

# DETROIT DIESEL



## Turbocharger Technician's Guide



***Inspection/Analysis***

***Reusable Parts Guide***

***Troubleshooting***

## WORK SAFELY



### CAUTION:

The service procedures recommended by Detroit Diesel Corporation and described in this Technicians Guide are effective methods of performing service and repairs. Some of these procedures require the use of tools specially designed for this purpose.

Accordingly, anyone who intends to use a replacement part, service procedure or tool which is not recommended by Detroit Diesel Corporation must first determine that neither their safety nor the safe operation of the engine will be jeopardized by the replacement part, service procedure or tool selected.

This Technician's Guide contains various work procedures that must be carefully observed in order to reduce the risk of personal injury during service or repair or the possibility that

improper service or repair may damage the engine or render it unsafe. It is also important to understand that these work procedures are not exhaustive, because it is impossible for Detroit Diesel Corporation to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

A service technician can be severely injured if caught in the pulleys, belts or rotating parts of an engine that is accidentally started. To avoid personal injury, take this precaution before starting to work on an engine:

*Disconnect the battery from the starting system by removing one or both of the battery cables (disconnect negative [ground] cable first). With the electrical circuit disrupted, accidental contact with the starter button will not produce an engine start.*

# SOME SAFETY PRECAUTIONS TO OBSERVE WHEN WORKING ON THE ENGINE

1. Consider the hazards of the job and wear protective gear such as safety glasses, safety shoes, hard hats, hearing protection, etc. to provide adequate protection.
  2. When lifting an engine, make sure the lifting device is fastened securely. Be sure the item to be lifted does not exceed the capacity of the lifting device.
  3. The front engine lifter bracket is not designed to lift more than the basic engine. When lifting with transmission attached, the proper hook points on the engine cradle or mounting rail **must** be used. Do not use the front lifter bracket alone under these circumstances. Failure to observe this precaution can result in personal injury and/or serious damage.
  4. Always use caution when using power tools.
  5. When using compressed air to clean a component, such as flushing a radiator or cleaning an air cleaner element, use a safe amount of air. Recommendations regarding the use of air are indicated throughout the manual. Too much air can rupture or in some other way damage a component and create a hazardous situation that can lead to personal injury. Always wear adequate eye protection (safety glasses, safety face shield) when working with compressed air.
  6. To avoid possible personal injury when working with chemicals, steam and/or hot water, wear adequate protective clothing (face shield, rubber apron, gloves, boots, etc.) work in a well ventilated area, and exercise caution
  7. Avoid the use of carbon tetrachloride, carbon dissolved, methylene, chloride, perchloroethylene and trichloroethylene as cleaning agents because of harmful vapors they release. Use 1.1.1-trichloroethane. However, while less toxic than other chlorinated solvents, use it with caution. Be sure the work area is adequately ventilated and wear protective gloves, goggles or face shield and an apron. Follow chemical manufacturer's use and safety recommendations.
- Mineral spirits or mineral spirits based solvents are highly flammable. They must be stored and used in "No Smoking" areas away from sparks and open flames.**
8. Do not weld on or near the diesel fuel tank until it has been thoroughly emptied and ventilated. Possible explosion could result if this precaution is not taken.
  9. Failure to inspect parts thoroughly before installation, failure to install the proper parts, or failure to install parts properly can result in component or engine malfunction and/or damage and may also result in personal injury.
  10. When working on an engine that is running, accidental contact with the hot exhaust manifold or catalytic converter can cause severe burns. Remain alert to the location of the rotating fan, pulleys and belts. Avoid making contact across the two terminals of a battery which can result in severe arcing.
  11. Turbocharger air inlet shield - If operation of the turbocharger is necessary without normal piping, use turbocharger air inlet shield.

# Contents

	Page
INTRODUCTION .....	2
SAFETY .....	2
LUBRICATION .....	2
OPERATION .....	3
MAINTENANCE .....	4
INSPECTION .....	5
FAILURES .....	6
1. TURBINE WHEEL AND SHAFT ASSEMBLY .....	7
Nomenclature	
Turbine Wheel Blades	
Turbine Wheel Back Face	
Oil Seal Ring Groove	
Bearing Journals	
2. TURBINE (EXHAUST) HOUSING .....	12
Nomenclature	
Bolts	
Contour Bore	
3. COMPRESSOR WHEEL .....	15
Nomenclature	
Blades	
Nut Face	
Back Face	
Bore	
4. COMPRESSOR HOUSING .....	19
Nomenclature	
Contour Bore	
O-Ring Bore	
5. CENTER HOUSING .....	21
Nomenclature	
Thrust Bearing	
Thrust Spacer	
Bearing Bore	
Thrust Plate	
6. TROUBLESHOOTING GUIDE .....	28
Troubleshooting - Bearings	
Troubleshooting - Operational	

**NOTE:**

This technician's guide is intended for use by a technician who is skilled in diagnosis and repair of turbochargers. Contact an authorized Detroit Diesel service outlet for further information or clarification if required.

# TURBOCHARGER INTRODUCTION

There are five reasons why a turbocharger will quit performing.

1. Lack of lubrication.
2. Foreign material in the exhaust or inlet air supply.
3. Contaminated lube oil.
4. Defects in manufacture/workmanship.
5. Operating outside of design speed range. If any of the above situations occur prior to replacement, the main reason for deterioration must be fully understood and the condition corrected.

Failure to correct any of these reasons for turbocharger failure will result in repeated occurrences.

Turbochargers will operate for many trouble free hours or miles without any major wear or deterioration occurring, providing good, clean air and lubrication are supplied to the turbocharger. Clean air and lubrication are the two items that have always provided for long engine life. Assuring yourself that these two systems are being maintained will be beneficial in the extended operation of turbocharged diesel engines.

Experience has indicated that if the turbocharger becomes inoperative due to lack of lubrication, diluted lubrication or contaminated lubrication or from foreign objects on either side of the turbocharger, very few parts can be reused. Any parts being considered for reuse should be properly inspected, using procedures outlined in Detroit Diesel service manuals or turbocharger manufacturer's recommendations.

## SAFETY



### CAUTION:

Turbochargers generate high operating temperatures and speeds which could cause personal injury. Also, there are high pressures at the compressor outlet and a high vacuum at compressor inlet.



### CAUTION:

Operation of the turbocharger without all normally installed inlet piping and filters, along with exhaust piping, can result in injury to personnel and damage to equipment from foreign objects entering the turbocharger.

If operation of the turbocharger is necessary for tune-up without normal piping, use Turbocharger Air Inlet Shield J-26554A. Some turbochargers are equipped with permanently installed shield that should **never** be removed. (Obtainable from Detroit Diesel authorized outlet.)



### Notice:

Engine oil pressure provides lubrication and cooling to the rotating components of the turbocharger. If oil pressure for any reason is lost or restricted, serious damage will occur immediately to the shaft and full floating bearing.

## LUBRICATION

If oil gage pressure is lost or oil warning light comes on, shut down the engine as soon as possible. On most applications, oil pressure is supplied with an external oil line from the main oil gallery and returned to the crankcase in the same manner. Some turbocharged engines return oil to the crankcase via a cast-in return passage in the adaptor that the turbocharger is mounted on. It is important that this return oil flows freely to prevent overheating of the turbocharger.

