

Chapter 1

Introduction

A century ago the first aircraft took off and aviation started to make tremendous progress. Half a century ago we succeeded for the first time in sending a man into space. This great step excited hopes of being able to travel to the planets of our solar system within the next few decades. But in astronautics this rapid evolution was not repeated. Today the transport of payload from our precious planet into orbit around it or into space beyond is still a huge challenge for men.

In aviation, air breathing propulsion systems are applicable for flights up to around 30 km and less than 3 km/s. Innovative electrical propulsion systems for in-space flight have proven their efficiency in space and their ability to maintain and control the orbit velocity of the spacecraft. But for the gap between these two propulsion systems, only the rocket engine with a chemical process is available.

The fact that all propellants for the flight have to be onboard necessitates a huge launcher with high take off mass compared to the mass of the payload. Hence a space mission is drastically more expensive than any other transport. High reliability despite high load is therefore a requirement for all components of a launcher system.

The performance and reliability of the propulsion system is of essential importance for any space mission. A failure of the propulsion system mostly leads to destruction of the whole launcher and loss of the complete mission. Fifty percent of lost launcher missions have their origin in a failure of the propulsion system.

Great efforts have been made to improve the performance and reliability of chemical propulsion systems. Special materials were developed, the design of the components of the rocket engines were optimised, the behaviour of the propulsion systems was carefully scrutinised and the theoretical prediction of the performance was improved. However, the prediction of the behaviour of this complex system is still very difficult, since it requires the knowledge of dynamic processes, transients and interaction of various subcomponents of the propulsion system.

Many remaining questions and the confirmation of all calculations are left to the test of the rocket engine on a test facility. Here we can study the real characteristics of the engine, we can subject it to the limits of its performance, and we can observe which traces under the load of repeated long duration tests will occur on the engine subcomponents. The test facility is an indispensable tool to bring a propulsion system to maturity for flight and is therefore a most interesting place of work for space scientists.

Normally a test facility is specially designed for the very rocket engine to be developed and qualified. Each test preparation begins with an intensive look at the details of the propulsion system. Its characteristics and the test requirements have to be matched with the performance of the facility. Test preparation, execution and post-test activities are laid down in a system of procedures performed by a specially trained test team. The procedures not only cover the handling and testing of the rocket engine but also the operation of various bench subsystems. All bench systems have the central aim of enabling the engine test and to simulate an environment to the tested rocket engine as if it were on the real launcher.

As well as the launcher, the test facility is a very valuable module for astronautics. In spite of the high investment, the combined experience and know-how of the test facility and its team is of even higher value. The extraordinary, almost unique process of running a test facility for rocket engines and the gaining of experience from operating the facility and the rocket engine have to be combined and conserved in order to build up the art of operating rocket engine test facilities as a reliable module within space science. This book is an outline of how to operate a test facility, how to maintain it and keep it available and how to modify it over the decades to meet the needs of rocket propulsion technology.

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An Outline with Down-to-Earth and Up-to-Space
Remarks

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