TURBO FAILURE:

OIL CONTAMINATION

FACT SHEET 1

- **Turbochargers are very reliable: less than 1% of turbos fail due to a manufacturing fault with the turbo itself.**
- **95% of turbo failures are because of problems with oil starvation, oil contamination or foreign object damage.**

BEFORE YOU FIT A NEW TURBO, FIND OUT WHAT CAUSED THE FIRST UNIT TO FAIL OR YOU RISK THE REPLACEMENT FAILING TOO.

Why does oil contamination damage turbos?

As turbochargers can operate at over 6,000 revs per second (360,000 rpm) and endure temperatures of 950°C, turbo bearings are under great stress. The turbine shaft and bearings rotate in a thin film of oil. Consequently any fault with the oil supply to the turbo means its bearings are likely to fail before the engine's main bearings. Running a turbo without oil for five seconds is as harmful as running an engine without oil for five minutes.

While it is important to check the engine oil pressure meets the manufacturer's specifications, it is even more critical that the oil feed pipes to the turbo are clean and clear, so you are certain they can supply uncontaminated oil, at the correct pressure. Contaminated or dirty oil will scratch or score the bearings, leading to rapid wear and ultimately, turbocharger failure.

This marking is evidence of contaminated oil

Severe scoring on to the journal bearings

Extreme wear on the turbine shaft

What causes contaminated oil?

- A blocked, damaged or poor quality oil filter.
- High carbon build-up in the engine. This can rapidly contaminate even new oil.
- Accidental contamination of new oil during servicing.
- A malfunctioning oil filter bypass valve.
- Engine wear, leaving swarf deposits in the oil.
- Oil that has degraded due to excessive temperatures or extended service intervals

Preventing turbo failure caused by contaminated oil

- Always use fresh oil and new oil filters as recommended by the engine manufacturer when fitting a new turbo.
- Ensure the oil is the correct grade for the engine.
- Clean or replace oil inlet pipes to eliminate any carbon deposits or sludge that could enter the turbo or restrict oil flow to the bearings

BTN Turbo supplies brand new replacement turbochargers, made by the original manufacturers to the highest quality standards. Though we confidently guarantee them, our standard warranty does not cover turbocharger failure caused by oil contamination.

This is one of a series of Turbo Failure Fact Sheets from BTN Turbo.

Safeguard your reputation and your business – make sure you read them all.

BTN TURBO

The Turbocharger People

BTN Turbo Limited, BTN House, Zodiac Park, High Road, Cowley, Uxbridge, UB8 2GU Telephone: **01895 466666** Web: **www.btnturbo.com**

DS76 ISSUE 1

TURBO FAILURE:

IMPACT DAMAGE

FACT SHEET 2

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- **95% of turbo failures are because of problems with oil starvation, oil contamination or foreign object damage.**

BEFORE YOU FIT A NEW TURBO, FIND OUT WHAT CAUSED THE FIRST UNIT TO FAIL OR YOU RISK THE REPLACEMENT FAILING TOO.

How do ingested objects damage turbos?

Turbochargers can spin at over 6,000 revs per second (360,000 rpm) and endure temperatures of 950°C. In these conditions, even the smallest object ingested or sucked into the turbo can damage or destroy the compressor and turbine, leading to low pressure or total failure.

Compressor damage is caused by objects being sucked into the air intake. Turbine damage is usually caused by engine components, such as injector tips or valve train parts.


Any object sucked into the compressor will damage it

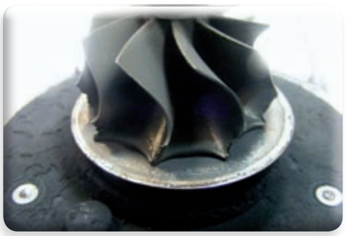
What are the causes of impact damage?

