

## Foreword

This book is intended for the interested field working practitioner, consulting engineers and those who have to decide on the investment of a industrial gas turbine, mostly stationary gas turbine. The intention is to explain connections around the gas turbine. Of special concern is the understanding of prescriptions, specifications and rules you have to deal with during the „life“ of your gas turbine.

To make the understanding easier the chapters are labeled in front with a logo for the situation „from the life of an owner-driver“. This shall give the operator of a gas turbine the motivation to care for the requirements for the problem- and failure free use. So he is in them position for an economic success of his plant.

There will be answers to the question „*what is the reason?*“. They try to illustrate the answer without scientific claim but with technical acceptable explanations. Special effort was applied to the pictures. With this I hope to contribute essentially to the understanding of complex facts.

The special design of this book with many detailed described pictures and cross references shall ease look-ups without painful searching and introduction. This advantage may be bought by recapitulations in other parts of the book.

Condensed this book has a predecessor in the german edition „Ratgeber für Gasturbinenbetreiber“ 1999 published by Vulkan Verlag. It was realized in cooperation with Peter König. This english volume is an update with extensive additions and new issues. The pictures got more detailed descriptions to make technical connections more understandable.

The interested reader gets much more extensive informations in the 4 Volumes „Aircraft Turbine Engine Safety - Problem Oriented Technology for Professionals“ translated from German into English. They are distributed in the Home Page [www.turboconsult.de](http://www.turboconsult.de). The technology of industrial gas turbines is more and more alike this of aircraft engines. This is specially true for so called ‘derivates’.

# Contents

## Foreword

## Introduction

Our contribution towards a smooth operation

## Chapter 1

The procurement

1.1 The choice of a gas turbine

1.2 The acceptance run

## Chapter 2

The technology

2.1 Principles

2.2 The start

2.2.1 *The time of the start*

2.2.2 *Time dependent, rotational speed and temperature progression.*

2.2.3 *Operating performance in the start phase*

2.2.4 *The number of starts*

2.2.5 *Start abort and new start*

2.3 Steady state operation

2.4 Shut down and standstill

2.5 Changes of the operation performance with the running time

2.5.1 *The fall in the degree of efficiency during running time*

2.5.1.1 *Influence of the seals on engine performance*

2.5.1.2 *Increase of blade-roughness and profile changes*

2.5.2 Vibrations

2.6 The fuel

---

## Chapter 3

### Operation load and behavior of the components

#### 3.1 The compressor

3.1.1 *Typical problems, causes and effects on operation performance*

3.1.2 *Typical component problems in the compressor: causes and remedies*

3.1.2.1 *Mechanical problems*

3.1.2.2 *Air pollutants and foreign objects in the compressor: Causes and consequences*

3.1.2.3 *Corrosion and erosion*

3.1.2.4 *Sealing problems and establishment of clearance of rub systems*

#### 3.2 The combustion chamber

3.2.1 *Design layout*

3.2.2 *The operation behavior of the combustor*

3.2.3 *Typical problems of the combustion chamber, causes and remedies*

#### 3.3 The high pressure turbine, operation behavior and operation load

3.3.1 *Components of the high pressure turbine*

3.3.1.1 *HPT - Rotor blades*

3.3.1.2 *HPT- Disks*

3.3.1.3 *HPT- Nozzle guide vanes*

3.3.2 *Typical problems of the high pressure turbine - causes and remedies*

3.3.3 *Monitoring of the temperatures of turbine rotor blades with pyrometer*

#### 3.4 The low pressure or power turbine

3.4.1 *Operation behavior and operation load.*

3.4.2 *Typical problems of the low pressure turbine, causes and remedies*

---

### 3.5 The oil system and the bearings

3.5.1 *Typical problems, their causes and remedies in oil systems and bearings*

3.5.2 *Failures of bearings*

3.5.2.1 *Antifriction bearings*

3.5.2.2 *Sliding bearings/journal bearings*

### 3.6 Accessories

3.6.1 *Gears, controls, pumps and starters (-generators)*

3.6.2 *Problems with monitoring systems and probes.*

### 3.7 Periphery

3.7.1 *Inlet air and the exhaust area*

3.7.2 *Stationary gears*

## Chapter 4

### Maintenance, inspection, overhaul and repair

#### 4.1. Control measures

4.1.1 *The inspection.*

4.1.2 *Overhaul/'revision' (main inspection)*

4.1.3 *Monitoring during operation*

#### 4.2 Work on site.

4.2.1 *Repair friendliness of the gas turbine locally*

4.2.2 *Auxiliary and consumable materials - what one should observe*

4.2.2.1 *Cleaning agent*

4.2.2.2 *Sealing compounds*

4.2.2.3 *Lubricants*

4.2.2.4 *Markings*

4.2.3 *„Consumables“ which are normally replaced during maintenance and assembly*

4.2.3.1 *Bolts and nuts*

4.2.3.2 *Sealings*

---

#### 4.3 Maintenance and overhaul in the „shop“

4.3.1 *Repair friendliness of the gs turbine in the „shop“*

4.3.2 *The problematic of cheaper spare parts.*

4.3.3 *The operator is not always to blame! Failure favorable influences due to production and assembly.*

### **Chapter 5**

New technologies: risks and chances

#### 5.1. Technical monitoring of gas turbines.

5.1.1 *Continuous monitoring - „condition monitoring“*

5.1.2 *Sensors and methods for remote monitoring*

#### 5.2 Technology of the components of modern gas turbines

5.2.1 *Trends in material and production technologies*

#### 5.3 The determination of life from new and operated components

5.3.1 *Lifetime estimation from operation data*

### **Index**