

14.10.2025

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Customer Information and Awereness Course 2025 Agenda

- Accelleron Industries
- Purpose of turbocharging
- Layout of Accelleron turbochargers
- Necessity of Service on turbochargers
- Typical failure modes
- Turbo Upgrade



CIAC Budapest 2025 Agenda

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Our Purpose

Accelerating sustainability in marine and energy



Our Values

We are curious

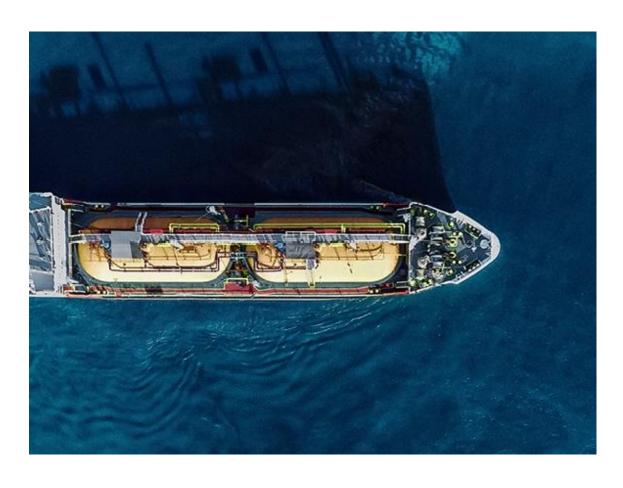
We are all entrepreneurs

We go further

We trust each other



Global technology leader in turbocharging, fuel injection and digital solutions





Supporting our customers to decarbonize



Industry leading solutions for mission-critical applications



Preferred partner to both OEMs¹ and operators



>180k turbocharger installed base



>100 service stations globally



~75% recurring service-driven revenues



The basis for our success: our skills and competence

- ~3,000 people with clear goals
- ~200 R&D employees
- >500 service engineers
- 80 training hours per annum per engineer
- Training regional teams worldwide according to Swiss standard
- USD 58.2 million invested in R&D
- 120 patent families





The industries we serve with our High-Speed products

Energy



Marine



Off-Highway



Service & product customers are:

- End users of large diesel & gas engines in all industries
- Engine builders of large diesel & gas engines



Accelleron Industries

Service customers **Over 100** 6,000 1,200 Trained employees Customers Service stations in over 50 countries



Accelleron Industries

Headquarters Switzerland - Overview





Accelleron Industries

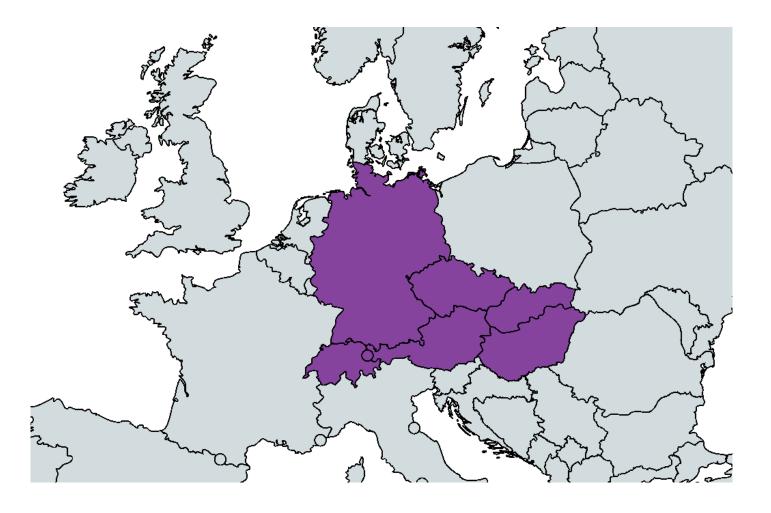
Headquarters Switzerland – Service Center





Accelleron Germany GmbH

Allocated countries



Austria
Czech Republic
Germany
Hungary
Slovakia
Switzerland



Accelleron Industries Local Division Germany



Ingolstadt

AUSTRIA

Pforzheim









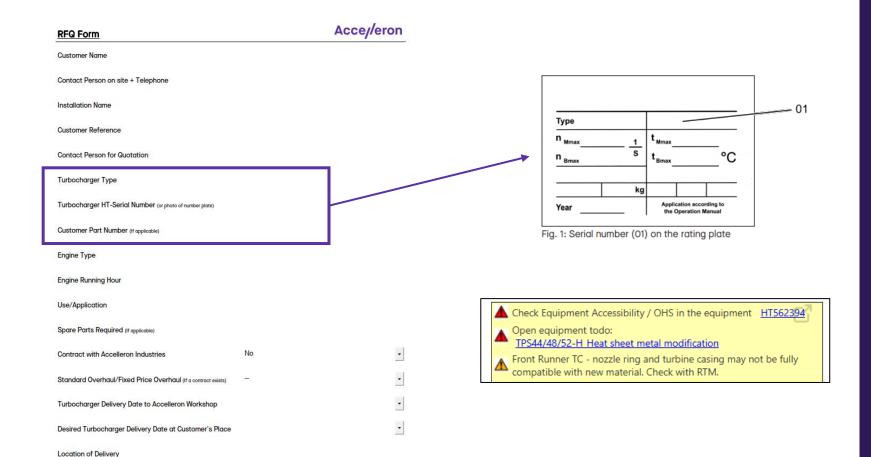
Accelleron Germany GmbH

Service Stations - Workshop





Accelleron Germany GmbH Order Handling



- Serial Number of the TC is key to check the specification and service history upfront
- If it comes to necessary modifications, it ensures that we are prepared and the spare parts are available on time
- The better we know your needs, the better we can serve you and fulfill your expectation on an excellent service



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- Non-Accelleron



Purpose of turbocharging Effective engine power

$$P_e = \frac{H_u}{L_{min}} \cdot \frac{V_h \cdot z}{a} \cdot \frac{\eta_e \cdot \lambda_l \cdot \rho_L \cdot n}{\lambda_V}$$

• P_e Effective engine power

• H_u Lower heating value

• L_{min} Minimum air consumption

• V_h Volume of one cylinder

z Number of cylinders

a Crankshaft rotations / working cycle

• η_e Effective engine efficiency

• λ_l Volumetric efficiency

• ρ_L Air density

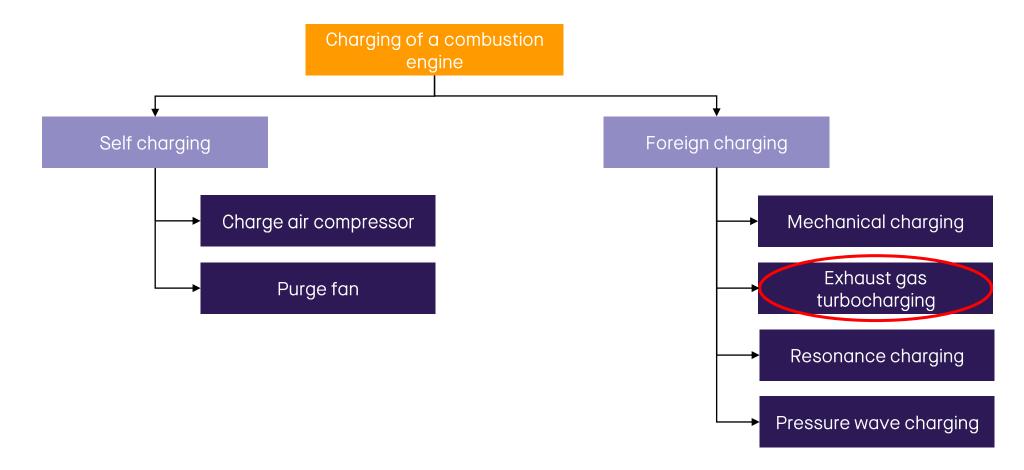
n

Engine speed

• λ_V Combustion-air ratio



Purpose of turbocharging Ways of charging





Purpose of turbocharging Facts

Main purpose:

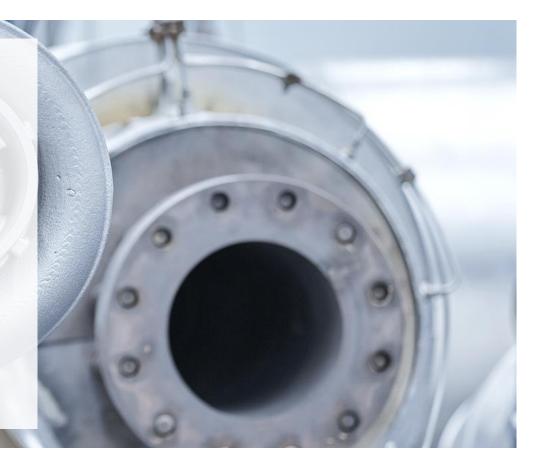
- Provide pressurized air for the combustion process by utilizing residual energy of the exhaust gas
- Increase the specific power output of the engine

Key performance facts:

- Achievable compressor pressure ratio
- Turbocharger efficiency
- Specific airflow
- Load response capabilities

Customer benefits:

- 300% more power
- Up to 10% lower fuel consumption
- Up to 60% lower NOx emissions





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Necessity of service on turbochargers

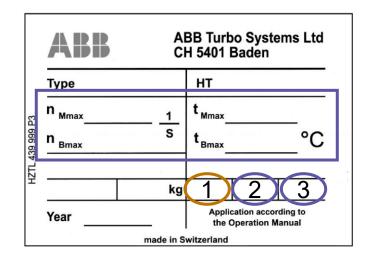
Standard Service interval

Secure good turbocharger performance

Minimize risk of operation

Condition based

Empirical inspection interval



SIKO - Safety Design Concept

Turbine and compressor wheel only

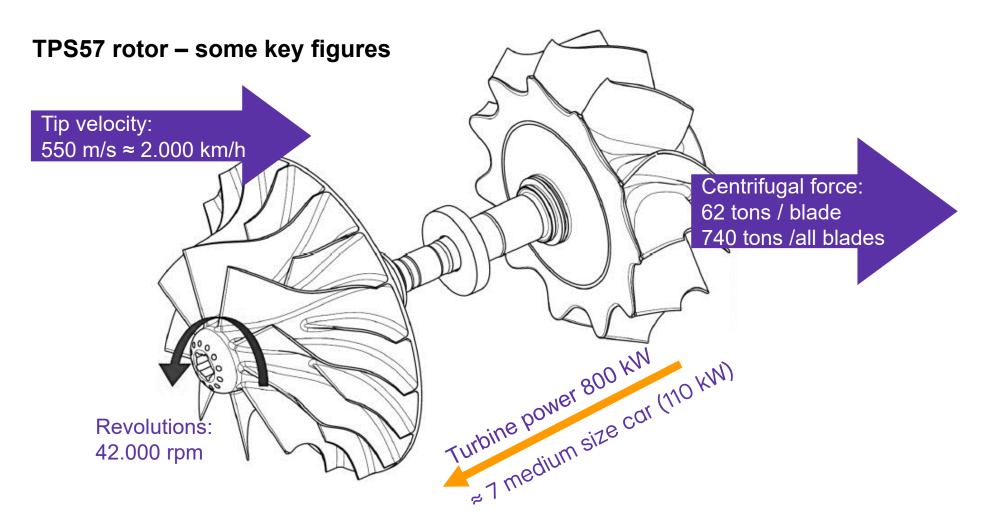
Prevent part failure due to creep and fatigue

Calculated replacement interval

- 1) Standard Service interval in 1.000 h
- Replacement interval for compressor wheel in 1.000 h
- 3) Replacement interval for turbine in 1.000 h



Necessity of service on turbochargers - SIKO



Necessity of service on turbochargers - SIKO

TPS57 rotor – comparison of breakdown

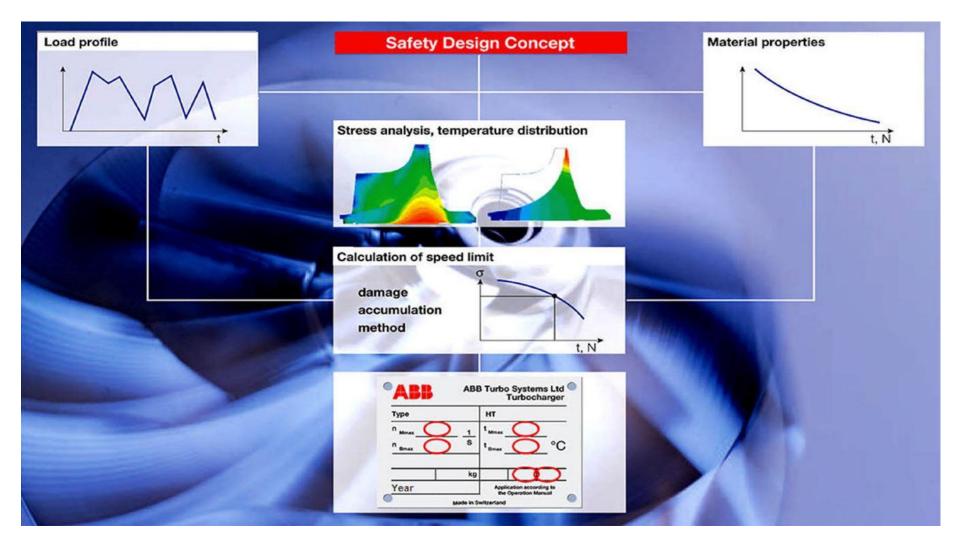
Kinetic energy of the turbine wheel:

≈ equivalent of a medium size car crashing at 90 km/h



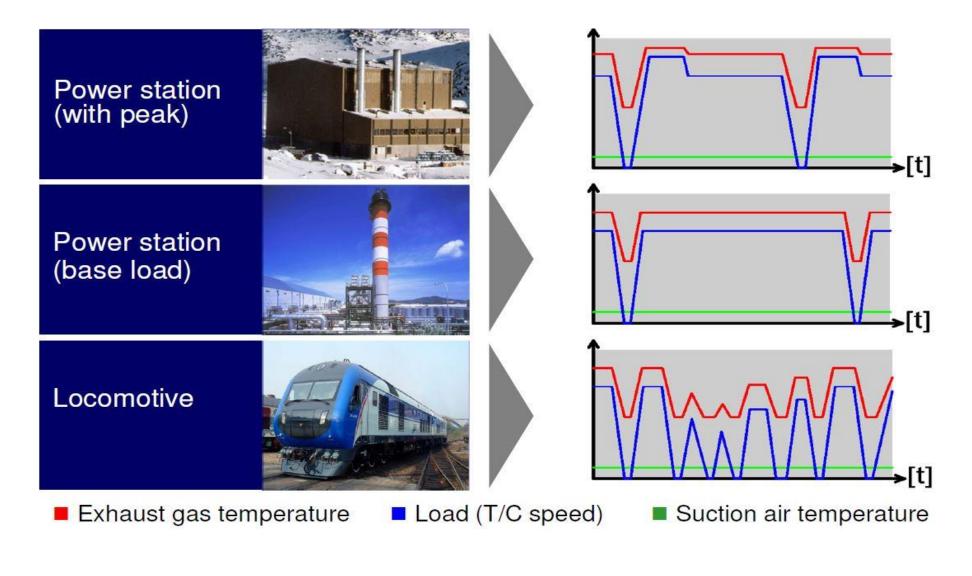


Necessity of service on turbochargers - SIKO





Necessity of service on turbochargers - SIKO





Necessity of service on turbochargers - SIKO

T/C rotors are subjected to **very high loads** and their parts are exposed to a **damage process even under normal operating conditions**

ABB specifies operational limits and recommended exchange intervals aimed at highest operational reliability

The relevant data are given on the turbocharger rating plates.

Benefits of the ABB Safety Design Concept:

Safe and reliable turbocharger operation

Avoidance of cost intensive downtime

Pro-active planning of overhauls

Optimized maintenance and exchange intervals



Necessity of service on turbochargers

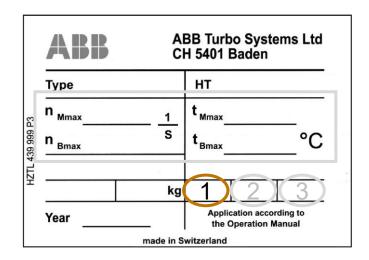
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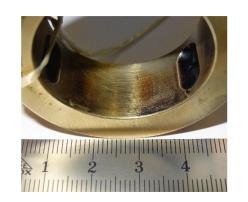


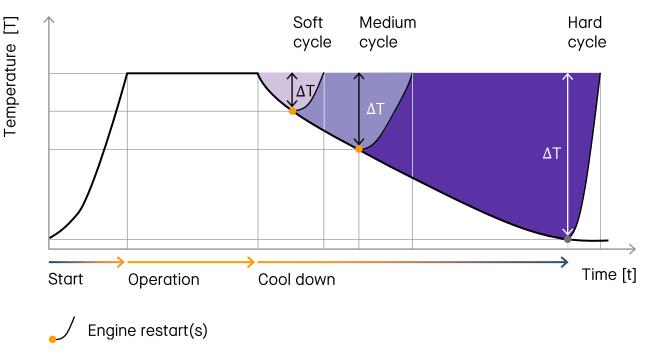
Necessity of service on turbochargers

Due to more and more enignes in peak shaving operation service is recommended

- → Hours as per rating plate
- → 5000 Starts
- → After 5 years

Whatever comes first!