## Hot Shutdown

When an engine operating under full load is shut down without a short idle period, the heat of operation is not dissipated and all parts remain **extremely hot**. Oil films can be destroyed under this condition and, when the engine is started, considerable wear can take place before lubrication is sufficient. Extreme heat in the turbocharger can warp shafts and bores, making repair difficult. The bearings in the turbocharger are especially likely to be damaged.

# TURBOCHARGER OPERATION

## How a Turbocharger Works

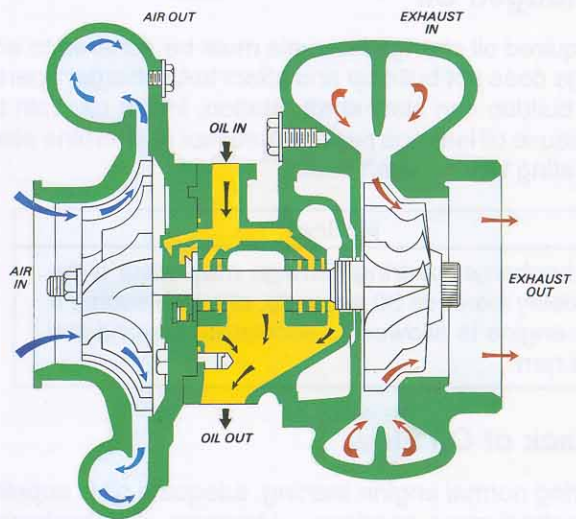
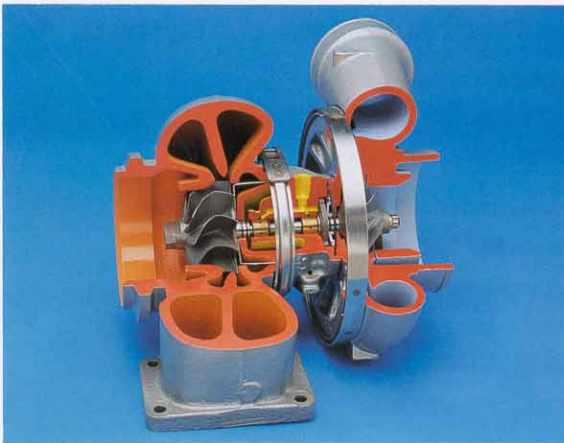
The heat energy and pressure in the engine exhaust gas is utilized to drive the turbine wheel. The speed of the rotating assembly and output of the compressor wheel is controlled by the design and sizing of the turbine housing. The housing acts as a nozzle to direct the exhaust gas flow to the turbine wheel blades which, in turn, drive the compressor. Clean air from the air cleaner is drawn into the compressor housing and wheel where it is compressed and delivered to the charged air cooler and then to the engine air intake manifold. The amount of air pressure rise and air volume delivered to the engine from the compressor outlet is determined by wheel size, housing size, and performance matching of the turbocharger to a given engine. Each engine size must be properly matched.

## What a Turbocharger Does

There are a number of benefits to be gained by turbocharging a diesel engine because the turbocharger delivers an abundance of compressed air to the engine. Combustion of the fuel is more complete, resulting in cleaner exhaust. The positive air pressure head (above atmospheric pressure) that is maintained in the engine intake manifold benefits the engine in several ways. During engine valve overlap (before intake stroke starts on four-cycle engines), clean air is pushed across the combustion chamber, scavenging all remaining burning gases, cooling cylinder heads, pistons, valves and exhaust gas. The cleaner burning of the fuel plus the engine cooling which results help to extend engine life.

Many turbochargers are used primarily for what is called normalizing or altitude compensating of a naturally aspirated engine. By this we mean that an engine and turbocharger are matched to give only a mild boost of air pressure to improve combustion, reduce smoke, and give a moderate power increase with no increase in fuel delivery.

It is possible to safely increase power output of some engines by as much as 40% to 50% with the correct selection and/or matching of a turbocharger. Care must be exercised to select exactly the right turbocharger and engine fuel settings, since the turbocharger has air delivery and pressure capabilities that could exceed engine tolerances. Failure to exercise proper care can result in engine overheating, excessive combustion chamber firing pressure and increased temperatures, which have detrimental effects on engine life. These conditions can cause deterioration of engine components, such as cracked heads, scored pistons and liners, blown head gaskets, damaged bearings, malfunctioning turbocharger, etc. Changing the engine fuel delivery schedule in the field on any turbocharged engine should only be made by following Detroit Diesel's recommendation, and procedures.



# TURBOCHARGER PROBLEMS RESULTING FROM LACK OF MAINTENANCE

To obtain good service life and efficient performance of the turbocharger, always observe good maintenance practices.

**Air and oil filtration** - are the most important areas for maintaining the turbocharger. The majority of inoperative turbochargers are caused by:

1. Dirt in the oil
2. Sludged oil
3. Oil lag/lack of good oil flow
4. Foreign objects or material entering the turbocharger
5. Plugged or restricted air inlet system
6. Contaminated oil or use of improperly formulated oil

## 1. Dirt in the Oil

Dirt or other contaminants introduced into the turbocharger bearing system create wear, primarily on journal bearing surfaces and the bearing center housing bore surface. Turbocharger and engine performance can quickly deteriorate, resulting in engine power loss, excessive smoke, noise, or turbocharger oil seal leaks.

## 2. Sludged Oil

Required oil change intervals must be adhered to so that sludge does not build up and affect turbocharger operation. This buildup can slow shaft rotation, inhibit oil drain back, and cause oil leakage past compressor and turbine seals by unseating turbine shaft seals.

<p><b>Notice:</b></p> <p>Turbocharger bearing damage may occur if the oil delay exceeds 30 seconds, or much sooner if the engine is allowed to accelerate beyond low idle rpm.</p>
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## 3. Lack of Oil Flow

During normal engine starting, adequate oil is supplied to the turbocharger bearings. However, a turbocharger is

more sensitive to a limited oil supply than an engine because of the high rotational speed of the shaft.

Low oil pressure and/or flow lag during engine starting can have destructive effects on the turbocharger bearings. Use care when starting the engine after oil/filter change or extended storage. During normal engine starting, this should not be a concern.

## 4. Foreign Objects or Material Entering the Turbocharger

Dust, sand or dirt, etc., entering the turbocharger compressor housing from a leaky air inlet system or inadequate air cleaner can erode the compressor wheel blades and significantly reduce turbocharger and engine performance. Uneven wear of compressor wheel blades can cause shaft motion (imbalance) that will eventually damage the turbocharger shaft bearings. Entrance of large or heavy objects (bolts, nuts, rocks, tools, etc.) will completely destroy the turbocharger, possibly causing severe damage to the engine.

## 5. Plugged or Restricted Air Inlet System

Plugged or restricted air inlet systems are the result of poor maintenance procedures and will reduce air flow rate at the compressor air inlet. This may cause:

- A. Loss of turbocharger performance
- B. High exhaust and engine temperature
- C. Black smoke
- D. Compressor and/or turbine oil seal leaks
- E. Compressor surge

Proper servicing of the air inlet system can prevent and correct the above conditions.

## 6. Contaminated Oil or Use of Improperly Formulated Oil

Proper care should be given when oil is added, that it meets the Detroit Diesel requirements and that the source of the oil is known.

