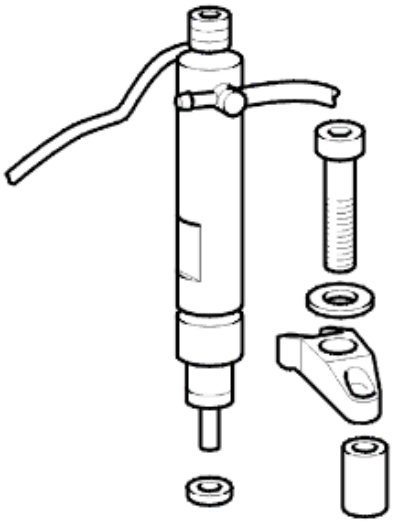
INJECTORS

Torque Specs

Fuel delivery lines, install nuts and tighten by hand, tighten nuts to **25 Nm**



Installing glow plug and injector

Install:

- glow plugs. Tighten to **15 Nm**.
- heat shield.
- injector.
- spacer.
- holder.

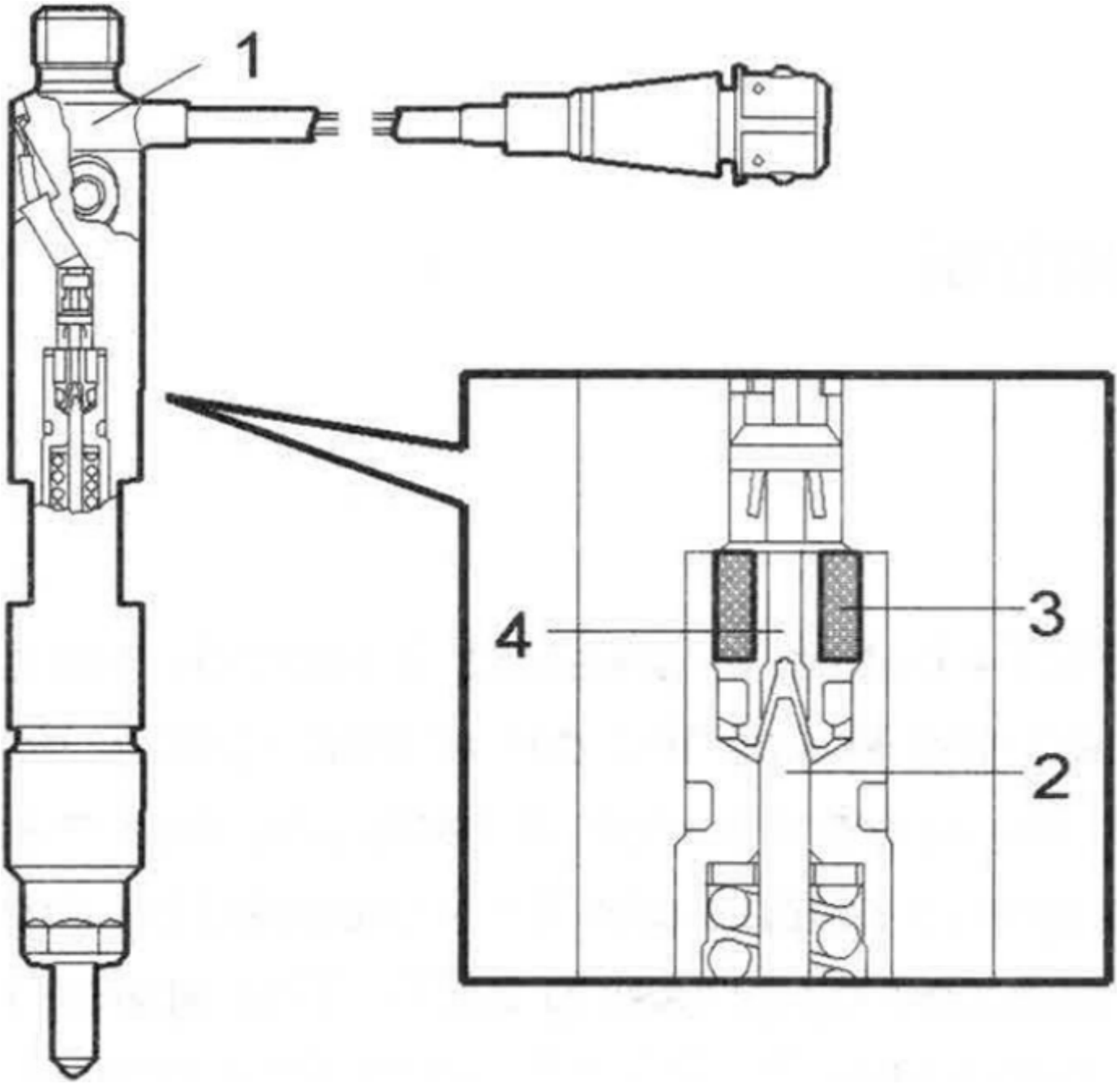
Tighten injector to **20 Nm**.