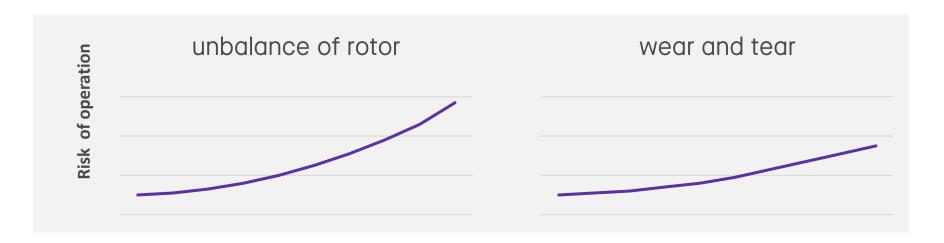






Necessity of service on turbochargers





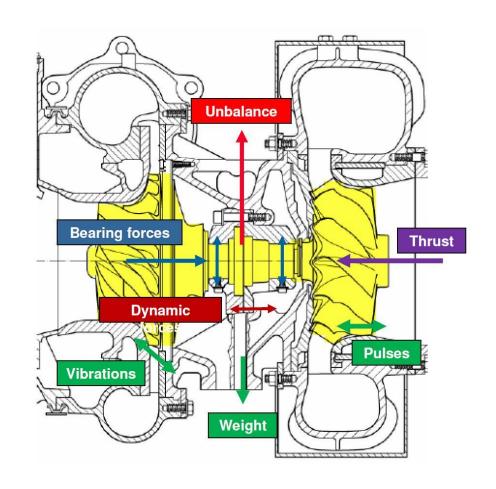


Necessity of service on turbochargers





Necessity of service on turbochargers



$$U = M \times R (gmm)$$

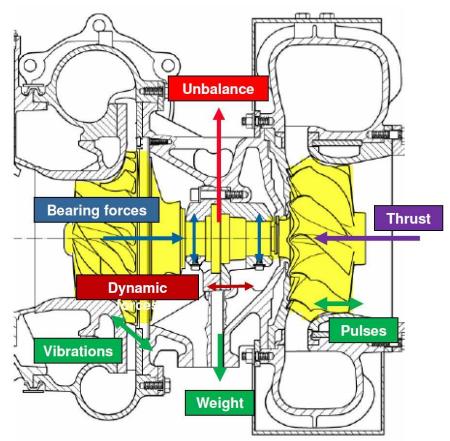
$$F = M \times R \times \omega^{2}$$

Example for TPS57 Turbine

M = 2,3 g (1 €Cent-Coin), R = 60mm U = 2,3 g*60mm = **138gmm**

Tol. residual unbalance (TS): **11gmm** or **0,18g** at a 60mm Radius

Necessity of service on turbochargers

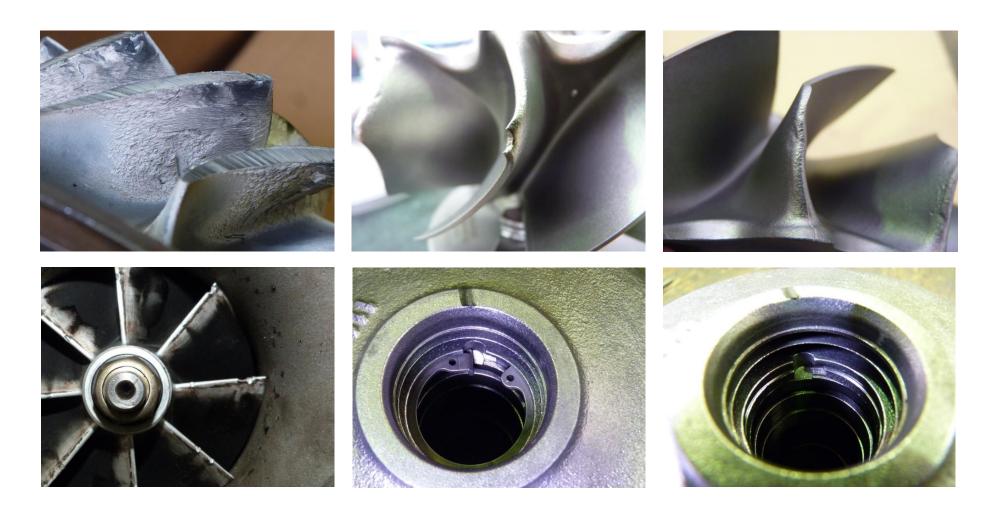


$$U = M \times R (gmm)$$

$$F = M \times R \times \omega^{2}$$

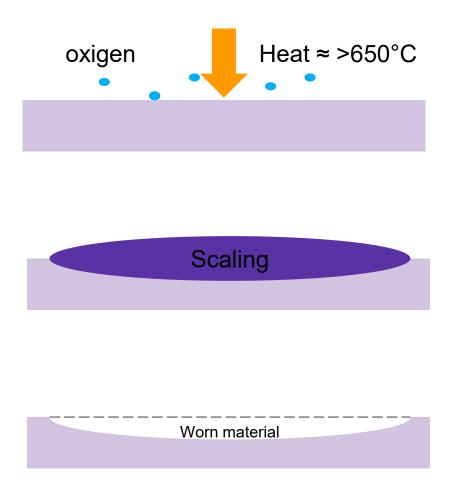
 $F \approx 8.500 N \approx 870 kg$

Necessity of service on turbochargers





Necessity of service on turbochargers



Scaling is a chemical reaction of the ferruginous material

Type of oxidation, known from casting
Influenced by material properties, heat and oxygen

- > Hot components effected only
- Most critical parts: gas outlet flange and turbine casing