# INSPECTION AND ANALYSIS COMPRESSOR WHEEL AND BACK PLATE

Be aware that faulty or improperly maintained air system hose connections can cause oil leaks. There have been cases in which a compressor outlet hose came loose and the resulting sudden air pressure drop allowed oil to leak past the turbocharger seal and enter the compressor. The compressor

components can become oily and dirty and give the turbocharger the appearance that it has failed, when in fact the turbocharger is still functional. Photographs provided show examples of typical oil leakage that is considered acceptable.



# TURBOCHARGER FAILURES

A low power complaint or oil leakage found in the turbocharger housings can be the result of a number of factors. Locate the problem in the engine or support system and repair it, and then bring the turbocharger up to temperature.

The following list gives some possible causes for wetness.

1. Excessive idle.
2. Engine oil ingestion.
3. High crankcase pressure.
4. Dirty air cleaner.
5. Restricted turbocharger oil drain.
6. Sudden drop in compressor inlet air pressure.

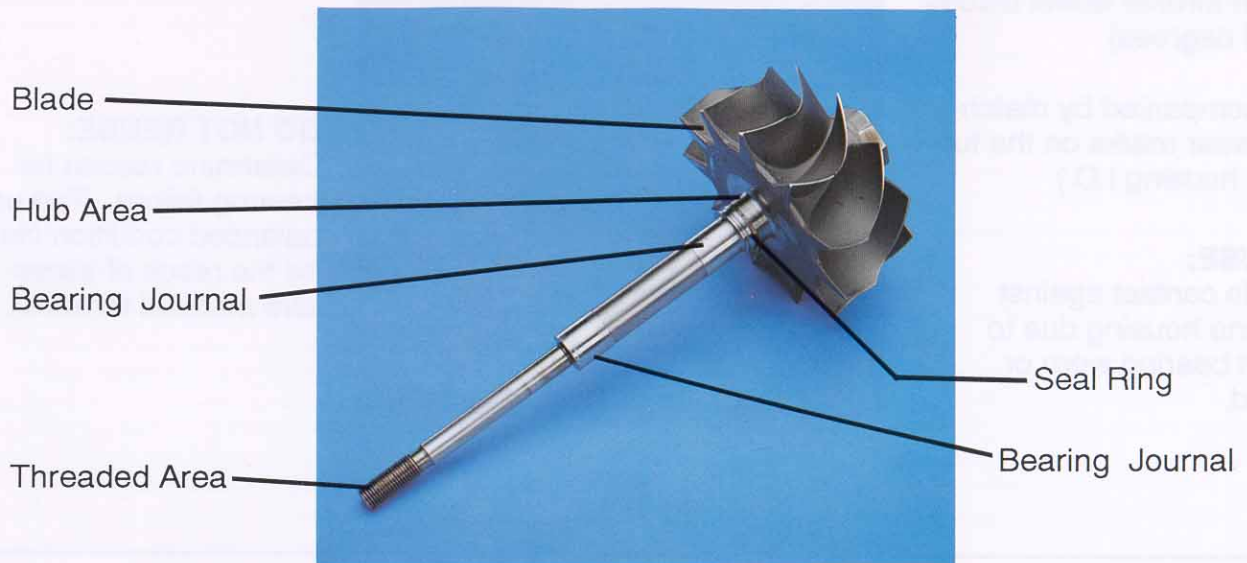
The following list provides reasons for pressure drop at the inlet or exhaust side of the turbocharger that allows oil to push past the seals.

1. Blown air discharge hose.
2. Blown charge air cooler hose.
3. Restricted air inlet (plugged cleaner).
4. High or low exhaust back pressure.
5. Faulty oil pressure regulator.

In addition to these items, debris from a failed turbocharger can become lodged temporarily in the exhaust and muffler system, particularly in installations with vertical exhaust systems. This debris must be removed prior to installing a replacement turbocharger. This will prevent another failure caused by debris dropping back into the turbocharger wheel once the engine is restarted and operated. It may be necessary to replace the muffler if the debris cannot be removed.

# INSPECTION AND ANALYSIS TURBINE WHEEL AND SHAFT ASSEMBLY

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# INSPECTION AND ANALYSIS

## TURBINE WHEEL AND SHAFT ASSEMBLY

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**CONDITION:**

Worn turbine wheel blades  
(360 degrees)

(Accompanied by matching wear marks on the turbine housing I.D.)

**CAUSE:**

Blade contact against turbine housing due to shaft bearing worn or failed.



**RECOMMENDATION:**

**DO NOT REUSE:**

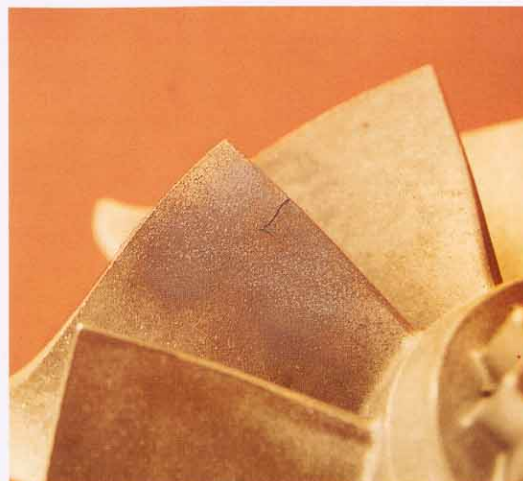
Determine reason for bearing failure. The unbalanced condition can be the result of excessive material removal.

**CONDITION:**

Cracked turbine blade  
(minor damage shown).

**CAUSE:**

Foreign debris in exhaust system.



**RECOMMENDATION:**

**DO NOT REUSE:**

Further examination of the engine is required to determine the cause of the debris and eliminate it.

# INSPECTION AND ANALYSIS TURBINE WHEEL AND SHAFT ASSEMBLY

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**CONDITION:**

Damaged turbine blades  
(major damage shown)

**CAUSE:**

Foreign objects from engine, such as pieces of valves or broken piston rings.



**RECOMMENDATION:**

**DO NOT REUSE:**

Determine the reason for foreign objects entering the turbocharger before replacement with a new assembly.

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**CONDITION:**

Turbine wheel back-side damage. Broken shaft shown.

**CAUSE:**

Foreign object damage causing an imbalance.



**RECOMMENDATION:**

**DO NOT REUSE:**

Determine the initial cause of damage. Repair or replace the turbocharger or part(s). Bearings should be pre-lubed during assembly. Wait for oil pressure to be observed after starting.

# INSPECTION AND ANALYSIS

## TURBINE WHEEL AND SHAFT ASSEMBLY

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**CONDITION:**

Excessive oil consumption

**CAUSE:**

Worn, broken, or missing seal ring



**RECOMMENDATION:**

**DO NOT REUSE:**

Replace and examine other components during rebuild.

**CONDITION:**

Worn shaft journals

**CAUSE:**

Contaminated lubricating oil, overspeed, overheat, rotating imbalance or normal wear.



**RECOMMENDATION:**

**DO NOT REUSE:**

Determine the cause of contaminated oil, such as fuel dilution or extended oil change intervals.

# INSPECTION AND ANALYSIS TURBINE WHEEL AND SHAFT ASSEMBLY

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## CONDITION:

Turbine wheel/shaft assembly broken, scored and discolored

## CAUSE:

Lack of lubrication to turbine bearing and shaft journal surface.