Note! Injection valves may not be cleaned with jet nozzle. Injectors must not be handled in such a way that the tip with spray holes comes into contact with any hard surfaces such as workbenches. This would cause damage to the nozzle tip.

Injector 4 (Needle Lift Sensor)

Engine speed SEC (RPM) and crankshaft position, from the engine speed (RPM) sensor and needle lift sensor.

Design and function



— Needle lift sensor (1)
— Needle (2)
— Magnet coil (3)
— Magnetic core (4)

The needle lift sensor is located in the injector for cylinder four. The value at this injector must represent all the injectors in the engine. The needle lift sensor transmits signal to the engine control module (ECM) when injection starts.

By comparing this signal with the signal from the engine speed (RPM) sensor the engine control module (ECM) can calculate the difference between calculated and actual injection timing and make necessary corrections.

If the signal which represents the movement of the needle is missing, the quantity of fuel injected is limited and injection timing is overridden. If at the same time there is a fault in the engine speed (RPM) sensor the engine will stop.

The needle lift sensor consists of a magnet coil wound around a magnetic core. The coil has a DC

voltage supply, regulated so that current remains constant, irrespective of temperature variations. When injection starts the magnetic core (connected to the needle) moves upward disturbing the magnetic field. This causes a change in voltage in the power supply. The engine control module (ECM) determines when injection starts by registering this change in voltage.

EFI-711 Needle lift sensor, signal

Condition

A diagnostic trouble code (DTC) is stored if battery volt age is greater than 9.14 V and the signal from the needle lift sensor is greater than 0.60 V or below 0.10 V.

Substitute value

— Only initial boost pressure permitted
— EGR control is disabled

Possible source

Signal too high:
Open-circuit in signal cable or ground lead
Short-circuit to battery voltage in signal
Contact resistance in terminals
— Defective needle lift sensor
Signal too low:
— Short-circuit to ground in signal cable
— Defective needle lift sensor

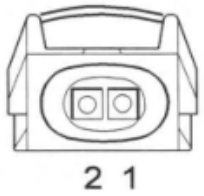
Fault symptom(s)

— Poor acceleration, engine sluggish
— Engine knocks when idling

U C. Signal too high. Permanent fault

U C1

Checking ground lead



A3000223

A3000036

Check cable between needle lift sensor connector terminal 2 and engine control module (ECM) #A19 for an open-circuit according to **BBB A2**. Check engine control module (ECM) connector for contact resistance and oxidation according to **BBB A5**.

Note! With the ignition off, main relay off and the needle lift sensor connector disconnected, the resistance between the needle lift sensor connector terminal 2 (engine control module (ECM) side) and ground should be approx. 0 Ω.

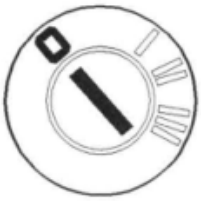
Was a fault detected?