Volume of scaled material increases

By removing scaling basic material has to be removed also

Wear of parts



Necessity of service on turbochargers





Necessity of service on turbochargers





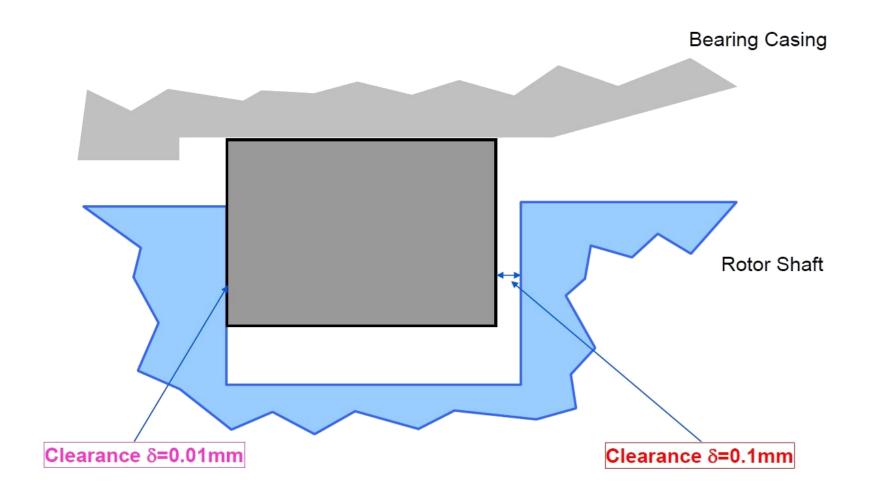




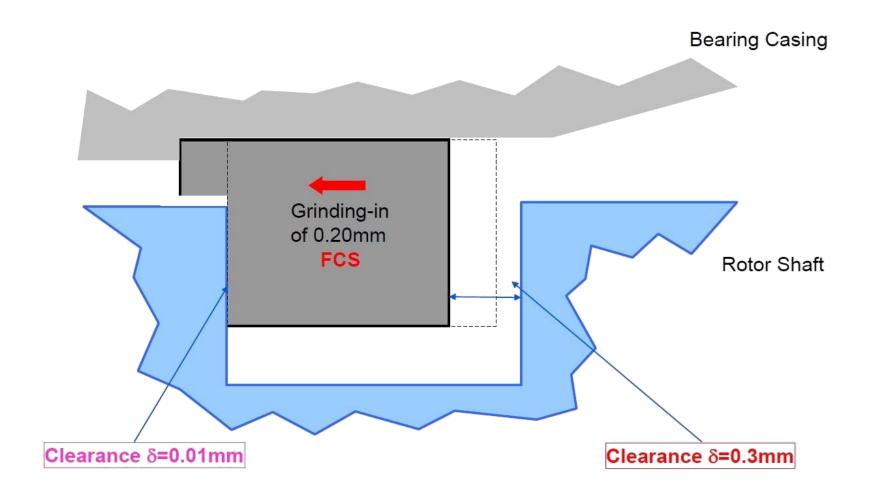




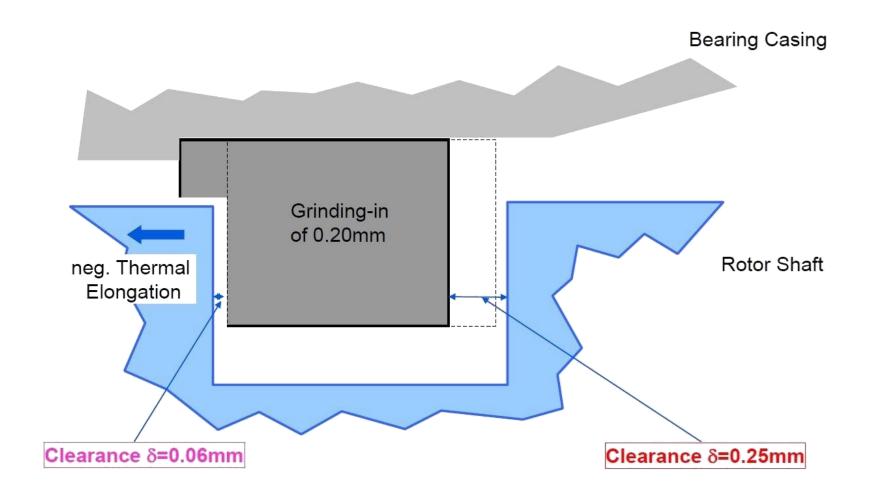




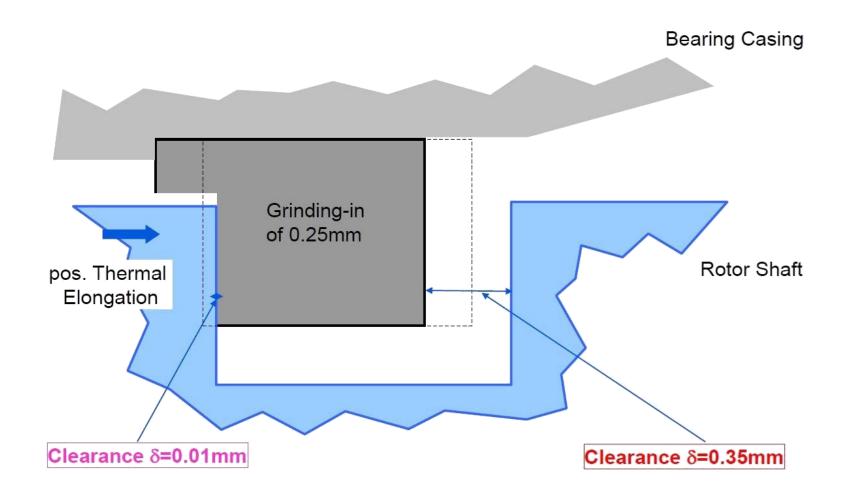




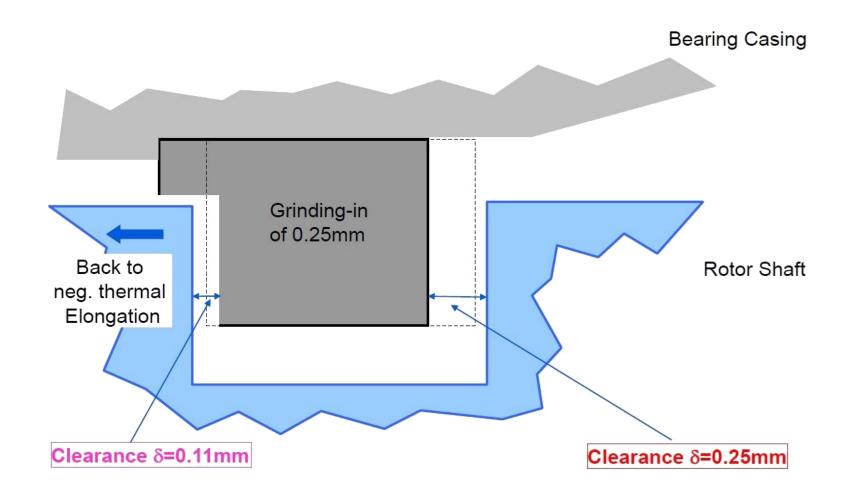






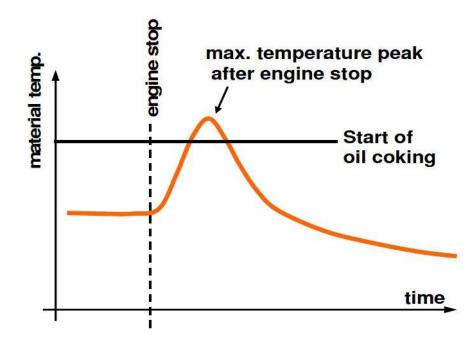






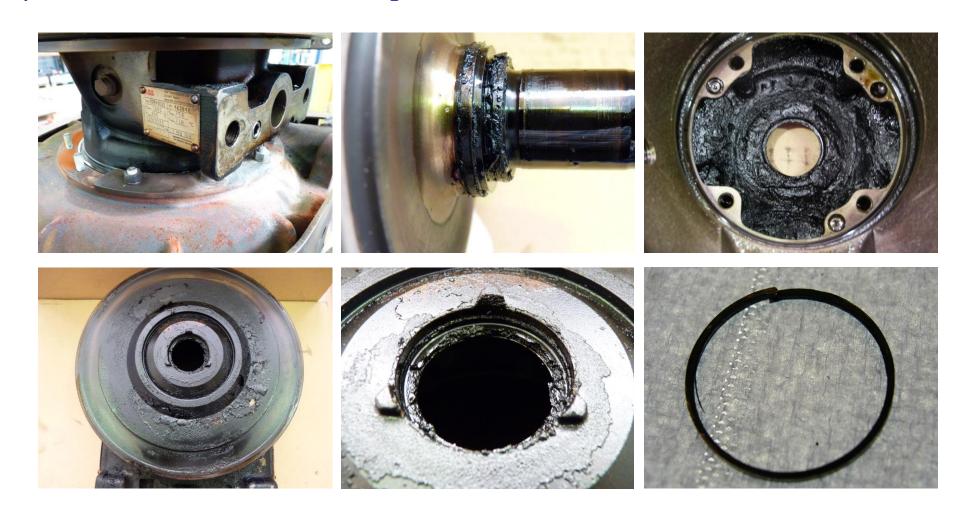




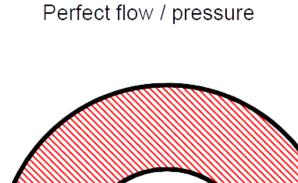


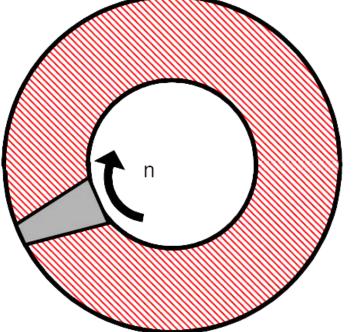
- High oil temperatures lead into oil coking which is abrasive and could lead into
 a failure of the piston ring
- Type of oil and oil quality influence the critical temperature where the oil starts coking
- Starts and Stops increase probability of coking, emergency stops even more

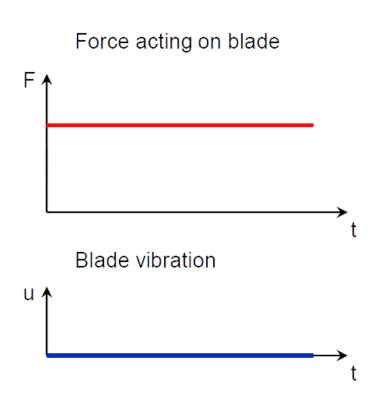








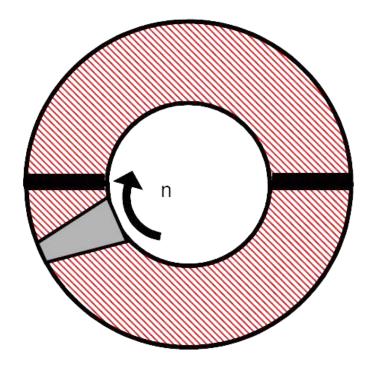




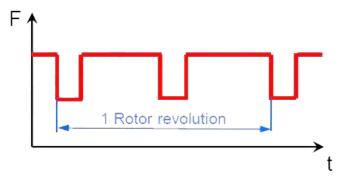


Necessity of service on turbochargers

Disturbed flow / pressure e.g. by two struts



Force acting on blade



Blade vibration

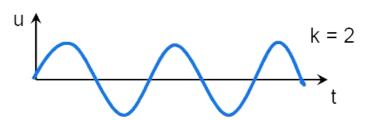
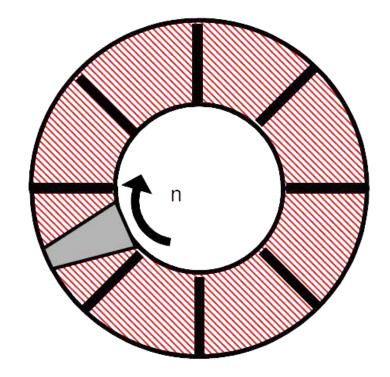