- Items sucked into the air intake because of a damaged, poor quality or missing air filter.
- Damaged hoses allowing small particles to enter the intake.
- Gasket material entering the intake.
- Nuts, bolts, washers, rags or other items left in the intake pipe during servicing.
- Broken engine components, e.g. injector tips, valves or fragments of damaged piston.
- Fragments from a previous turbocharger failure.


Even small items can completely destroy the blades

Preventing turbo failure caused by impact damage

- Ensure all air hoses are in good condition, intact and free from blockages or loose items.
- Always use new gaskets to create perfect seals and avoid gasket breakup.
- Always fit the correct new air filter.
- Check there are no turbo or engine fragments in the system from the previous failure, before fitting the replacement.


Damaged blades mean the turbo won't provide boost

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DS77 ISSUE 1

TURBO FAILURE:

OIL LEAKS

FACT SHEET 3

- **Turbochargers are very reliable: less than 1% of turbos fail due to a manufacturing fault with the turbo itself.**
- **95% of turbo failures are because of problems with oil starvation, oil contamination or foreign object damage.**

BEFORE YOU FIT A NEW TURBO, FIND OUT WHAT CAUSED THE FIRST UNIT TO FAIL OR YOU RISK THE REPLACEMENT FAILING TOO.

Why does oil leakage damage turbos?

Turbochargers can spin at over 6,000 revs per second (360,000 rpm) and endure temperatures of 950°C. The turbo relies on the thin film of oil that lubricates the bearings on the turbine shaft. This oil is kept in place by seals for the turbine and compressor ends of the bearing housing.

These seals are unlike conventional oil seals, and similar to piston rings. They need positive air pressure inside the compressor and turbine to keep oil lubricating the bearings and prevent it seeping into the end housings. A restriction on the inlet side will create a vacuum that will to pull oil past the seals at the compressor end housing. If the engine idles for long periods, the turbo will rotate at very low speed with correspondingly low air pressure. The resulting vacuum will cause oil to seep into the turbine housing. Either situation results in insufficient oil for the turbine bearings.

Compressor end oil leakage due to low air pressure

Turbine end oil leakage due to restriction in oil drain

Compressor end oil leakage

What causes oil leaks at the compressor end?

- Blocked or restricted air intake filter.
- Blocked or restricted air intake pipe or hose.
- Air leaks on intake hoses or at the intercooler.

What causes oil leaks at the turbine end?

- Leaks in the exhaust system.
- Leaks in the EGR system.

What causes oil leaks at both the compressor and turbine end?

- Any restriction in the oil drain pipe from the turbo to the engine.
- Restriction in the engine breather.
- Physical damage to the turbo's rotating parts, and excessive bearing clearance.
- Repeated hot engine shutdowns leading to carbon deposits (coke) in the centre housing.
- Incorrect turbo fitted.

Preventing turbo failure caused by oil leakage.

- Ensure there are no blockages or restrictions in the air and oil drain systems.
- Ensure there are no leaks in the exhaust system.

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DS78 ISSUE 1

TURBO FAILURE:

OIL STARVATION

FACT SHEET 4

- **Turbochargers are very reliable: less than 1% of turbos fail due to a manufacturing fault with the turbo itself.**
- **95% of turbo failures are because of problems with oil starvation, oil contamination or foreign object damage.**

BEFORE YOU FIT A NEW TURBO, FIND OUT WHAT CAUSED THE FIRST UNIT TO FAIL OR YOU RISK THE REPLACEMENT FAILING TOO.

Why does oil starvation damage turbos?

As turbochargers can operate at over 6,000 revs per second (360,000 rpm) and endure temperatures of 950°C, turbo bearings are under great stress. The turbine shaft and bearings rotate in a thin film of oil. If oil is not present at start-up and while the turbo is running, the bearings will fail. Running a turbo without oil for five seconds is as harmful as running an engine without oil for five minutes.

While it is important to check the engine oil pressure meets the manufacturer's specifications, it is even more critical that the oil feed pipes to turbo are clear and clean, so you are certain they can supply oil at the correct pressure.

