varies by engine; the OE service manual always takes precedence.

Parameter	Typical reference range	Note
Intake valve clearance (cold)	~0.20 – 0.40 mm	Engine-specific; the manual takes precedence
Exhaust valve clearance (cold)	~0.40 – 0.60 mm	Exhaust is generally larger
Cylinder compression (healthy)	~24 – 32 bar (≈350–465 psi)	Difference between cylinders should not exceed 10%
Leak-down acceptance limit	Below 15–20% is ideal	Above this, suspect valve/ring
Valve operating temperature (exhaust)	~300 – 700 °C locally	Surface temperature, varies with load
Stem-guide clearance	~0.03 – 0.08 mm	Exceeding it means oil leak/seating fault
Adjustment shim thickness step	~0.05 mm increments	The shim series is engine-specific

The torque of the fasteners is at least as important as the clearance. The torque values below are a **general guiding reference**; refer to the manual for the actual value.

Fastener	Typical torque range	Method
Valve cover bolt	~15 – 30 Nm	Sequential, gradual
Rocker/cam bearing bolt	~40 – 90 Nm (+ angle possible)	Per manufacturer sequence
Adjustment lock nut (rocker type)	~25 – 45 Nm	Lock without disturbing the adjustment

 **TIP — Field tip:** Always repeat the clearance measurement under the same temperature conditions and at the crank angle specified by the manual. A second confirmation measurement after warming and cooling the engine following a shim change catches shifts caused by assembly settling.

- Record the compression values for each cylinder in writing; trend tracking is more valuable than a one-time measurement.
- Look for burning/erosion on the valve face, discolouration on the stem (excess heat) and cracks in the spring.
- Verify the new valve's seating contact with a dye/marker test as an uninterrupted 360° ring.
- Mark the shim numbers and positions on a map; they become a reference at the next service.

Maintenance and Service Life

With correct maintenance, the valve train can run for the life of the engine without a major overhaul; when neglected, it leads to costs that can extend all the way to a complete cylinder head rebuild. In heavy commercial use, the main factors that determine service life are oil quality, timely clearance maintenance and protecting the engine from overheating.

- **Periodic clearance check:** In mechanical systems, measure the valve clearances at the interval specified by the manufacturer (typically a certain km/operating hours) and correct with a shim if necessary.
- **Correct oil and filter:** Especially in hydraulic lifter systems, oil pressure and cleanliness directly affect valve operation; use oil of the approved viscosity.
- **Heat management:** Keep the cooling system and thermostat maintained; chronic overheating rapidly burns the exhaust valves.
- **Quality fuel and correct injection:** Poor combustion and late injection cause deposits and local heating on the valve face.
- **Stem seal and guide monitoring:** If oil consumption is rising, early intervention is cheaper than a complete cylinder head rebuild.
- **Kit replacement at overhaul:** When the head is opened, renewing the valve seals, worn springs and shims as a group rather than one by one is safer in the long run.

In short, valve train maintenance, when done "on schedule rather than when a fault appears," both protects fuel economy and prevents unexpected roadside breakdowns and expensive engine damage. A small clearance adjustment is usually far cheaper than a burnt exhaust valve.

Frequently Asked Questions

How often should valve clearance be adjusted?

This depends on the engine type. In mechanical shim/rocker systems, it should be checked at the maintenance interval set by the manufacturer (a certain km or operating hours). In hydraulic lifter systems, routine adjustment is not required; however, if there is ticking or power loss, it should still be checked. For the exact interval, the vehicle's service manual takes precedence.

What are the symptoms of a burnt valve?

The most typical symptoms are noticeable power loss in the relevant cylinder, vibration/rough running at idle, a continuous hissing sound from the exhaust, and a low value in that cylinder in the compression test. In the leak-down test, air coming from the exhaust side confirms an exhaust valve burn.

Should just one valve be replaced, or the whole set?

If a single valve is damaged, technically only that one can be replaced; however, if the cylinder head is already open, renewing the other valves, seals and fatigued springs of the same age and mileage usually makes more sense in terms of labour and the cost of a second disassembly. Exhaust valves in particular are assessed as a group.

What does a valve adjustment shim do, and can any thickness be fitted?

The adjustment shim is a steel disc that precisely sets the clearance between the cam and the valve. The thickness is not chosen at random; the correct shim thickness is selected by calculating the difference between the measured existing clearance and the target clearance. The wrong shim causes the valve to burn or to tick.

Does the engine need to be dismantled to change the valve seal?

The stem seals can be replaced without completely removing the cylinder head, by holding the cylinder with compressed air with the piston at top dead centre; this is a common method. However, if there is also guide wear or the valve faces are damaged, the head must be removed and machined in a workshop.

How much difference is normal in a compression test?

In a healthy engine, the compression difference between cylinders is generally accepted to be no more than 10%. Larger differences point to a valve seating problem, a burnt valve or a ring leak in the low-value cylinder, and should be distinguished with a leak-down test.

Does fitting an equivalent valve train harm the engine?

An equivalent (OE-type/equivalent) valve train produced to the correct dimensions and quality can be used safely. What matters is that the valve diameter, stem length, guide dimension and material strength conform to the OE values. The wrong dimension or a part with low heat resistance is the real risk; that is why the part number and cross-reference must always be verified.

When I hear valve ticking, should I stop immediately?

A light tick that eases as the engine warms up usually points to the clearance adjustment and requires adjustment at the first opportunity. But if it comes with a hard, irregular metallic knock, power loss or kickback, there is a risk of valve/spring breakage; in that case, stopping the engine without straining it and having it checked is the cheapest way to save the engine.

The VADEN ORIGINAL Engine Valve Train (+ adjustment shim) product family is produced with OE-type/equivalent dimensions and heat resistance for the intake and exhaust side of heavy commercial diesel engines; by offering the valve, spring, seal, guide and adjustment shims in the correct thickness series together, it helps you safely complete the diagnosis, replacement and maintenance processes described above. Use the VADEN catalogue and cross-reference list to select the correct reference by your vehicle's engine number.

This document is for information only; in practice the vehicle manufacturer's current service manual and safety instructions apply. Values are general references for common heavy-duty systems; use the relevant OE service document for model-specific figures. © VADEN Otomotiv San. Tic. A.Ş. · vadenoriginal.com