**Note:** Exhaust side is more sensitive to lubrication and cooling requirements due to abnormally high operating temperatures or turbocharger overspeed.



## RECOMMENDATION:

### DO NOT REUSE:

Replace turbine wheel/shaft assembly. If center housing is qualified for reuse, make certain oil passages are clean and unrestricted.

## CONDITION:

Turbine wheel back face cracked

## CAUSE:

Excessive exhaust back pressure resulting in high exhaust temperature. Examine other engine components for cause of high exhaust back pressure.



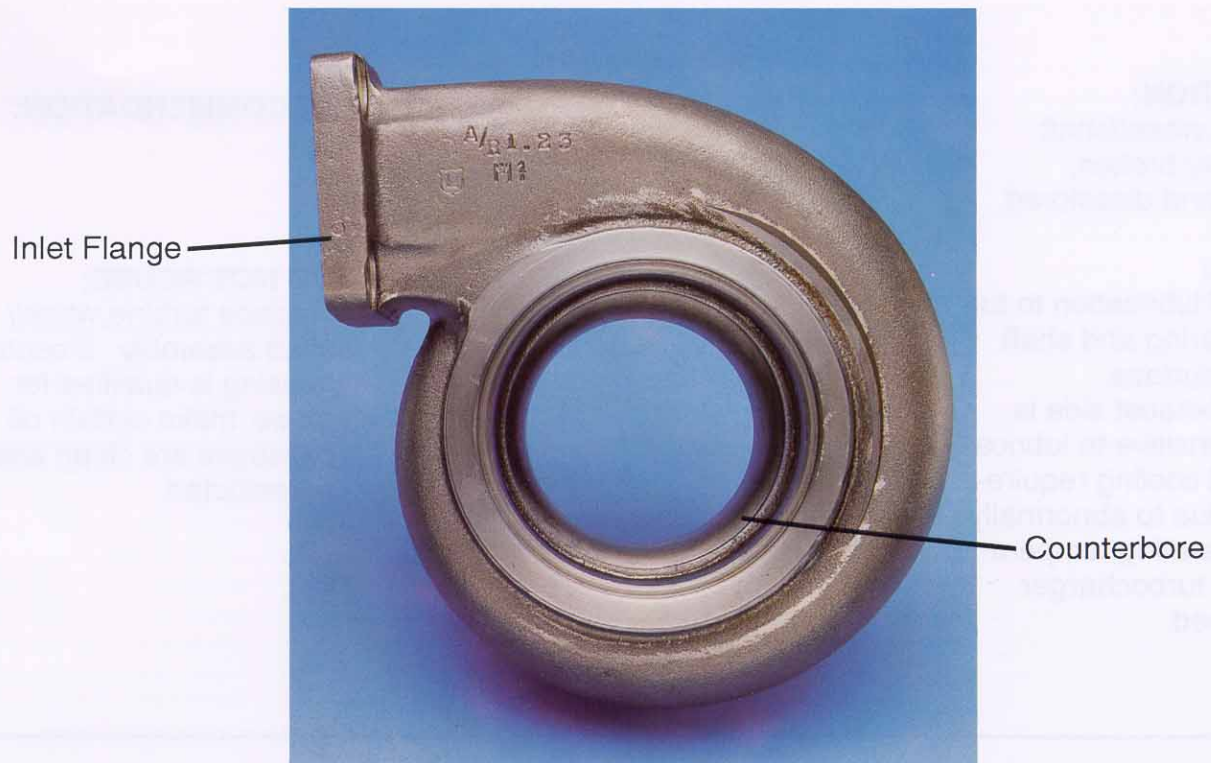
## RECOMMENDATION:

### DO NOT REUSE:

Check exhaust and intake restriction according to manufacturer's specification.

# INSPECTION AND ANALYSIS TURBINE (EXHAUST) HOUSING

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# INSPECTION AND ANALYSIS TURBINE HOUSING

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**CONDITION:**

Broken bolts in turbine housing

**CAUSE:**

Excessive torque on bolts or incorrect tensile strength bolts used.



**RECOMMENDATION:**

**REUSE AFTER THE BROKEN BOLTS ARE PROPERLY REMOVED FROM THE HOUSING:**

If the threads are damaged, repair with thread inserts and replace all of the bolts with new bolts.

**CONDITION:**

Turbine housing contact from turbine blades accompanied by wear on turbine wheel O.D.

**CAUSE:**

Blade/housing contact due to worn or failed shaft bearing.



**RECOMMENDATION:**

**REUSE:**

If scoring is light, it may be possible to stone smooth. If not, replace the housing.

# INSPECTION AND ANALYSIS TURBINE HOUSING

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**CONDITION:**

Turbine housing cracked

**CAUSE:**

High exhaust temperature, material defect or mechanical damage.



**RECOMMENDATION:**

**REUSE:**

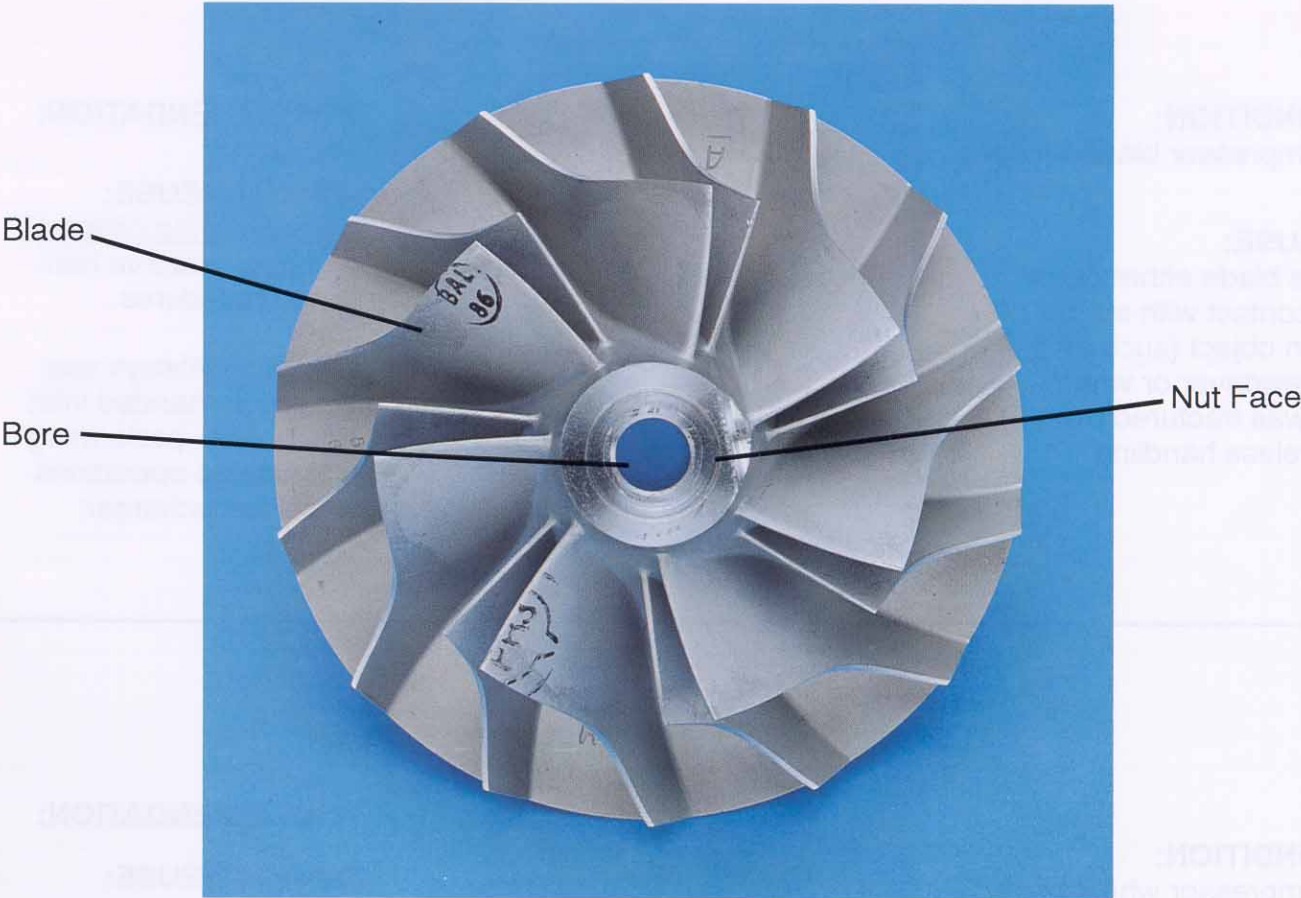
If crack does not extend to outside of housing.