Extreme heat damage due to lack of oil

The blue colouring indicates excessive temperatures

Scored and discoloured surface due to insufficient oil

What causes oil starvation?

- Low engine oil level in the sump.
- A bent or kinked oil feed pipe.
- Carbon deposits (coking) in the oil feed pipe.
- Blockage caused by applying silicone to the oil inlet gasket.
- Incorrect oil inlet gasket restricting oil supply.
- A blocked, damaged or poor quality oil filter.
- Worn oil pump.
- Failure to prime the replacement turbo with oil during fitting.
- The engine not being used for long periods, particularly in cold weather.

Preventing turbo failure caused by oil starvation

- Do not use silicone on oil gaskets; it can easily become detached and block oil passages.
- Clean or replace oil inlet pipes to eliminate any carbon deposits or sludge that could restrict oil flow to the bearings.
- It is important to check the oil pressure and oil supply to the turbo.
- Always use fresh oil and new oil filters as recommended by the engine manufacturer when fitting a new turbo.

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DS75 ISSUE 1

TURBO FAILURE:

OVERSPEEDING

FACT SHEET 5

- **Turbochargers are very reliable: less than 1% of turbos fail due to a manufacturing fault with the turbo itself.**
- **95% of turbo failures are because of problems with oil starvation, oil contamination or foreign object damage.**

BEFORE YOU FIT A NEW TURBO, FIND OUT WHAT CAUSED THE FIRST UNIT TO FAIL OR YOU RISK THE REPLACEMENT FAILING TOO.

Why does overspeeding damage turbos?

Turbochargers can operate at speeds in excess of 6,000 revs per second (360,000 rpm), with exhaust gases around 800°C. Each turbo is designed and manufactured to rotate at the correct speed for its application. Overspeeding is when the turbo rotates at a greater speed than its operational limits.

Overspeeding can push the turbo beyond its safe operating parameters, causing it to fail by damaging the turbine or compressor wheels and bearings. If the turbo continues to overspeed, it can overboost the engine, resulting in serious damage to the internal components and potentially complete engine failure.

Compressor destroyed by overspeeding

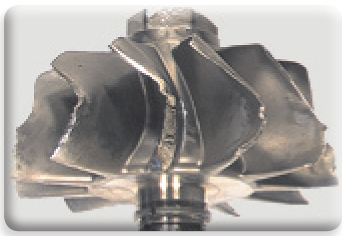
What causes overspeeding?

- A restriction in the air intake filter or pipe work, or a split or detached air hose, allowing incorrect amounts of air into the turbo.
- A 'chipped' or 'overfuelled' engine that isn't to standard specification.
- Tampering with the wastegate.
- Worn injectors.
- Loss of signal to the SREA (Simple Rotary Electronic Actuator) for the wastegate or VNT control.
- Fitting the incorrect turbo.

Orange Peel effect on backface

Preventing turbo failure caused by overspeeding

- Check there are no restrictions or leaks in the air intake pipe work.
- Ensure the wastegate or VNT linkage is operating freely.
- Check the electronic sensors and ECU are operating correctly.



Turbine blade fracture

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DS082 Iss001 TQA0027

TURBO FAILURE:

REEA – Rotary Electronic Actuator
SREA – Simple Rotary Electronic Actuator

FACT SHEET 6

- **Turbochargers are very reliable: less than 1% of turbos fail due to a manufacturing fault with the turbo itself.**
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BEFORE YOU FIT A NEW TURBO, FIND OUT WHAT CAUSED THE FIRST UNIT TO FAIL OR YOU RISK THE REPLACEMENT FAILING TOO.

The VNT (Variable Nozzle Turbine) turbocharger is designed to match the size of the turbine to suit the maximum rated power of the engine, without compromising on low speed response. Latest VNT models use full electronic control of the vanes for:

- Rapid response
- Accuracy
- Feedback to the vehicle's ECU.