Yes:
- **U C6**

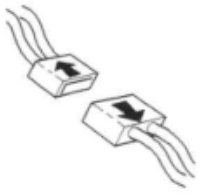
No:
- **U C2**

U C2

Checking needle lift sensor



A3000037



A3000244

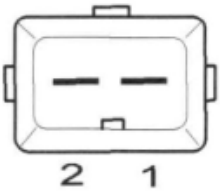
- Ignition off.
- Disconnect needle lift sensor connector.

Connect an ohmmeter between needle lift sensor connector terminals 1 and 2 (needle lift sensor side).

The ohmmeter should read between 80 and 120 Ω.

If reading is OK:
- **U C4**

If reading is incorrect:
- **U C3**

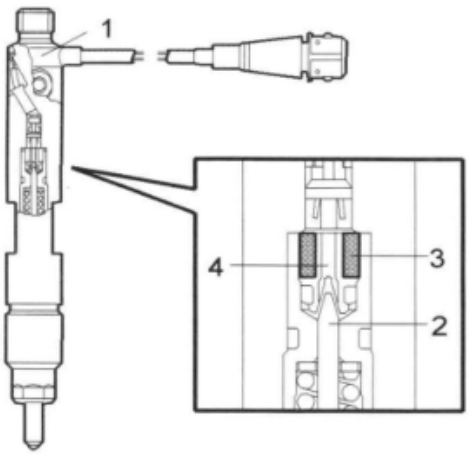


A3000211

A3000036

U C3

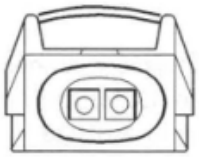
Replacing component



Try a new injector with needle lift sensor for cylinder 4 according to Service Manual Section 2(21—23, 25—26) Engine D5252T 850 1996—.

Then continue with:
- **U C6**

Checking signal cable



A3000223

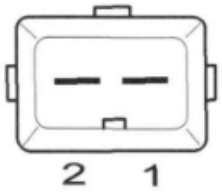
Check cable between needle lift sensor connector terminal 1 and engine control module (ECM) #A5 for an open-circuit according to **BBB A2** and a short-circuit to supply voltage according to **BBB A4**.

Was a fault detected?

Yes:
- **UC6**

No:
- **UC5**

Contact resistance and oxidation

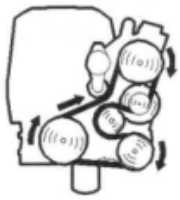


A3000211

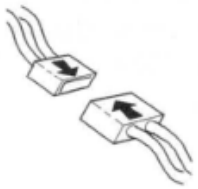
The cause of the diagnostic trouble code (DTC) has been loose connections in the needle lift sensor connector. Check for contact resistance and oxidation and remedy according to **BBB A5**.

Then continue with:
- **UC6**

Verification



A3000019



A3000243

A0800023

Hint: After carrying out the repair, check that the fault has been remedied.

- Ignition off.
- Reconnect connectors, reinstall components etc.
- Engine running.
- Go into scrolling values.

Read off engine speed (RPM) and secondary engine speed and compare them.

Secondary engine speed must not deviate more than 25 rpm from engine speed (RPM).

If reading is OK:
- Fault corrected

If reading is incorrect:
- **UC7**

Fault-tracing information

The verification result shows that the fault persists.

Do you want to exit fault-tracing?

Yes:
- Fault not corrected

No:
- **UC1**

U D. Signal too low. Permanent fault

U D1

Checking signal cable

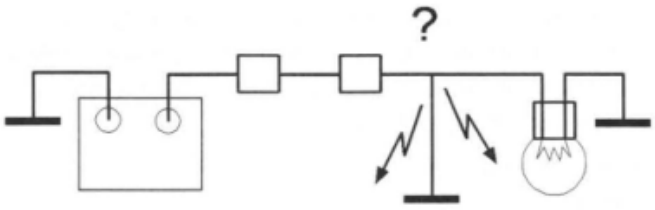
A3000223

A3000031

Check cable between needle lift sensor connector terminal 1 and engine control module (ECM) #A5 for a short-circuit to ground according to **BBB A3**.