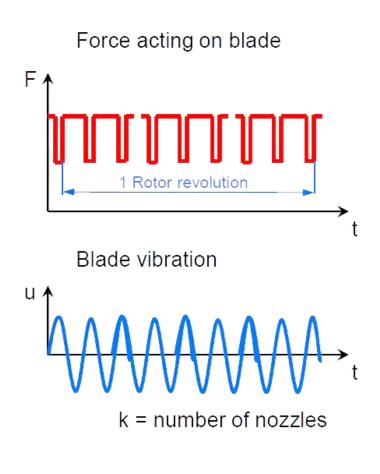


ABB Group / ABB Turbocharging onl 3, 2013 | Slide 14 | filename

Necessity of service on turbochargers

Disturbed flow / pressure e.g. by nozzle ring



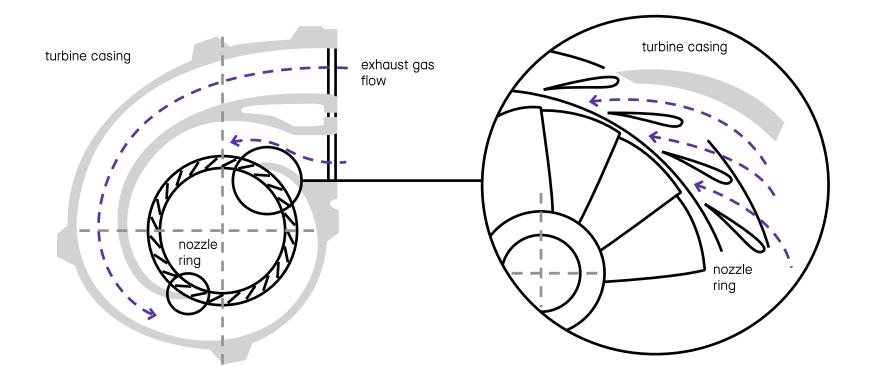




Turbocharger failures caused by inadmissible excitations

• What can cause fatigue failures

- Angle of incidence
- Principle:

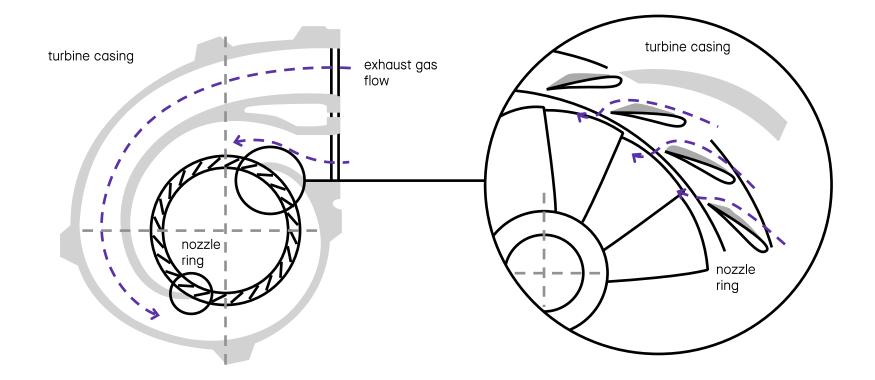




Turbocharger failures caused by inadmissible excitations

• What can cause fatigue failures

- Angle of incidence
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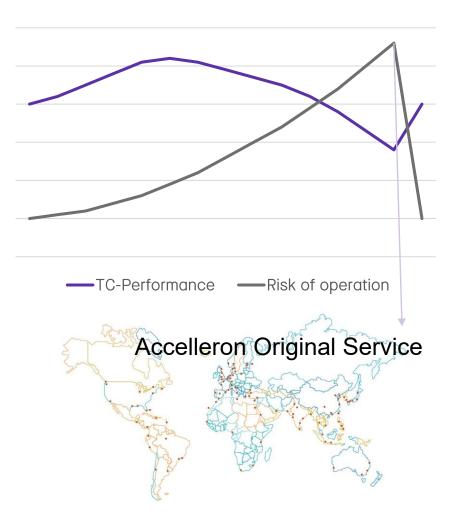
CIAC Budapest 2025 Necessity of service on turbochargers

Turbocharger performance increases slightly within first hundreds hrs. after overhaul (exhaust deposits reducing turbine side clearances)

Performance decreases continuously after reaching a maximum during operation

Risk of operation determined by unbalance and wear
Risk of operation increases continuously during operation

A// standard service intervals **keep TC performance at high level** and reduces **risk of operation to a controllable level**





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Typical failure modes - Obstacles







