Product information

TPR
Our turbocharging platform for your rail engine
Powerful turbochargers for the long haul
75 % of a locomotive diesel engine’s power relies on one vital component – the turbocharger.

Diesel locomotive engines operate with duty cycles and in environments that make unique demands on the performance and reliability of their turbochargers. The TPR is ABB’s dedicated railroad turbocharger, with features developed specifically for long haul and heavy shunting applications.

ABB has designed the TPR single stage turbocharger for modern medium-speed engines used on heavy duty locomotives. Components proven in the field ensure high durability and reliability plus ease of maintenance, while satisfying demand for higher power density and operational flexibility, fuel economy and compliance with strict emissions legislation. The TPR turbocharger meets the technical, environmental and cost requirements of the traction market well into the next decade.

Two frame sizes
The TPR design concept provides a robust, reliable platform for turbochargers for locomotive diesel engines. Two frame sizes are available: the TPR 61 for engines rated up to 6000 horsepower and the TPR 56 for engines rated up to 4500 horsepower in a twin turbocharger arrangement. With the TPR, ABB offers locomotive operators a turbocharger that combines highest performance and reliability with fuel saving and environmental compatibility.

The TPR turbocharger family was launched in the early 2000s. It takes advantage of the extensive experience gained with ABB’s highly successful VTC and TPL turbocharger platform, in a unique design featuring greater compactness combined with an even more robust design and a quantum leap in turbocharger performance. The special conditions in which heavy duty locomotives operate impact diesel engine and turbocharger design in the three following areas:

Economic operation
A feature of heavy hauling today is that more powerful units are being used at higher speeds to increase track capacities. This is leading to increased demands being made on the performance of the power pack and turbocharger module as well as a need for total compactness. Good serviceability and longer component lifetimes are essential for high turbocharger reliability and long service intervals. To maximize power output and lower fuel consumption, higher boost pressures and a reduction in fluid flow and mechanical losses are key.

Operational considerations
Locomotive engine operation is characterized by a constantly changing load. Engine de-rating is an issue at altitude, in tunnels and in cold conditions. The engine and turbocharger must satisfy these requirements without compromising overall reliability. High mechanical loading of components due to vibration and coupling makes a robust construction essential.

Emissions regulations
Overall optimization of combustion and charging parameters is required to ensure compliance with the emission limits for NOx and particulates, etc. set by regulatory authorities such as the Environmental Protection Agency (EPA) and the International Union of Railways (UIC).
The TPR turbocharger takes special account of the heavy duty work performed by long haul and heavy shunting locomotives: load variation due to acceleration and dynamic braking, high temperatures in tunnels, and the effect of altitude operation.

A unique, compact construction with single entry gas inlet and a patented integrated foot is combined in the TPR with a purpose-built, high efficiency turbine stage and a single-piece compressor wheel, without bore, for long times between overhauls. Life cycle costs are lower thanks to the modular, service friendly design.

### Features
- Compact, robust and rigid construction
- Uncooled gas casings
- Integral axial turbine; no damping wire; wide chord blade design
- Single-piece radial compressor with flow stabilizer
- High pressure ratio combined with high overall efficiency
- Squeeze oil film damper
- Free-floating axial bearing disk
- Gas outlet casing with integrated foot and drain
- Unique, patented foot connection

### Benefits
- Withstands high mechanical loads
- No water connections; no corrosion or erosion problems
- Low cost; high efficiency; high LCF capability
- Wide compressor map and increased surge margin
- Emissions compliance; saves fuel
- Increased rotor stability
- Reduced friction; longer lifetime; inclination compensation
- Compact, with high rigidity; optional drainage points
- Easy removal and replacement of complete turbocharger, small footprint

### Turbine
The integral high efficiency turbine allows all the requirements of locomotive operation to be met: high rotational speeds, very high inlet temperatures and a very long low cycle fatigue (LCF) life. Wide chord blades featuring an optimized airfoil design eliminate the need for damping wires and improve thermodynamic performance. Secondary flow losses are minimized by reduced tip clearances. Gas inlet casings have been optimized for use with constant pressure turbocharging systems. Highest turbine stage efficiency is supported by the outlet casing’s large flow-duct cross sections.