Note! With the ignition on, main relay on and needle lift sensor connector disconnected, the voltage between needle lift sensor connector terminal 1 (engine control module (ECM) side) and ground should be greater than 6 V.

Was a fault detected?



Yes:

- **U D3**

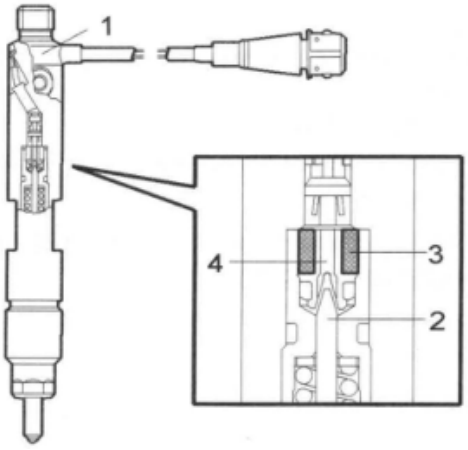
No:

- **U D2**

U D2

Replacing component

A8700265



Try a new injector with needle lift sensor for cylinder 4 according to Service Manual Section 2(21—23, 25—26) Engine D5252T 850 1996—.

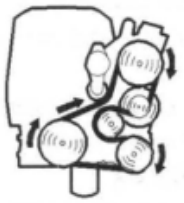
Then continue with:

- **U D3**

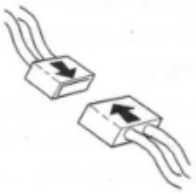
U D3

Verification

Hint: After carrying out the repair, check that the fault has been remedied.



A3000019



A3000243

- Ignition off.
- Reconnect connectors, reinstall components etc.
- Engine running.
- Go into scrolling values.

Read off engine speed (RPM) and secondary engine speed and compare them.

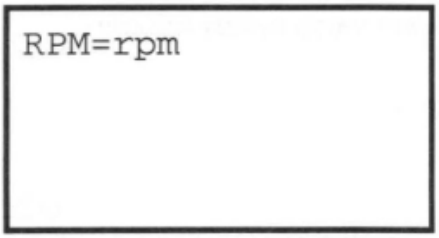
Secondary engine speed must not deviate more than 25 rpm from engine speed (RPM).

If reading is OK:

- Fault corrected

If reading is incorrect:

- **U D4**



A0800023

U D4

Fault-tracing information

The verification result shows that the fault persists.

Do you want to exit fault-tracing?

Yes:

- Fault not corrected

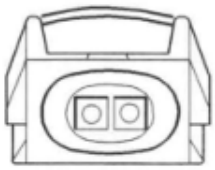
No:

- **U D1**

U E. Signal too high. Intermittent fault

U E1

Checking cables and terminals



A3000223

Check control module connector for loose connections according to **BBB B5** and contact resistance and oxidation according to **BBB B6**.
Check cable between needle lift sensor connector terminal 2 and engine control module (ECM) #A19 for an intermittent open-circuit according to **BBB B2**.
Check cable between needle lift sensor connector terminal 1 and engine control module (ECM) #A5 for an intermittent open-circuit according to **BBB B2** and an intermittent short-circuit to supply voltage according to **BBB B4**.

Then continue with:

- **U E2**

U E2

Fault-tracing information

For intermittent faults fault-tracing is not followed by a verification because the fault is not present at this moment.

Do you want to repeat fault-tracing?

Yes:

- **U E1**

No:

- Operation done

U F. Signal too low. Intermittent fault

A3000223

A3000036

U F1

Checking cables and terminals

Check cable between needle lift sensor connector terminal 1 and engine control module (ECM) #A5 for an intermittent short-circuit to ground according to **BBB B3**.

Then continue with:

- **U F2**

U F2

Fault-tracing information

For intermittent faults fault-tracing is not followed by a verification because the fault is not present at this moment.

Do you want to repeat fault-tracing?

