Tech Sheet
‘Turbo Basics’

Basics:

Air entering the engine first passes through an exhaust driven compressor. Compressed air results in a larger quantity of air being forced into the engine, creating more power.

The energy used to drive the turbo compressor is extracted from waste exhaust gasses. As exhaust gasses leave the engine they are directed through a wheel placed in the exhaust flow. The gasses drive the turbine wheel around, which is directly connected via a shaft, to the compressor wheel.

Increased exhaust gas drives the turbine wheel faster, this provides the engine more air, producing more power. A limit is met once a pre-determined boost pressure is achieved. At this point the exhaust gas is redirected away from the turbine wheel, thus slowing it down and limiting the maximum boost pressure. This redirection valve is known as the wastegate.

This extraction of energy, from exhaust gas, to improve engine efficiency is the device known as the turbocharger.

Turbochargers were once usually seen as power enhancements on performance cars, but today, turbochargers are becoming more regularly used to provide greater torque on small capacity engines. The advantages of using a turbo engine include improved fuel efficiency and reduced exhaust emissions.

Compressor housing and wheel:

A close-fitting compressor wheel with vane type blades revolves inside a contoured housing. Speeds of up to 150,000 rpm are achieved. Air is drawn onto the centre and exits around the rim of the housing. Made in aluminium, and machined to a high degree of accuracy. Pressure signal

for the actuator is usually taken from this housing.

Bearing Housing:
This cast iron housing contains the journal and thrust bearings. Its function is to support the bearings and direct oil, via small internal passages, to the bearing surfaces. The bearings accurately locate the main shaft connecting turbine and compressor wheels. Some bearing housings incorporate a water jacket to reduce the transfer of heat.

Turbine wheel:
The turbine wheel is located inside the exhaust housing and is driven by the passing exhaust gas. It can reach speed of 150,000 rpm and temperatures of up to 1000º centigrade. The shaft is supported on two journal bearings, and connects to the compressor wheel at its opposite end. Heat transfer to the compressor end is kept to a minimum by passing oil over the surface of the shaft and usually with assistance of a water cooled housing.

Journal bearings:
Turbocharger journal bearings are made of a bronze alloy. Two bearings support the rotating shaft connecting the exhaust turbine to the compressor impeller wheel. Each bearing has an inner and outer load bearing surface, each machined to extremely fine tolerances. The shaft rotates within the bearing at speeds up to 150,000 rpm, whilst the bearing also rotates at around 80,000rpm. Under these conditions, lubrication is critical.
Turbochargers are lubricated by the engine's oil, supplied along a pipe to the top of the turbo. Many turbo failures are caused by this pipe becoming blocked or restricted, resulting is oil starvation. It results in deep scoring around the bearing surface. This can be caused in under 1 second.
The second most common cause of turbo failure is due to particles of dirt, suspended in the oil, entering into the turbo. Tiny particles, half the width of a human hair, can damage a journal bearing's surface leading to failure. Even particles of carbon, disturbed from within the engine, can cause turbo failure. It goes without saying that, whenever engine oil is changed or any work carried out on the turbo, the strictest cleanliness must always be observed.
Once a journal bearing is damaged, turbo oil will escape into the exhaust system producing large quantities of blue exhaust smoke.

Thrust bearings:
The thrust bearing controls the lateral movement, or end-float, of the

main turbo shaft. It is particularly important for a turbocharger to have as little movement as possible, to ensure that clearance between the rotating blades and housings is maintained.
The efficiency of the compressor wheel, in relation to the housing surrounding it, will be adversely affected if this clearance is too large. If the clearance is reduced, contact between the housing and wheel will result in severe damage to both components.
Thrust bearings are easily damaged by oil contamination or by excessive boost pressure.
Hybrid turbochargers for modified engines are often fitted with a 360º thrust bearing. These have a larger contact face which can withstand the greater pressure exerted upon them.

Turbine housing:
Usually attached to the engine's exhaust manifold, the housing directs the hot exhaust gas onto the turbine wheel for maximum efficiency. Some turbine housings also incorporate the wastegate mechanism. This internal passage redirects the exhaust away from the turbine wheel thus limiting boost. The housing is made from a thick walled cast iron to prevent metal parts escaping should the turbine wheel break. It is this housing which glows red hot whilst the engine is under load.

Wastegate:
Either an integral or remote type wastegate may be fitted. The wastegate redirects exhaust gasses away from the turbine wheel to control the boost pressure.

Actuator:
A spring diaphragm device for opening the wastegate. Many variations, similar in appearance, are produced to create the correct boost characteristics required by each engine application.