Determine if high exhaust back pressure or air intake restriction has occurred prior to the replacement of a new turbocharger assembly.

If two cracks are intersecting, **do not reuse**.

# INSPECTION AND ANALYSIS COMPRESSOR WHEEL

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# INSPECTION AND ANALYSIS COMPRESSOR WHEEL

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**CONDITION:**

Compressor blade broken

**CAUSE:**

The blade either came in contact with a foreign object (such as a screwdriver or wrench) or was fractured from careless handling.



**RECOMMENDATION:**

**DO NOT REUSE:**

Determine the cause of damage, observe handling procedures.

**Caution** - Always use the recommended inlet guard while performing any service operations to the turbocharger.

**CONDITION:**

Compressor wheel blades bent.

**CAUSE:**

Ingestion of soft material, such as rubber booting or shop towels.



**RECOMMENDATION:**

**DO NOT REUSE:**

Investigate the reason for the entrance of foreign material into the compressor inlet.

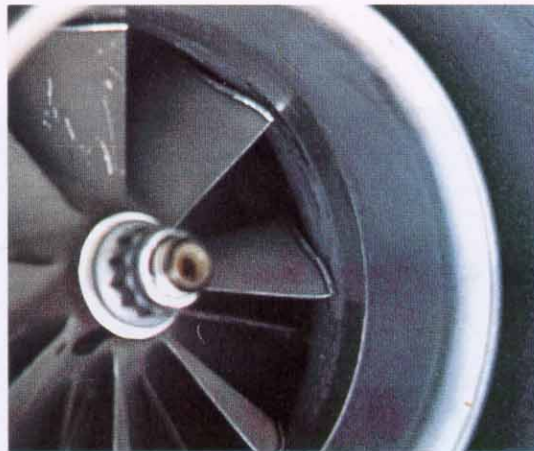
**Caution** - Always use the recommended inlet guard while performing any service operations to the turbocharger.

# INSPECTION AND ANALYSIS COMPRESSOR WHEEL

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**CONDITION:**  
Compressor wheel  
rubbing

**CAUSE:**  
Worn shaft bearings or  
thrust washer.



**RECOMMENDATION:**

**DO NOT REUSE:**  
Worn parts must be re-  
placed and cause of wear  
eliminated.

**CONDITION:**  
Compressor wheel spun  
on shaft

**CAUSE:**  
Loose compressor  
wheel lock nut from  
improper assembly.



**RECOMMENDATION:**

**DO NOT REUSE:**  
Review proper assembly  
technique as outlined in  
the service manual.

**Note** - Never reuse  
compressor wheel lock  
nuts.

# INSPECTION AND ANALYSIS COMPRESSOR WHEEL

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## CONDITION:

Compressor wheel damaged from foreign object

## CAUSE:

A foreign object entered the air intake system.

Some possibilities of entry are:

- a) foreign object was left in the duct work.
- b) foreign object was dropped in during assembly or disassembly.
- c) foreign object broke loose from the air intake components.



## RECOMMENDATION:

### DO NOT REUSE:

Determine the cause of entry of foreign objects into the system. Determine possible secondary damage to the engine components.

## CONDITION:

Compressor wheel worn from dirt ingestion

## CAUSE:

Air inlet system leaking, hole in air cleaner element or improper element.



## RECOMMENDATION:

### DO NOT REUSE:

A complete review of the application's air intake system should be performed. Air inlet adaptors, duct work and air cleaners **must** be inspected for the source of dirt entry.

# INSPECTION AND ANALYSIS

## COMPRESSOR HOUSING

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# INSPECTION AND ANALYSIS

## COMPRESSOR HOUSING

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### CONDITION:

Compressor wheel comes in contact with compressor housing

### CAUSE:

Any contact of the compressor contour is similar to the contact on the turbine housing and results from worn or failed shaft bearings.



### RECOMMENDATION:

#### DO NOT REUSE:

If wheel is making contact on only one side, either bent shaft or imbalance. Be sure to determine primary cause before replacement of the turbocharger.

### CONDITION:

Compressor wheel contact at only one location on the housing.

### CAUSE:

During assembly of the turbocharger to the engine, the clamp which secures the compressor housing to the center section was not properly positioned.