Yes:

- **U F1**

No:

- Operation done

How to install replacement TDI nozzles

difficulty: 2/5

Introduction

This article shows installation of new TDI fuel injector nozzles for all 1996-2003 Volkswagen TDI or Audi TDI engines (non pumpe duse)

Due to mileage and use, the tip of the fuel injector (the nozzle) will wear out and requires replacement to restore the injector's spray pattern to like new condition. The benefits are both more power and economy. If you think there is a problem due to bad fuel or buildup, you can try running a can of diesel purge through the fuel system. Buildup due to low quality fuel and normal wear will disturb the spray pattern and cause uneven combustion and temperatures. If the problem is wear, the only solution is nozzle replacement. You can also replace the nozzles with larger nozzles with a larger opening to make more power (and possibly more smoke) by injecting more fuel. It's unlikely for damage to occur from only worn OEM nozzles but replacing the nozzles

will restore your lost fuel economy, power, make less smoke, and give the car a smoother idle. For more information on nozzle selection and technical details, see 1000q: nozzle selection FAQ and 1000q: basic power modifications.

Although this is an easy job, cleanliness is extremely important! The nozzle holes are very small and particles can damage and clog the injectors. While the injector tips withstand thousands of psi of combustion in the engine, having dirt stuck behind the tiny nozzle orifice is like squeezing out an apple sized kidney stone - you're at risk of a blowout. Below is a slightly larger than life size picture of an old nozzle next to a caliper. The entire nozzle tip is less than 4mm and you can see the enlargement of a new nozzle tip with a red arrow pointing to the orifice measuring .184 millimeters (mm). You want the injector internals and area around the injector holes to be very clean. This is an easy job but please follow the directions below! Counterholding is suggested on some parts (like the fuel hard lines) because not counterholding could result in damage! The injector holding forks have been known to break due to overtorquing as well so make sure you have an accurate torque wrench. For more basic mechanic's tips, see 1000q: basic mechanic's tips .

nozzlescale.JPG

nozzletip.JPG

TDI nozzle Parts

10, 14, 13, 15mm wrenches and sockets.
17mm open faced wrench **or** 17mm flare nut wrench **or** VW special tool #3035, equivalent tool from metalnerd
torque wrench
brake cleaner spray
PB Blaster
lots of paper towels and rubber/vinyl gloves
vise
pliers
screwdriver
slide hammer to remove the injector (**Optional**) available from metalnerd tools (halfway down the page) or you can make your own (see below)
vacuum cleaner (**Optional**)

new nozzles (4 total) available from : kermaTDI.com, JSperformance (Canada)
new copper injector washers VW# 046 130 219 A (4 total, included with most nozzle sales but

always make sure)

Replacement procedure

Summary: Remove the glow plug harness, move the fuel lines to the side, and unbolt the injector holders. Pull out the injectors, remove the old nozzles, put the new nozzles on, replace as necessary.

noz4.jpg

Detailed procedure: First let the engine cool down so that is not hot to the touch and park/secure the car. Make sure the car is secure and off before doing anything else. Make sure there is adequate ventilation because some diesel fuel and vapors will be leaked and observe all safety practices cautioned in your factory service manual when working on the engine. Although diesel vapors aren't as flammable from an open flame at room temp/pressure as gasoline vapors (an example of this is shown in the video below at the 1:00 minute mark, don't try to replicate the experiment yourself), you still want to observe all safety practices in your factory service manual pertaining to this procedure and evacuate any fuel fumes that are present. Keep all sources of ignition away from spilled fuel and/or vapors. Diesel fuel will also melt rubber coolant lines or driveway asphalt.

Open the hood and remove the top plastic engine cover (3 x 10mm nuts).

Cleanliness is very important in this job! Put on rubber or vinyl gloves to protect your hands against the fuel. Once the engine is cool, wipe down any oil or dirt away from the front of the cylinder head, fuel injectors, and glow plugs. Then wad paper towels around the base to collect excess fluid and spray the metal head around the fuel injectors and glow plugs with cleaner. Also clean the flare nuts at the end of the fuel lines and wipe down the fuel lines. Clean it again. Repeat as necessary. You can also use a vacuum cleaner to help clean the area but I find that carb cleaner and compressed air is better at loosening stuck particles.