Typical failure modes - Obstacles





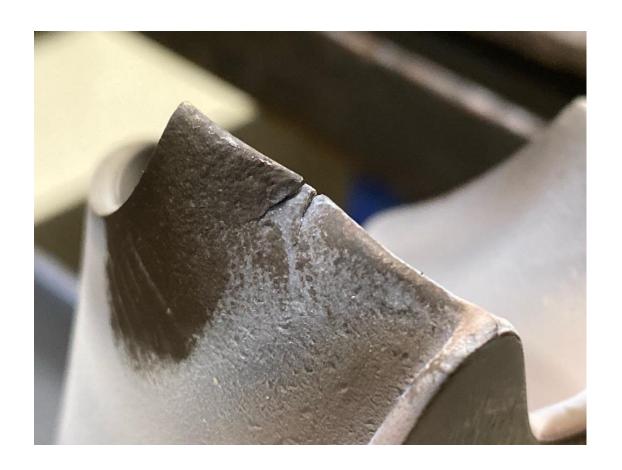
Typical failure modes - Foreign object

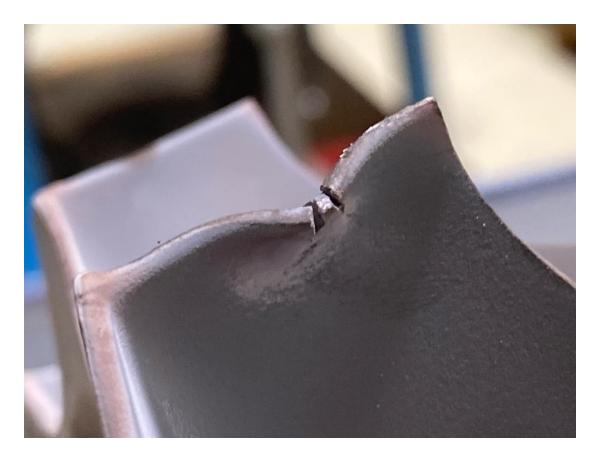




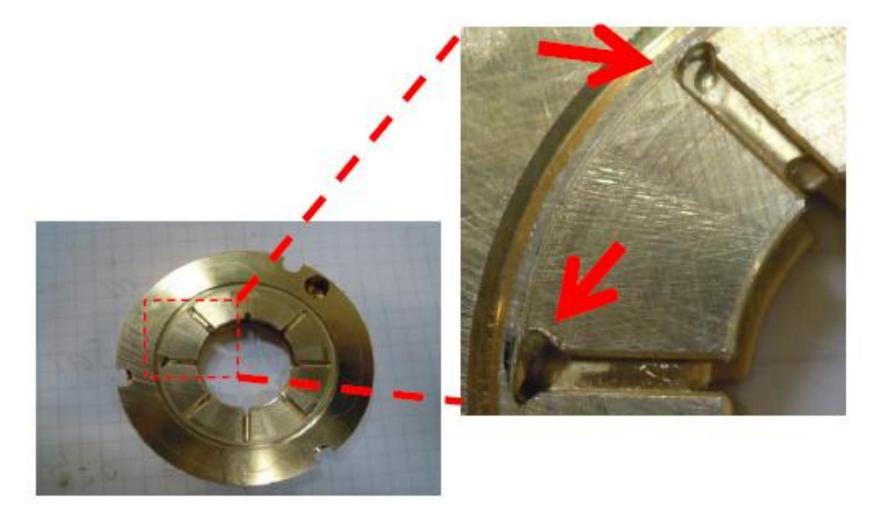


Typical failure modes - Foreign object





Typical failure modes - Oil auality





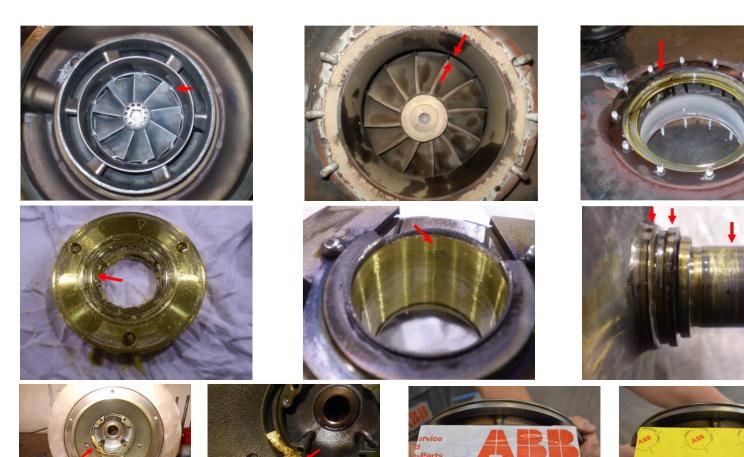
Typical failure modes - Self maintenance