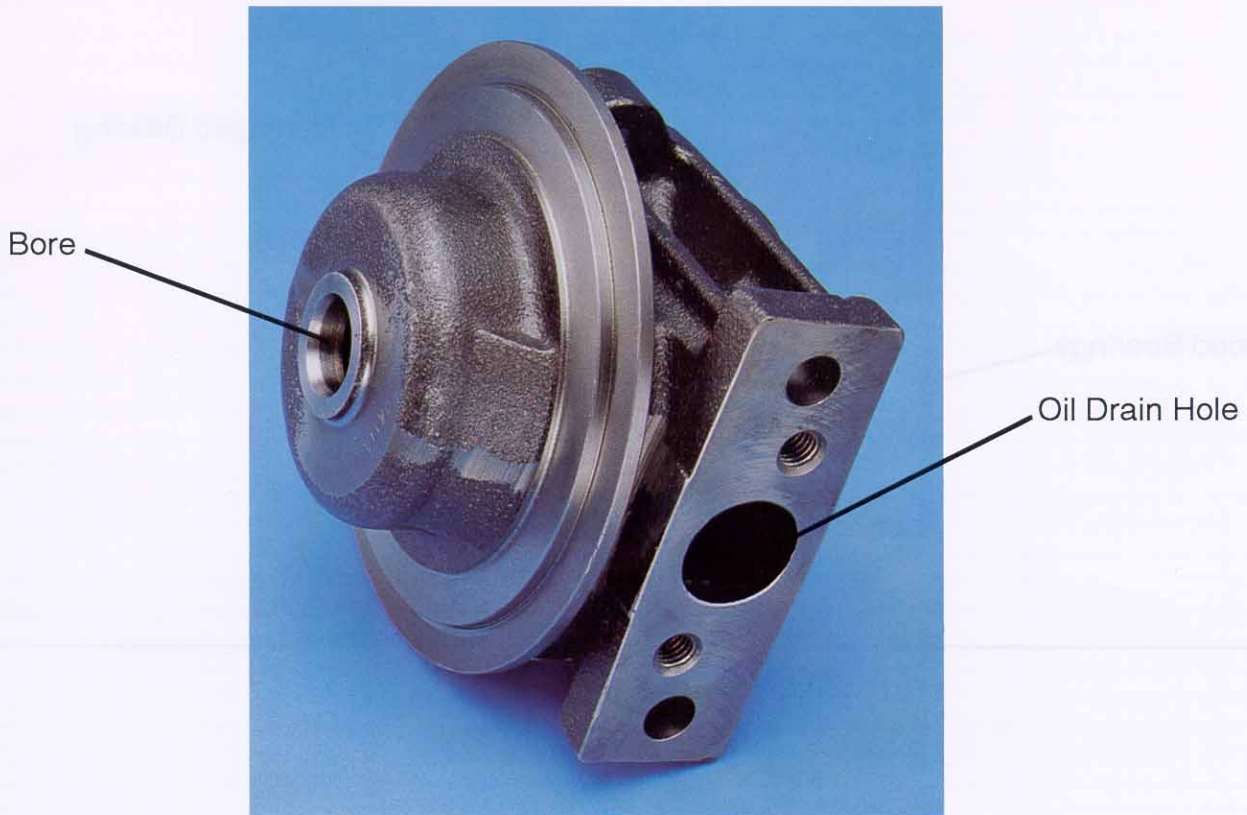
### RECOMMENDATION:

#### DO NOT REUSE:

Prior to installing any turbocharger to an engine, be sure that the housing is properly seated and the clamp is tightened to the torque specification in the service manual.

# INSPECTION AND ANALYSIS CENTER HOUSING

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# INSPECTION AND ANALYSIS CENTER HOUSING

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## CONDITION:

Shaft bearings worn from contaminants in the lubricating oil.

## CAUSE:

Poor add oil procedures - extended oil/filter change intervals.



## RECOMMENDATION:

### DO NOT REUSE:

To minimize wear rates and maximize component life, use recommended engine lube oil, maintain proper oil level and follow recommended schedule for oil and oil filter changes.

# INSPECTION AND ANALYSIS CENTER HOUSING

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**CONDITION:**

Thrust bearing worn from contaminants of fine abrasives in the lubricating oil.

**CAUSE:**

Poor fill procedures - extended oil/filter change intervals



**RECOMMENDATION:**

**DO NOT REUSE:**

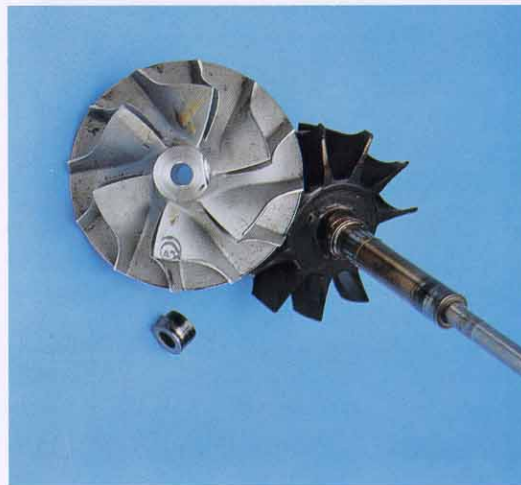
To minimize wear rates and maximize component life, use recommended engine lube oil, maintain proper oil level and follow recommended schedule for oil and oil filter changes.

**CONDITION:**

Noisy, lack of power

**CAUSE:**

Lack of lubrication to the shaft bearings and journals. This creates an imbalance with both wheels contacting the housing.



**RECOMMENDATION:**

**DO NOT REUSE:**

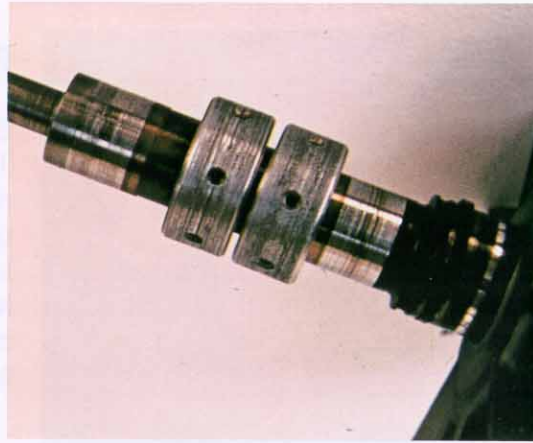
Determine what caused the lack of lubricant before replacing the turbo-charger.

# INSPECTION AND ANALYSIS CENTER HOUSING

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**CONDITION:**  
Driver abuse

**CAUSE:**  
Repeat shutdown of engine from high RPM operation without proper cool-down period.



**RECOMMENDATION:**

**DO NOT REUSE:**  
Reuse of this part may contribute to bearing or shaft failure in the near future. Reevaluate operating procedures.

**CONDITION:**  
Turbocharger bearings discolored

**CAUSE:**  
Coolant in lubricating oil (contaminated lube)



**RECOMMENDATION:**

**DO NOT REUSE:**  
Find the cause for coolant contamination. May have been a previous failure. An oil analysis may be required.

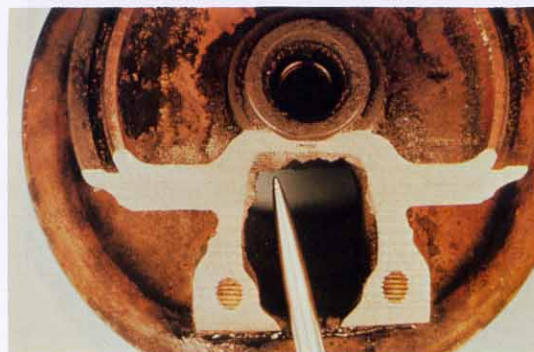
# INSPECTION AND ANALYSIS CENTER HOUSING

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**CONDITION:**  
Heavy sludge  
accumulation

**CAUSE:**  
Improper shutdown  
procedures - worn or  
broken seal ring on  
turbine shaft or oil  
drain restricted.



**RECOMMENDATION:**

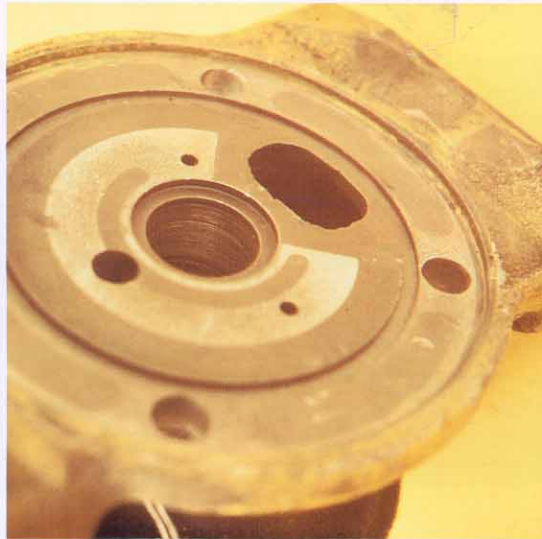
**REUSE ONLY AFTER  
PROPER CLEANING  
AND INSPECTION:**  
Instruct user on proper  
shutdown procedures.  
Replace seal ring.