### Compressor
The compressor features a single-piece, splitter bladed aluminum alloy wheel with backswept blades for high efficiency and a wide compressor map. The solid wheel greatly reduces internal stress, allowing an increase in the maximum speed of rotation and in exchange intervals. Two compressor stages with flow stabilizer are available: F32 and F33 for a maximum pressure ratio up to 4.7.
Increased bearing lifetime
The TPR turbocharger’s bearing assembly is designed for direct lubrication by the engine lube oil system. The main axial bearing consists of a free-floating thrust disk with profiles on both sides, rotating at about half the rotor speed. The effect of this design is to lower friction losses and increase the thrust bearing’s ability to compensate for shaft inclination. Disk wear is reduced by an extremely hard coating that offers very high resistance to abrasion caused by contaminated oil. The non-rotating, three-lobe radial bearing bushes are centered in a squeeze oil film damper. The bearing concept leads to higher rotor stability and therefore to higher reliability and improved durability.

Optimized casing design
TPR casings ensure excellent flow dynamics and minimize thermal stress. The uncooled turbine casing has been designed for large flow cross-sections after the turbine and features a patented integrated foot fixation and drain. The compact, rigid casing offers maximum resistance to vibration and shock loads while taking full account of the space restrictions of locomotive applications.

Containment
One of the most vital factors for turbocharger components is the capability to withstand a worst case scenario where parts rotating at very high speeds lose their integrity, fragment and are hurled with immense force at turbine and compressor casings. ABB Turbocharging goes to great lengths to design these casings in high grade materials with the necessary strength to promote absolute safety. Full-scale containment qualification tests are carried out on every new ABB turbocharger type under conditions as near to reality as possible. The result is justified confidence in the components’ fitness for purpose and an unrivaled record of operational safety.
Extended capabilities
Compressor technology pushes the boundaries.

F compressor technology
Incorporation of ABB’s F compressor technology, featuring air recirculation for better surge margins and enlarged map widths, has brought new benefits to the TPR turbocharger series. This compressor platform is especially suitable for emissions compliant engines used in a wide range of locomotive duties. Two compressor stages, F32 and F33, are available for both TPR frame sizes, offering compressor ratios of up to 4.7, thereby surpassing the previous level available with the TPR-A. With this technology in place, engine builders have an extra incentive to introduce Miller timing on their engines without any trade-off on locomotive field operation flexibility.

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* depending on configuration
Emissions and Miller timing
Win-win with high pressure turbocharging.

While the potential high pressure turbocharging brings to engine performance is undisputed, it is for the engine builder to decide how much of the benefit should be used to reduce emissions and how much should be employed for lowering fuel consumption and for locomotive operation field flexibility. TPR-F compressor technology supports engine builders’ and end users’ efforts to comply with current as well as future emissions legislation by allowing Miller timing to be used to reduce combustion temperatures and NOx emissions.

Emissions down, efficiency up
Miller timing has gained favor with engine builders by allowing emissions to be reduced without compromising efficiency – a true win-win situation. The basic principle underlying the Miller process is that the engine’s effective compression stroke can be made shorter than the expansion stroke by suitable shifting of the inlet valve timing. The result is a reduced cylinder filling, so that more boost pressure is required to get the same quantity of air into the cylinder.

Maximizing the benefits of Miller timing reduces the temperature in the cylinders, allowing NOx formation to be minimized. However, ever shorter inlet valve opening times make increasing demands on the turbocharging system, which has to ensure constant engine output. Through high pressure turbocharging, TPR-F compressor technology enables a stronger Miller effect for additional end user benefits.
Higher engine operation flexibility is also available through Variable Turbine Geometry. VTG’s key benefit is that it allows flexible adjustment of boost pressure along the engine’s operating line, leading to precise control of the air/fuel ratio for optimized combustion and enabling emissions to be reduced while maximizing engine efficiency and improving part-load behavior.