The fuel injector metal pressure lines will loosen much more easily if you put a few drops of PB Blaster, liquid wrench, or a similar penetrating lubricant around the threads. Also apply to the fuel line side of the injector pump union fitting only to help prevent loosening the unions.

Remove the black glow plug harness (outlined in red below). Each of the 4 plugs should pull straight off easily. Place to the side and clean as necessary. You can also remove it later if you don't have enough clearance.

noz1.jpg

Use a screwdriver to remove the black plastic clips (outlined in green above) holding the pairs of metal fuel lines together. Some cars have a metal clip.

Remove the fuel pressure lines from the injector tops. **Note**: you probably don't have to counterhold the injector body during fuel line removal since the injectors will be frozen with buildup but it is suggested to counterhold them for reinstallation or if the injectors are loose. To counterhold, use a 15mm open wrench against the flat part of the injector body to prevent movement while you use a 17mm wrench to remove the nut at the fuel line. The tightening torque is only 15 ft-lbs but for some reason, the forks on the injector holding bracket have broken with only a little excess force. It's tempting to not counterhold but it couldn't hurt. The forks can also break when it's 13mm bolt is torqued to greater than 15 ft-lbs, so take note for reinstallation!

If you don't have a torque wrench that will fit on the nuts, use a permanent marker to make an index mark on the nuts before loosening them. Make each mark in the same direction (like pointing up or down) so that you have a better idea of how much to tighten the nuts during installation.

Now loosen the fuel lines at the lines at the injection pump (17mm nut), just enough to swivel the fuel hard lines out of the way as necessary. I suggest using a 14mm wrench to counterhold the union at the lines at the injection pump end (so the union at the injection pump doesn't spin in the pump).

Caution: the moved fuel lines may interfere with the hood so avoid closing the hood if there is a clearance issue.

You should now have plenty of room to remove the needle lift sensor's wire coming from injector #3. It's the only injector with the wire coming out of the top. Pinch in the metal or plastic clip at the plug (circled in red below) and carefully wiggle the plug off. Pictured are 3rd generation and ALH engines, they are similar except the plug is in a slightly different location and uses a different connector.

nedliftplug.jpg

noz7.jpg

Remove the 4 injector holders (the metal fork holding the injector) and place to the side. There is 1 conical washer on each injector holder and they are each held by 1 x 13mm bolt (circled in red below). In the below picture I removed a glow plug to do a compression test and hadn't yet cleaned the other spots or removed the fuel lines.

noz2.jpg

Now you can remove the injector bodies. They'll be stuck so below are some tips.

Injector removal tips

The injectors are pulled straight out since there are no threads, there is nothing but carbon buildup holding them in place. Most people find that the injectors will wiggle out, some people find that they are completely frozen in place. To help loosen the injectors, put a drop of PB Blaster penetrating lubricant around each injector hole when you start the project. This will give the PB Blaster time to penetrate the area and should break up the buildup. After you start to wiggle the injector and get motion, add another drop to lubricate the hole.

Caution: here's what NOT to do:

1. If you leave the injectors out of the car and dry for more than a day or two, keep them immersed in diesel or diesel fuel additive. Injectors have been known to seize when left dry for a week.
2. Don't pull on the fuel lines or return line nipples at the top with anything more than a gentle touch.
3. Try to avoid spinning the injector body counter-clockwise if it's seized. This can release the retaining nut while it's still stuck in the cylinder head and pop out the injector internals. This will make life difficult. If this happens, you can take apart another injector to see how it should be put back together.
4. Don't heat the injector or nozzles with a torch since this could damage them. You can torch a rusted bolt on the muffler but don't use it on the sensitive needles and springs of the injector or nozzle because they could get messed up.

Wrench method

First try using a 15mm open faced wrench on the flat part of the metal injector body to wiggle them back and forth. Do NOT pull on the fuel lines or nipples with anything more than a gentle touch. Try to make the first "break" clockwise or wiggle it back and forth so that it doesn't loosen the retaining nut before you loosen the whole assembly. If this happens, the injector internals will pop out and the injectors will not make you happy. As they start to move, put another drop of PB Blaster at the base of the injector body to lubricate the hole.