# INSPECTION AND ANALYSIS CENTER HOUSING

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**CONDITION:**  
Bearing journal bores  
damaged

**CAUSE:**  
Lack of lubrication or  
restricted lubrication



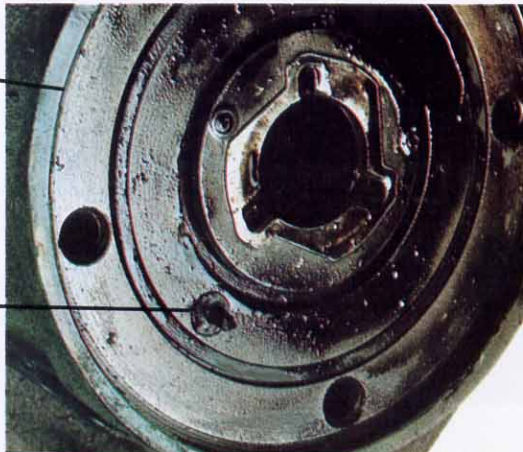
**RECOMMENDATION:**

**DO NOT REUSE:**  
Determine the cause of  
lack of lubrication or  
restricted lubrication to  
the turbocharger.

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Center Housing

Foreign Material



# INSPECTION AND ANALYSIS CENTER HOUSING

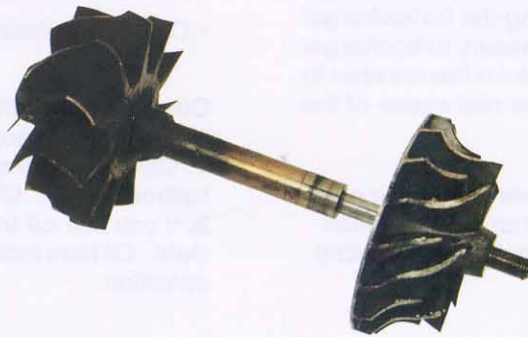
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**CONDITION:**

Turbocharger seized

**CAUSE:**

Lack of lubrication to the shaft bushings and journals due to foreign material in oil passage in the center housing.



**RECOMMENDATION:**

**DO NOT REUSE:**

Determine the cause of restriction of oil to the bushing. Example shown: a piece of debris entered the lubrication system, blocking the oil flow.

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**CONDITION:**

Compressor seal faces worn

**CAUSE:**

Usually related to bearing damage and also considered secondary damage caused by bearing damage.



**RECOMMENDATION:**

**DO NOT REUSE:**

Determine the cause of bearing damage.

# TURBOCHARGER TROUBLESHOOTING

A GUIDE TO FINDING THE CAUSE

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**It is not always the fault of the turbocharger.** Don't respond to a low power, black smoke, or oil consumption condition by immediately removing the turbocharger. You may be too hasty - often the condition is turbocharger related, but other outside factors can create the same symptoms as a faulty turbocharger, causing the turbocharger to leak oil or make noise. Save unnecessary turbocharger repair or replacement expense and take a few minutes to "troubleshoot" the system. Locate the real cause of the condition.

## **Listen, Look and Feel:**

The most useful troubleshooting knowledge is your own understanding of the turbocharger unit and your familiarity with it. Just follow this three-part method for locating the condition.

## **STEP 1. LISTEN**

**Listen** to identify certain conditions. Listen to the sound the turbocharger makes. After you have worked with turbocharged equipment for a while, you will know the sound of a normal, smoothly running turbocharger. Listen to the turbocharger - does it sound normal? If not, check the following guide:

- A high-pitched whine may indicate an exhaust leak or a leak in the air induction system.
- A cycling up and down in pitch often indicates a blockage in the air inlet duct, a restricted air cleaner, or a build-up of dirt on the compressor wheel or diffuser vanes of the turbocharger.
- A sharp, high-pitched scream may indicate that the bearings have deteriorated and one (or both) of the wheels is rubbing on its housing.

## **STEP 2. LOOK (engine stopped)**

**Look** at the turbocharger. Use your sight to locate possible condition, such as;

### **Condition A - Blade Damage**

- Look at the wheels. Remove the exhaust pipe from the turbine outlet and the air intake pipe from the compressor outlet. Use a flashlight and check for rub marks on wheels or housings.
- Look for signs of blade damage from foreign objects.

### **Condition B - Dirt, Coke and Carbon Deposits**

- Look at the compressor wheel. Check for build-up of dirt.
- Look at the turbine wheel. Check for heavy deposits of coke or carbon.
- Check for missing blades.

### **Condition C - Oil Build Up**

- If you see heavy accumulation of oil, locate the source.
- 1. Oil in the compressor inlet is not coming from the turbocharger. Check the vehicle air compressor.**
  - If you see **oil in the turbine**, check the **exhaust manifold**. Oil here indicates an engine fault, not a turbocharger condition.

### **Condition D - Oil Leaks**

Oil leaks into the turbine housing are a common occurrence. Turbochargers do not generally use mechanical oil seals (rings in turbochargers seal against gas leakage, like compression rings in an engine), so a "faulty seal" is not the most common cause of turbocharger oil leaks. Because of the high temperature and high speeds at which turbochargers run, oil sealing is dynamic (uses oil slingers) unlike the seals you see in lower speed equipment.

Listed below are the most common causes of turbocharger oil leaks.

1. Too much idling of the engine.
2. Obstructed air intake ducting or clogged air filter.
3. Plugged or kinked oil drain line from turbocharger.
4. Plugged crankcase vent.
5. High engine crankcase pressure.
6. Sludged oil accumulation in turbocharger center housing.
7. Damage to turbocharger bearings or wheel.

# TURBOCHARGERS TROUBLESHOOTING

## A GUIDE TO FINDING THE CAUSE

The above items will give a good, quick indication of the turbocharger condition and can save time. Using this method of checking helps prevent unnecessary turbocharger removal and replacement.

### Correct the above conditions

1. If you see a heavy build-up of carbon, **clean the wheel with a non corrosive cleaning solvent and a soft bristle brush.**

### NOTICE:

Do not use a wire brush, screwdriver, or other metallic instrument. These can scratch or nick the turbine blades.

### Cleaning Procedure

- Remove the end housing(s) so you can clean evenly all around the wheel.
  - Be sure to **clean evenly** - uneven cleaning can cause an imbalance condition and be worse than no cleaning at all.
  - Stubborn carbon build-up can be removed with a hard-wood scraper.
2. If you found evidence of an oil leak from the turbocharger, **DON'T REMOVE IT YET.**
  3. If there is damage to the blade or rub marks on the housings, replace the turbocharger or overhaul it.