REA/SREA malfunction

Movement of the vanes is controlled by the REA (Rotary Electronic Actuator) or SREA (Simple Rotary Electronic Actuator). Failure (or apparent failure) of the actuator is indicated by:

- ECU Error Symptoms control.
- Low Boost
- High Boost
- Noise.

What should you do if you suspect a fault in the REA or SREA?

1. Ask the customer to fully describe the problem, including the exact conditions when the failure occurred:
   - What was the engine speed and load – was the driver accelerating or braking?
   - Was the engine hot – how long since it was previously started?
   - Was there any electrical equipment being operated at the time, e.g. electric windows?
   - At the time of the suspected turbo problem, were there any other electrical component failures?
2. Check the vehicle service history for past problems, previously recorded ECU error codes and replaced engine components, particularly concerning the EGR valve(s).
3. Check the vehicle records to see if the battery or alternator has been changed, or if the voltage has ever dropped low enough to prevent the engine cranking. Check the voltage now; if it is correct, the actuator should reset itself.
4. Plug in the diagnostics for the vehicle engine control unit (ECU) and record all failure codes, and their frequency.
5. With the engine immobilised and cold, check if you can see or feel the linkage between the REA/SREA and the turbo. If it's accessible, check it's not detached at either end.

continued...

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DS083 ISSUE 001 TQA0028

TURBO FAILURE:

REA – Rotary Electronic Actuator
SREA – Simple Rotary Electronic Actuator

FACT SHEET 6 ...contd.

Test the linkage to check that there's a small amount of play at each end. If there is no play, check for corrosion at each end of the linkage; this may be restricting movement.

Remove and check that the vane assembly operating lever is free. If the linkage is tight, move the crank assembly by had a few times. If it frees up, reconnect the linkage and test again. If the crank assembly is very tight or won't move at all, contact BTN Turbo for further advice. Do not apply leverage as this may cause further damage. The turbo will need to be removed to diagnose the reason for restricted vane movement.

6. Check the REA/SREA electrical connector is firmly located. Press both end tabs, pull it off and check for damage. Check for water or staining below the connector seal and in the REA/SREA connector well.

   Check the REA/SREA connector walls for damage or cracks. While the plug is disconnected, inspect all the individual wires on the vehicle wiring loom for damage or breaks. Reconnect, ensuring the location tabs click into place securely. See photo 1.

   Gently pull on each harness wire in turn to check it's firmly located within the connector. Check each wire is sealed as it enters the connector; if there are less than five wires, the unused positions are fitted with a sealing plug. See photo 2.

Photo1: Locking Tabs: squeeze inwards to remove connector

7. Switch on the ignition without cranking the engine and check the warning lights status, including the glow plug if applicable. You should see or hear the REA move to the minimum vane open position.

   Start the engine and watch or listen again for the REA movement. Check again if any warning lights are on, indicating a possible electrical fault.

   Switch the ignition off. The REA should move rapidly to the open vanes position, often with a high-pitched noise. On some applications, the REA may do this two or three times during the shutdown cycle after the engine has stopped. This is the clean the vane path.

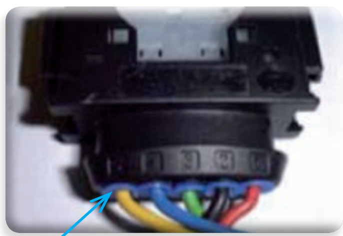

Photo 2: Waterproof seals around the wires

IF ALL TESTS UP TO STEP 7 ARE PASSED, STOP AT THIS POINT AND DIAGNOSE THE VEHICLE SYSTEMS – IT IS UNLIKELY THERE IS A FAULT WITH THE ELECTRONIC ACTUATOR.

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DS083 ISSUE 001 TQA0028

TURBO FAILURE:

EGR VALVE

FACT SHEET 7

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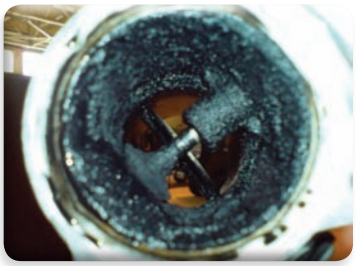
What is the EGR Valve?