Slide hammer method

You can either buy, rent, or make your own slide hammer to carefully pull them out. A slide hammer is a weighted rod that lets you apply force on the injector along the axis of the slide hammer. They are available from metalnerd tools (halfway down the page) or you can make your own. To make your own, find or rent a slide hammer and attach the end to the injector threads. The threads are 14mm x 1.5mm pitch. Some hardware coupling nuts are 2mm pitch. A 3lb weight should work, a 5lb weight may be needed for extreme cases. I took a damaged fuel pressure line

and bent it straight to make a puller, pictured below. It attaches to the top of the injector. A slide hammer attaches the same way.

injpull.JPG

Once you get the injectors out:

Place all 4 injectors a fresh and clean surface like clean paper towels. Lint free towels would be best.

Below is a picture of the head after injector removal. Note that the hole is not threaded - the injector fork holds the injector in place. You can see buildup in the #2 injector seating surface. Clean the area around the injector holes and seating surfaces. This is very important because excess dirt can cause a compression leak if not cleaned! I suggest using a soft swab moistened with carb cleaner to wet the area first. If you use a q-tip, tie a string around the end because it's small enough to fall into the hole and cause a bad day. To avoid getting fluid inside the injector hole (since it leads to the cylinder and could cause hydrolock), spray fluid directly on the q-tip instead of on the hole. This is a type of serious engine damage resulting from letting too much non-compressible liquid inside the cylinder. Carb cleaner should evaporate if it gets into the hole but I'd still rather not have it filled with fluid. I do not suggest using metal objects to clean the area since this can cause a scratch to the sealing surfaces and leak. I would avoid using a pick or screwdriver since the head is aluminum, a soft metal. Also do not use compressed air since this will blow particles all over the freshly cleaned surfaces and onto the exposed fuel lines. A vacuum cleaner works well here as well. If a small piece of built up soot falls into the hole it will burn up when you start the engine so don't freak out.

noz5.jpg

The sealing washer will be stuck on to the injector with soot. I suggest using pliers and turning the washer a 1/4 turn with a light pressure. This will break the carbon buildup and the seal. Don't go near the retaining nut's sealing surface to avoid scratching it (marked with a red line below). Don't use a screwdriver or pick to remove the washer because this can scratch the surface! Clean the exterior of the injector as much as possible.

If the copper washer is not there, it's probably stuck to the cylinder head! Remove it to prevent any compression leaks.

noz6.jpg

Use a vise to hold the flat part of the injector body - put a paper towel around the base in case fuel leaks out. (It also keeps the injector clean since my vise was dirty). If you are thinking of just holding it with pliers you are asking for a dropped/dirty/damaged nozzle. All four of my injectors also needed a breaker bar to loosen them, so some sort of vise is a must here!

Use a 15mm deep socket or wrench to loosen the retaining nut/cap. Because it will be so tight, I recommend using a 6 point deep socket/wrench instead of a 12 point socket/wrench or an open faced wrench. This will minimize the chances of the wrench slipping and scratching the retaining nut. Remember that a scratch on the sealing surfaces can cause a compression leak! See 1000q: mechanic's tips for more useful tips.

Remove the retaining nut/cap and clean the inside and outside of the nut/cap thoroughly. Also clean the outside of the injector body. Avoid turning it upside down since the metal bushing can fall out. There is a large metal disk with a bushing in the center. This can easily blow away if you wipe or use compressed air, so be careful! If it lifts up, it will only seat 1 way, and the nozzle will also only seat 1 way due to the offset pins.

noz3.jpg

noz4.jpg

Repeat for all 4 injectors. As you handle the nozzles, keep them pointed down so that the needle inside doesn't fall out.

