

2 Transient Performance

2.1 Introduction

Transient Performance is that area of the subject concerned usually with the changes in engine parameters during acceleration or deceleration of an engine from one steady-state point to a different steady state point. An engine can also experience cyclic aerodynamic phenomena which occur at a nominally steady condition; examples are compressor rotating stall and intake or afterburner buzz. It is worth noting that wherever the text refers to accelerations the statements generally apply equally to decelerations. The principles used to predict engine parameters during accelerations are those encountered in steady state performance, except whereas in steady state the turbine output power was identically equal to the required compressor power (plus suitably modelled losses), in transients the turbine excess power is used, to overcome component inertias and accelerate the shafts. In its simplest statement, devoid of the complexities of control system laws, the excess turbine power originates from the increased fuel flow at an rpm in the instant that the throttle is opened.

The ability to predict transient performance is required to:

- (a) Determine whether the proposed compressor working lines have sufficient margin from surge when the excursions during slam acceleration and/or slam decelerations are applied.
- (b) Predict the acceleration response of new engine designs to see if it is fast enough for the various requirements.
- (c) Predict transient performance at unusual conditions much more quickly and cheaply than by test, e.g. 50000 ft at stall Mach number.
- (d) Predict effects of failures on engine performance, e.g. failure of variable guide vanes to close.
- (e) Predict the behaviour of the engine after a shaft breakage.
- (f) Explore alternative engine control laws; for instance, if the datum laws have proved deficient on a development engine.
- (g) Predict the effects of cyclic changes on engine performance, e.g. rotating stall, and intake buzz.

2.2 Certification Requirements

CAA (British Civil Airworthiness Authority) and FAA (Federal Aviation Authority) requirements are basically similar.