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Reliability Development Process of a Turbo

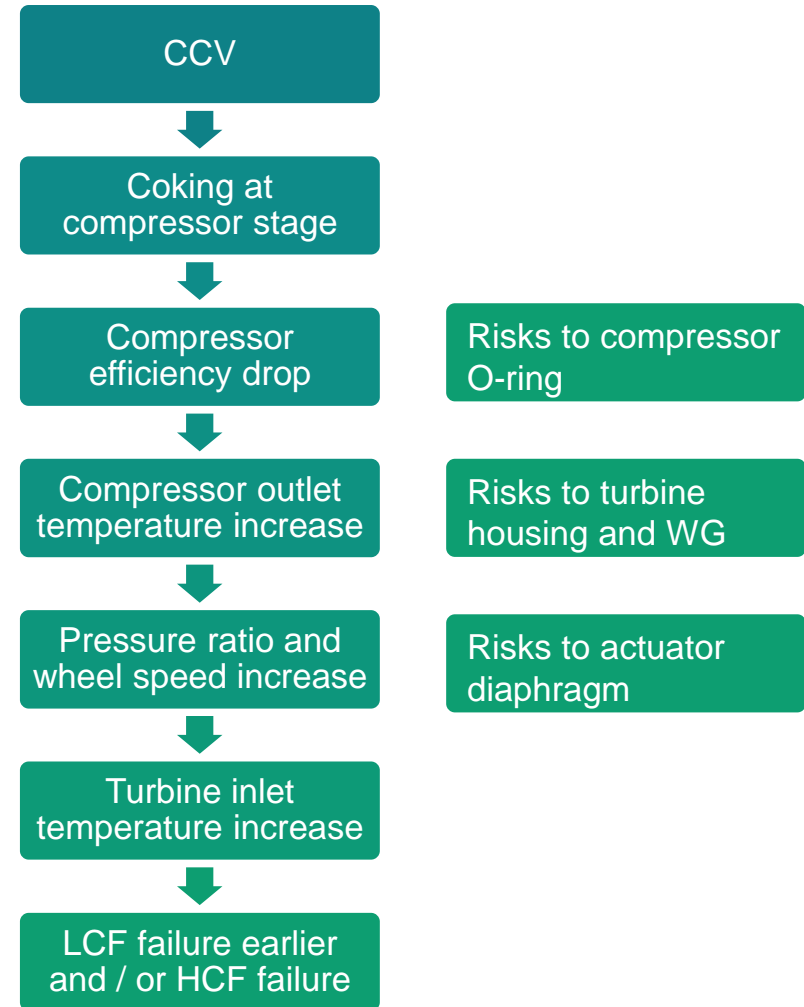
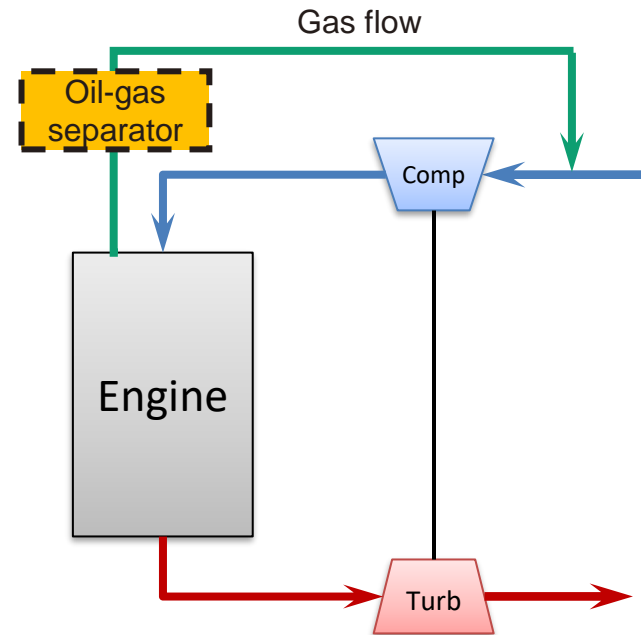