Put on the new nozzles, taking care not to touch the tip with anything that will leave a lot of lint or could scratch the metal. Take care not to drop the tip or hit it against anything. Again, the nozzle will only fit 1 way, the 2 pins on the injector are offset so that the 3rd hole of the nozzle aligns with the 3rd hole on the injector body. Also don't try to disassemble the nozzle or injector body - they're not toys and you are better off keeping them clean and intact!

When you slip the retaining nut on, go slow to avoid banging the tip. There is a preloaded spring inside so the nozzle will not be completely seated flat. When you tighten the nut it will seat and some diesel fuel may come out the fuel nipples at the bottom. **Note**: there is no torque setting, 33 ft-lbs has been mentioned but the correct way to tighten the retaining nut is to turn until wrench tight, then turn another 30 degrees. This should be be than 33 ft-lbs. Undertorquing the retaining nut/cap causes leaks!

You can drop the sealing washer into the injector hole and carefully center it with a thin screwdriver or use a very thin touch of grease to hold the washer on the bottom of the retaining nut as you lower it in. Make sure that the copper washer is fully seated, aftermarket washers have been known to not fully seat and cause compression leaks. Carefully slip the injectors in, replace the injector holders, bolt, and washer. **CAUTION** - the conical washer for the 13mm bolt is directional! The curved side points down. If you put the curved side up, it will crack the washer.

noz8.jpg

Remember, counterhold the injector body with a 15mm wrench while you tighten the fuel lines because the injector holding forks are weak and have been known to crack!

Replace all 4 fuel lines, 3rd injector needle lift sensor plug, and glow plug harness.

Torque settings:

1. If you missed it, the fuel injector retaining nozzle should be torqued to wrench tight and then another 30-45 degrees. 33 ft lbs has been mentioned but this oftentimes results in leaks. If you have an **accurate** torque wrench, 33 ft lbs plus a 30-45 degree turn can also be used.
2. fuel line flare nuts: 18 ft-lbs - remember to counterhold the injector body with a 15mm wrench. CAUTION: don't overtighten the flare nuts because you could distort them and cause a leak. Tight is good, overtightened is bad.
3. If the other end of the fuel line (the union) in the injection pump loosened and spun, torque the union to 33 ft-lbs.
4. forked injector holder bolt: 15 ft-lbs - WARNING: the injector holder forks have been known to break off when torqued too much, do not over tighten!
5. CAUTION - the conical washer for the 13mm bolt points down. If you put it face up it will crack.

Starting the car - it might not start without priming

You are now ready to start the car. It may take a while of cranking to start the engine. Try to crank for no longer than 30 seconds followed by at least 30 seconds of rest. As long as you did not empty the fuel filter or injection pump, there will still be some fuel in the system and the car should start with some cranking. If the car still doesn't want to start, slightly loosen one of the 17mm fuel line nuts at the fuel injector, wrap a rag around it, and crank the engine twice. It should be wet with fuel. Retighten the nut and crank the engine again.

Check for any fuel leaks or odors. Inspect the area around the base of the injectors for leaks or bubbles. Also inspect for any wet areas that would indicate a leak. Drive the car for about 500 miles or so to let the new nozzles settle in. If you also have a chip, you should ideally have a new chip made that takes into account the larger nozzles.

You may want to adjust fueling through injection quantity adaptation, see 1000q: injection quantity adjustment and the section "**Testing and changing IQ with software adaptation**" for more details and screenshots. Here is a summary: Drive the car and let it warm up to normal operating temperature. While idling, open VCDS, login with code "12233", adaptation, block 1. Adjust adaptation value higher or lower to adjust IQ to the 3.0-5.0 mg/R range. Hit "save" when you are satisfied. When you are done, exit and then go back to make sure the values you wanted are still there.

Do you know something that should be added or corrected in this article? Post your comments in the myturbodiesel.com forums

For reference, here is a parts listing for the ALH TDI fuel injector system:

TDIalhfuelinjector.png

Revision #4
Created 2025-06-21 16:51:11 UTC by Kyle Robertson
Updated 2026-05-23 13:00:11 UTC by Kyle Robertson