The EGR (Exhaust Gas Recirculation) valve directs a small amount of exhaust gases back into the inlet air charge, and lowers the maximum temperature of the burning fuel. The valve ensures the EGR system is disabled at idle, when it would otherwise lead to erratic idling, and at peak power, when adding exhaust gases would reduce power output.

The EGR valve is likely to stick and become coked up on some applications. This can have a significant effect on the performance of the turbocharger.

A faulty EGR valve can result in excessive carbon/soot at the turbine end. This could cause the VNT mechanism to stick.

It is important to check the EGR valve is functioning correctly.



EGR valve which is malfunctioning due to excessive carbon / coke.

EGR valve after cleaning.

If the EGR Valve does not open

- Excessive production of nitrogen oxide Erratic idling or unable to idle
- Poor operation when cold
- Increased fuel consumption
- Lack of performance
- Fault light and/or fault code activated

Possible reasons why the EGR Valve does not open

- EGR valve sticks/gummed up
- Air leak on the vacuum side
- Vacuum connections disconnected, leaking or incorrect
- Faulty electric switch pressure converter valve Non-opening blow-off valve (for turbocharger).

Possible reasons why the EGR Valve does not close

- Heavy deposits on tappet or valve
- EGR valve damaged through overheating, due to:
  - incorrect control
  - high exhaust back pressure
  - non-opening blow-off valve (for turbocharger)
- Air flow meter or other sensor signal faulty
- Intake pipe in the EGR system partly constricted by deposits
- Oil leak from turbocharger

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DS083 ISSUE 001 TQA0028

TURBO FAILURE:

LOOSE IMPELLER LOCKNUT

FACT SHEET 8

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BEFORE YOU FIT A NEW TURBO, FIND OUT WHAT CAUSED THE FIRST UNIT TO FAIL OR YOU RISK THE REPLACEMENT FAILING TOO.

Turbochargers can operate at speeds in excess of 6,000 revs per second (360,000 rpm), with exhaust gases up to 950°C. Each turbocharger is designed and manufactured to rotate at the correct speed for its application.

How the nuts are secured

Most turbochargers are manufactured with shafts that rotate clockwise, and shaft/impeller locknuts that have a left hand thread. Locknuts with left hand threads tend to have a self-tightening effect on the shaft. To understand this, you need to look at the two modes of turbo operation: acceleration and deceleration of the rotating assembly. The acceleration phase has by far the highest torque loading between the turbine wheel (driving) and compressor wheel (driven). During deceleration, the torque loadings are much lower as the turbo slows down.

Impeller nuts with right hand threads are perfectly satisfactory as long as the nut and shaft are in good clean condition and the correct tightening procedures are used.

Manufacturing procedure

Turbo manufacturers use 'Poka Yoke' fail-safe tooling fixtures and procedures to ensure the correct tightening process is carried out, with regular calibration to ensure compliance, and the calibration checked again by external examiners. The tightening procedure is: seating torque, loosen then pre-torque and a final angle of turn to ensure correct compression of joints and shaft 'stretch'.

This painstaking care during manufacture means that a loose impeller nut will almost certainly be due to other causes.

Causes to investigate if the locking nut is loose

- Worn bearings (usually due to oil contamination), allowing the impeller wheel to rub and 'stall' against the housing, loosening the locknut.
- Overspeeding (see our Overspeeding Fact Sheet) causing excessive radial expansion of the impeller wheel but shortening its length. This relaxes the tension on the pilot shaft, and the nut spins off.
- Foreign object damage (see our Impact Damage Fact Sheet) to the compressor and/or turbine wheel, putting it out of balance. This allows it to rub and 'stall' against the housing, loosening the locknut.

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