Developed by ABB, VTG has been successfully applied on TPS and TPL turbochargers. It allows, through adjustment of the turbine nozzle vanes, exact matching of the air pressure delivered by the turbocharging module to the engine to the actual working requirements in a wide range of ambient conditions. VTG technology achieves this by enabling the turbine’s flow area, and therefore its mass flow, to be optimized, practically without losses, at every point on the engine’s load profile.

Special benefits for locomotives
In the 4-stroke diesel engine sector, VTG, by saving fuel in the load range in which locomotives are mainly operated, lowers emissions, especially of soot. And by reducing temperatures VTG contributes to longer lifetimes for those engine parts subjected to the highest thermal loading. Importantly for railroad applications, it allows optimal adjustment to temperature fluctuations and differences in altitude. In other words, the VTG turbocharging module compensates for changing ambient conditions.

Emissions compliance
Countries and rail organizations around the world have introduced emissions regulations, among them: Euro IIIA and IIIB in Europe; EPA Tier 3 in the USA; and GOST for the former Soviet Republics that make up the CIS. Combining the TPR with VTG enables an emissions potential that exceeds the Tier 2 range and allows a considerable additional reduction in fuel consumption.

EPA Tier 4, due to come into force in the USA in 2015, will set a far stricter emissions benchmark. ABB’s new A100 turbocharger technology, with pressure ratios up to 5.5, opens up new possibilities here. A100 technology combined with VTG, plus additional measures such as high pressure external Exhaust Gas Recirculation (EGR), would provide unique flexibility for optimizing the EGR rate along the locomotive operating line so that the diesel engine complies with Tier 4. At the same time, this allows a competitive trade-off between locomotive heat rejection, fuel consumption and operational flexibility.

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<th>Features</th>
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<td>Variable Turbine Geometry (VTG) option</td>
<td>Greater operational flexibility; lower thermal loading; improved engine performance</td>
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<td>Compact, modular, with integrated actuator</td>
<td>All-in-one mechanical unit; drop-in design; easy to exchange</td>
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<tr>
<td>VTG control logic</td>
<td>“Stand-alone” system; ensures mechanical integrity of turbocharger and engine</td>
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Serviceability
Scheduling for a long turbocharger lifetime.

Long intervals between overhauls are a top priority for railway operators. ABB provides a service concept that has unit exchange at its center. It involves the removal of the entire turbocharger from the engine after a specified time and the replacement with a new or overhauled unit.

ABB recommends overhaul schedules which are proven in the field and specifically geared to the needs of locomotive operators. The schedule maximizes the lifetime of TPR turbochargers under operating conditions.

The overhaul process comprises disassembling, cleaning and a strictly defined assessment of the parts’ condition. Depending on the results, the parts are reconditioned or exchanged with new ones. Bearings and rotating parts are replaced based on pre-defined exchange intervals. Complete turbocharger units are reassembled using new consumables.

Exchanged turbocharger units come with the same functionality and a restored performance comparable with that of new units, resulting in renewed engine power, fuel economy, low emissions and high reliability for the next operational period within the prescribed service schedule.

**VTG reconditioning**

VTG modules and their actuators are assessed in accordance with ABB’s Customer Part Exchange Program (CPEX) as part of every scheduled turbocharger overhaul.

Reconditioning of individual turbocharger components and VTG modules is performed using state-of-the-art equipment and processes in dedicated CPEX facilities within the global ABB Turbocharging Service network.
A strong track record
Field experience confirms TPR reliability.

TPR turbochargers are built to standards that ensure long component lifetimes and highest reliability under operating conditions. To date, almost 2000 TPR turbochargers are successfully operating on main line locomotives in India and China and more than 50 million running hours have already been accumulated worldwide. ABB Turbocharging technology has also been introduced on US-built and Russian locomotives in commercial operation.

A global service network
Operators of locomotives equipped with TPR turbochargers benefit from a global ABB Service organization that ensures OEM support is always close by, securing the highest operational reliability for their business while keeping costs down and availability of rolling stock high. The ABB Turbocharging Service network comprises more than 100 fully equipped Service Stations around the world. ABB-trained service personnel and Original Parts guarantee the highest quality and standards for all work carried out.