Typical failure modes

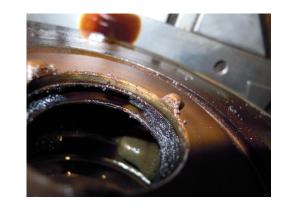




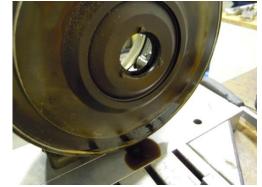
Typical failure modes - Oil sealing







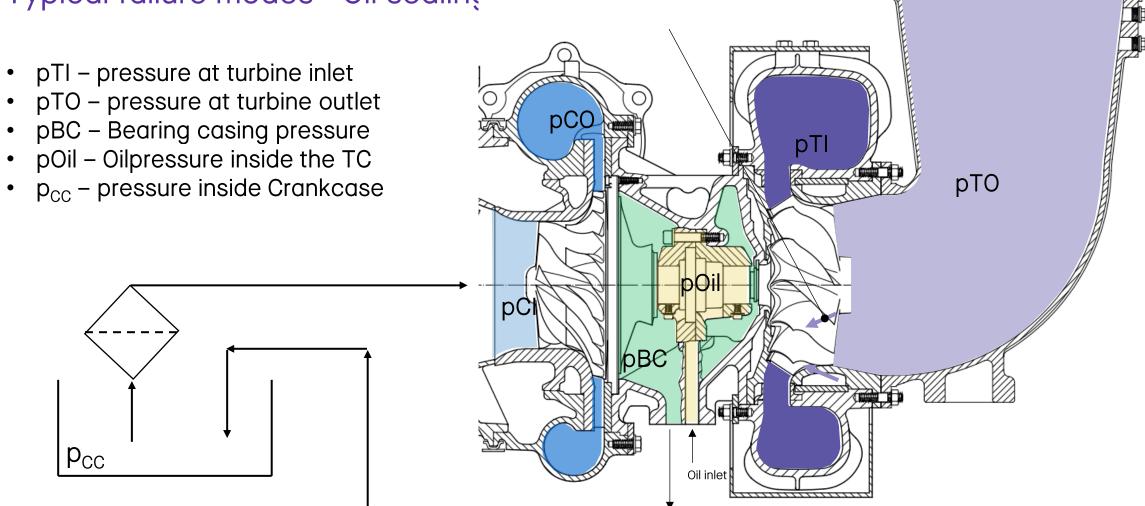








Typical failure modes - Oil sealing



Typical failure modes - Crankcase venting







CIAC Budapest 2025 Typical failure modes - Scaling







Typical failure modes - Water ingress





Typical failure modes

Poor air/gas treatment, and ambient conditions



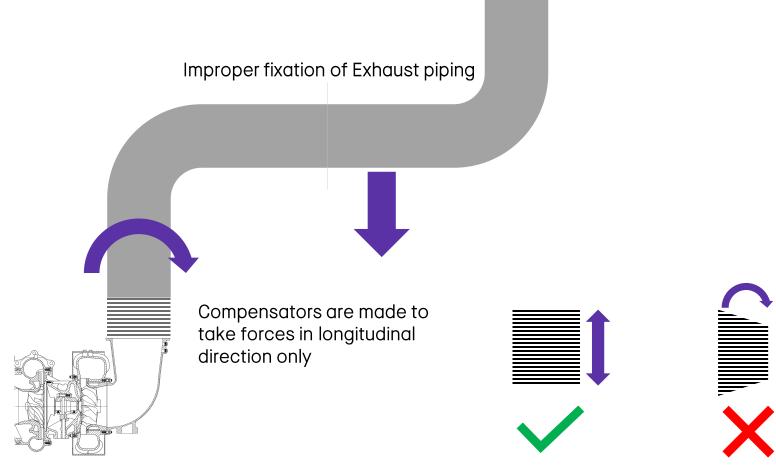




Typical failure modes - Gas leakage

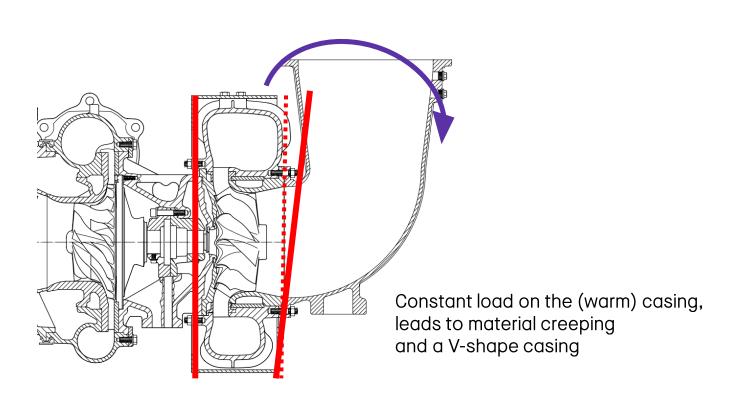


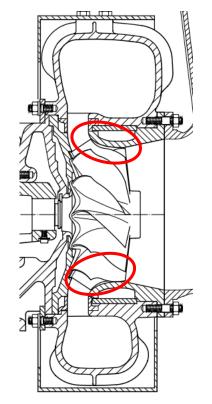






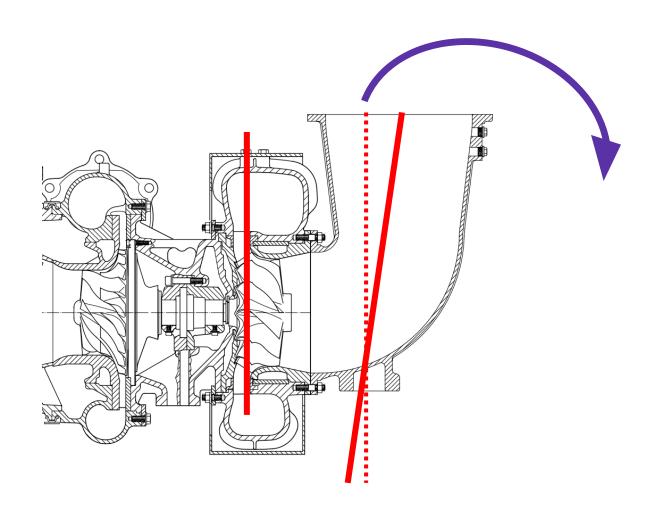
Typical failure modes - Installation

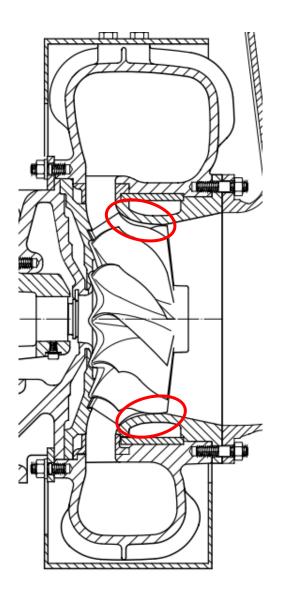




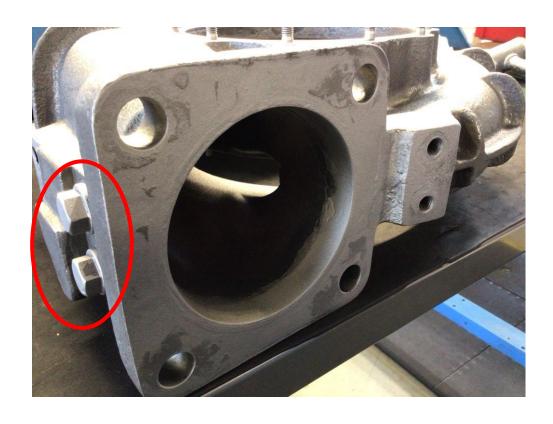
Deformation of the casing can lead into rubbing between casing and Turbine

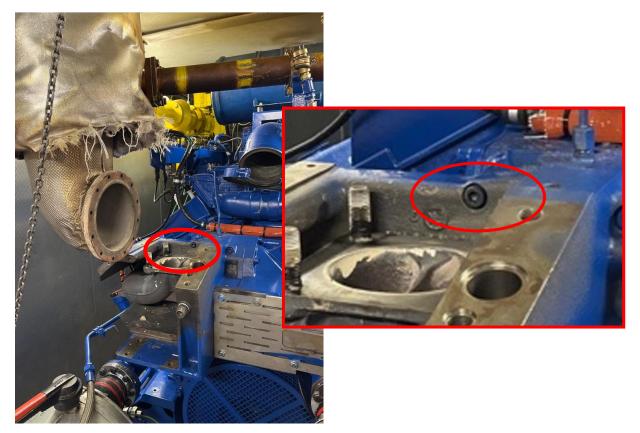




















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What is an upgrade?

Classic service

"I keep my power installation up and running"

Upgrades

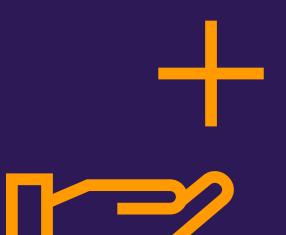
"I make my power installation more competitive"



Customer benefits

Upgrades create additional value

- Implement latest technology into existing power installation
- Tune engine and turbocharger for optimized performance
- Potential benefits
 - Higher efficiency, lower fuel consumption
 - Higher power output
 - Increased operational flexibility
 - Higher reliability and availability
 - Lower maintenance cost and total cost of ownership (TCO)





Components upgrade

- Turbocharger
- Hardware to be exchanged:
- 1. Compressor wheel (SIKO part)
- 2. Air diffuser
- 3. Bearing casing
- 4. Turbine rotor (SIKO part)
- 5. Nozzle ring (consumable part)
- 6. Turbine casing
- Implementation
- Drop-in solution (turbo mounting does not change)
- Installation of hardware within one day

Example: TPL76-C component upgrade

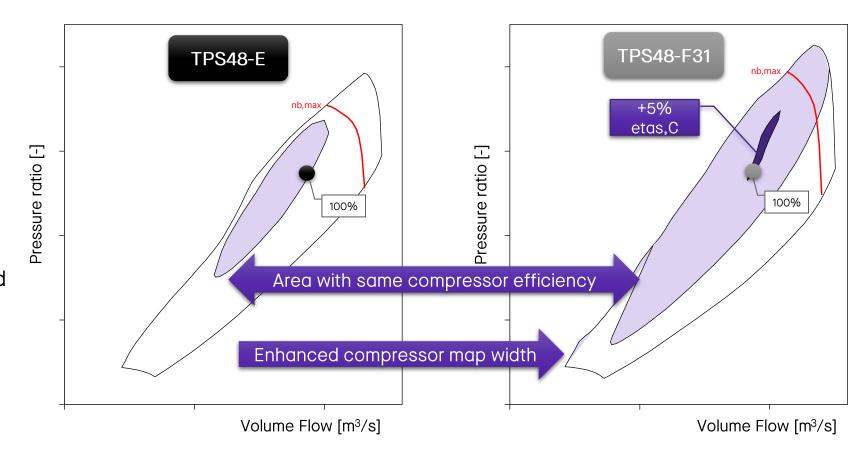




Compressor Stage Upgrade

• Operation point at 100% engine load

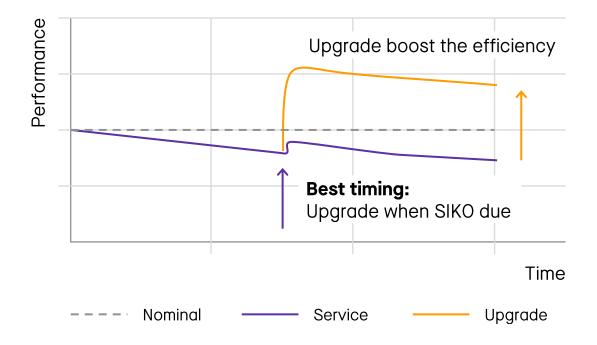
- TPS..-F maps are much wider
 - Increased tolerance toward changed site conditions (high ambient temperature, gas quality, wear & tear, ...)
- TPS..-F provide a quantum step in turbocharger efficiency
 - Further increased tolerance toward changed site condition or
 - Increased engine efficiency





When we actually do it

• Upgrade benefits compared to SIKO



SIKO	VS	Upgrade
Replacement with identical spare parts	→	Replacement of compressor stage and nozzle ring with a newer version
Reset to original efficiency & security	→	Increased efficiency & operational flexibility
Conventional service model	→	Proven solution with long-term customer benefits
		Collaboration and combined approach with engine OEM
		ROI < 2 years



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Acce/eron