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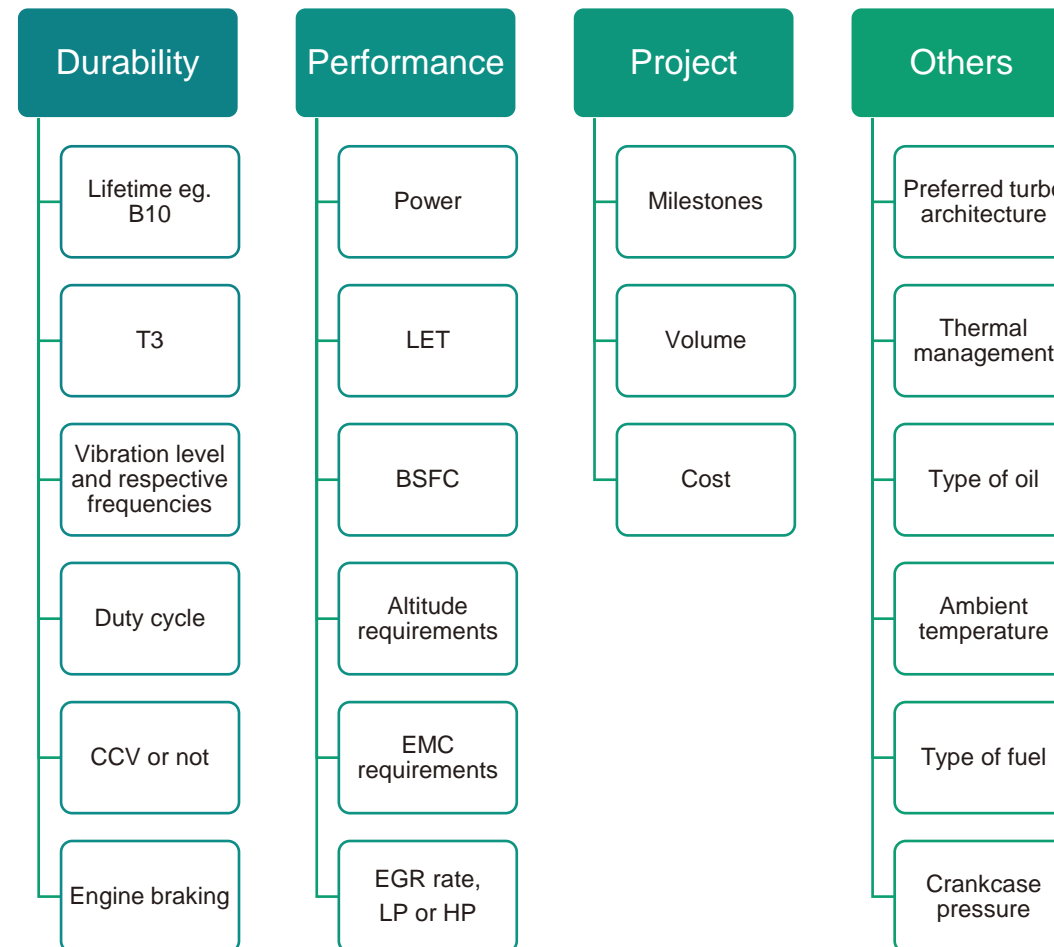
Market Needs

- Regulations
 - Closed Crankcase Ventilation
 - EGR and/or SCR
- Cost
- Types of fuels
- Application scenarios
 - City bus
 - Long haul truck
 - Hybrid
 - Etc
- Pain points
- Engine braking
 - Jacob brake (turbo overspeed concern)
- Driving / operating habits