### CAUTION:

**TO AVOID BEING BURNED, MAKE SURE ENGINE IS NOT RUNNING AND THE TURBINE HAS STOPPED ROTATING AND COOLED DOWN BEFORE FEELING ANY OF THE COMPONENTS OF THE TURBOCHARGER.**

### STEP 3. FEEL

**After you have made sure the engine is off and disabled, feel** how the turbocharger rotates when you turn it by hand, if:

1. You found no visible defects in the turbocharger
  2. Or you saw oil leakage that could have come from the turbocharger. Make this check before you remove the turbo.
    - First, rotate the turbine wheel by hand. It should turn smoothly and freely with no signs of binding or scraping.
    - Next push inward on the turbine wheel as you turn it by hand. Again, it should turn freely.
    - Finally, pull outward on the turbine wheel as you turn it, and check for rubbing and scraping.
    - If the turbocharger does not move freely, remove it, correct any faults that could harm the replacement turbocharger, and install the replacement unit.
- a) Remember to pre-lube the replacement turbocharger, shaft and bearings.
  - b) Check the intake and exhaust ducting for foreign material before installing the turbocharger.
  - c) Thoroughly check the oil return, crankcase ventilation system, oil feed lines to the turbocharger, and air filter/induction ducting. A few minutes spent now preventing a future condition could save hours of repair time later.

# TURBOCHARGER TROUBLESHOOTING

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## GLOSSARY OF TERMS

**ALIGNMENT** - Proper position of parts.  
**BURR** - Sharp, jagged, uneven metal surface.  
**COLD END** - Compressor end of turbocharger (air)  
**CONTAINER** - A box used to hold material.  
**DISCOLORATION** - Change in color.  
**DISSIPATED** - Dispersing or dispelling of heat.  
**DO NOT REUSE** - Excessive damage has occurred. Part requires replacement or possible remanufacturing.  
**EROSION** - Gradual wear of material.  
**EXCESSIVE** - Too much.  
**GLASS BEADING** - Procedure used to clean parts where air under pressure is used to force small glass particles at a high rate of speed against the surface of the part.  
**HOT SIDE** - Turbine side of turbocharger (exhaust)

**HOT SHUTDOWN** - Shutdown at high rpm will allow the turbocharger to continue spinning after the lubricant supply from the oil pump has stopped. Bearings will not be adequately lubricated or cooled.  
**NICK** - Small notch.  
**PITTING** - Wear or erosion that causes indentation in surface material.  
**POLISH** - To clean and smooth the surface.  
**REUSE** - Parts that require inspection and reconditioning according to published specifications.  
**ROTATING UNIT** - Compressor wheel-shaft-turbine assembly.  
**RUBBING** - Contact between two parts.  
**SEVERELY** - To a large degree.  
**SLIGHTLY** - Fine markings.  
**WARP** - To twist or bend out of shape.



# TURBOCHARGER TROUBLESHOOTING

(BEARINGS)

<b>APPEARANCE OF BEARING</b> Slight wear or scratches Moderate to heavy grooving Extruded or pounded Smooth underside O.D. Cracked or broken Deep groove Oil holes around center of O.D. Oil holes fully or partially closed Polished looking O.D. I.D. polished with carbon Melted (aluminum bearing)											CONDITION	PROBABLE CAUSE
•											Normal Use	Acceptable operating and maintenance procedures.
•	•	•	•	•	•	•	•	•	•	•	Contaminated oil (dirt in oil) Fine particles in oil (contaminated oil) Severely contaminated (dirty oil)	Engine oil and oil filter(s) not changed frequently enough, unfiltered air entering engine intake, malfunction of oil filter bypass valve. Also, remote-mounted oil filter plumbing incorrectly installed.
			•	•	•						Pounded by eccentric shaft motion	Foreign object damage to rotating wheels, coked or loose housing, excessive bearing clearance due to lube problems.
			•							•	Center housing bearing bores rough finish	Incorrect cleaning of center housing during overhaul of turbocharger. (Wrong chemicals cleaners or glass beading).
						•					Metal or large particle oil contamination	Severe engine wear, i.e., Bearing damage, camshaft or lifter wear, broken piston.
							•			•	Lack of lubrication, oil lag, insufficient lubrication	Low oil level, high speed shutdowns, lubrication system failure. Extended oil drain intervals.
								•			Coking	Hot shutdowns, engine overfueled, restricted or leaking air intake/inlet. Also retarded injector timing.
										•	Rough bearing journals on shaft	Bearing journals not protected from sand or glass beading during overhaul.

# TURBOCHARGER TROUBLESHOOTING

(OPERATIONAL)

CONDITION								CAUSE	CORRECTION	
Engine lacks power	Black exhaust smoke	Excessive engine oil consumption	Blue exhaust smoke	Turbocharger noisy	Cyclic sound from turbocharger	Oil leak from compressor seal	Oil leak from turbine seal			
•	•	•	•	•				•	Clogged air cleaner element	Replace element according to engine service manual recommendations
•	•	•	•	•	•	•			Obstructed air intake duct to turbocharger compressor	Remove obstruction or replace damaged parts as required
•	•			•					Obstructed air outlet duct from compressor to intake/manifold	Remove obstruction or replace damaged parts as required
•	•			•					Obstructed intake/manifold	Refer to engine service manual and remove obstruction
				•					Air leak in duct from air cleaner to compressor	Correct leak by replacing seals or tightening fasteners as required
•	•	•	•	•					Air leak in duct from compressor to intake/manifold	Correct leak by replacing seals or tightening fasteners as required
•	•	•	•	•					Air leak at intake/manifold engine inlet	Refer to engine service manual and replace or tighten fasteners as required
•	•	•	•	•			•		Obstruction in exhaust manifold	Refer to engine service manual and remove obstruction
•	•						•		Obstruction in muffler or exhaust stack	Remove obstruction or replace faulty components as required
•	•			•			•		Gas leak in exhaust manifold to engine connection	Refer to engine service manual and replace gasket or tighten fasteners as required

# TURBOCHARGER TROUBLESHOOTING

(OPERATIONAL continued)

CONDITION								CAUSE	CORRECTION	
Engine lacks power	Black exhaust smoke	Excessive engine smoke	Blue exhaust smoke	Turbocharger oil consumption	Cyclic sound/noisy	Oil leak from turbocharger	Oil leak from compressor seal	Oil leak from turbine seal		
•	•			•		•			Gas leak in turbine inlet to exhaust manifold connection	Replace gasket or tighten fasteners as required
				•					Gas leak in ducting after the turbine outlet	Refer to engine service manual and repair leak
		•	•		•	•			Obstructed turbocharger oil drain line	Remove obstruction or replace line as required
		•	•		•	•			Obstructed engine crankcase vent	Refer to engine service manual, clean obstruction
		•	•		•	•			Turbocharger center housing sludged or coked	Change engine oil and filter, overhaul or replace turbocharger as required
•	•								Fuel injectors incorrect output	Refer to engine service manual - replace or adjust faulty component(s) as required
•	•								Engine camshaft timing incorrect	Refer to engine service manual and replace worn parts
•	•	•	•			•	•		Worn engine piston rings or liners (blow by)	Refer to engine service manual and repair engine as required
•	•	•	•			•	•		Internal engine problem (valves pistons)	Refer to engine service manual and repair engine as required
•	•	•	•	•	•	•	•		Dirt caked on compressor wheel and/or compressor housing	Clean using a non-caustic and soft brush. Find and correct source of unfiltered air and change engine oil and filter
•	•	•	•	•		•	•		Damaged turbocharger	Analyze failed turbocharger. Find and correct cause of failure, overhaul or replace turbocharger as required

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