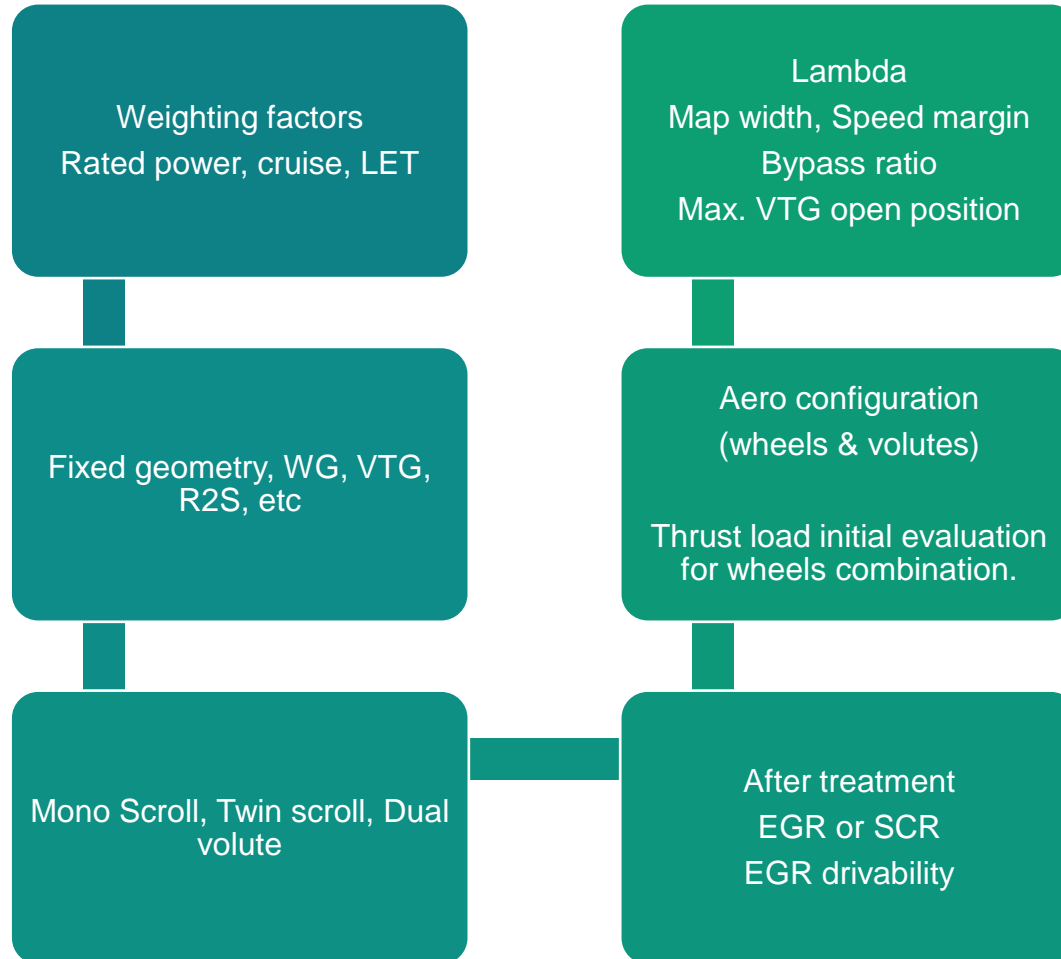
Development Targets

- Starting point of turbo reliability development.
- Identify and translate market needs / regulations into specific engine development targets, including but not limited to



Matching

- Based on specific technical inputs from customer, to define matching proposals



In general,
EGR requires higher PR, lower turbine
efficiency.
Suitable wheels to compensate for the
drawback.
SCR requires higher turbine efficiency.

Design

- Wastegate components selection
 - According to application and duty cycle, select proper wastegate components (LD, MD or HD)
- Bearing components selection
 - Engine performance data based thrust load calculation
- Material selection (temperature & duty cycle)
 - Compressor housing
 - Compressor wheel
 - Manufacturing process
 - Surface treatment
 - Turbine housing
 - O-ring
- Actuation components selection
 - Port size & actuator stroke balance
 - Heat shield

Simulation

- Thrust load calculation
- CFD simulation (optional, generally focused on performance)
- Kinematics calculation
- Thermal mechanical fatigue
- Modal analysis
- Blade frequency calculation
 - Compressor wheel
 - Turbine wheel
- LCF Lifetime calculation
 - Compressor wheel
 - Turbine wheel

Testing

- Generic development
 - Gen3 bearing system
 - Minimize axial packaging
 - Good rotor dynamic behavior for all rotor groups
 - Capability for lower viscosity oils, higher temps, higher speeds
 - Reduced friction
 - Reduced oil flow, improved oil sealing
- On engine
 - Temperature survey
 - Oil sealing
 - Vibration
 - Shaft motion
 - Thermal shock
 - Engine durability
 - Defined by customer
- On vehicle
 - Duty cycle measurement
 - Altitude / high temperature calibration
 - Overspeed avoidance during transient condition
 - Cold start
 - Vehicle durability
 - Defined by customer



Summary

- Market needs
 - Defines necessity of the development work
- Development Targets
 - Ensures the correct path
- Matching
 - Indicates aero configuration
- Design
 - Converts concepts / ideas to visualized model
 - Guides parts manufacturing process
- Simulation
 - Predicts risk tendency or level
- Testing
 - Verifies risks exist or not

A successful development relies on close cooperation and good trust!!!



