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Analysing Regulatory Standards for Flight Simulators

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Extended Abstract

The aviation regulatory standards applicable to all types of flight training devices are provided by four main authorities: the Civil Airworthiness Authority (CAA) [1], the Federal Aviation Authority (FAA) [2], the European Aviation Safety Agency (EASA) [3] and the International Civil Aviation Organization (ICAO) [4].

In order to be qualified for training, a flight simulator must demonstrate a close match to either flight test data obtained from actual flight tests or engineering validation data supplied by aircraft manufacturers. The Qualification Test Guide (QTG) defines the tests necessary to qualify training devices. Tolerances on key parameters determine the success or failure of each test.

In this paper, the focus is on QTG tests. The four regulatory standards are compared in order to determine the differences in tolerances. The tolerances are then analysed. For example, the normal landing test tolerances are identical for all four standards: ± 3 kts on airspeed, ± 1.5º on pitch angle and angle of attack (AOA), ± 10% or ± 3 m (10 ft) on height and, for aeroplanes with reversible flight control systems, ± 10% or ± 2·2 daN (5 lb) on column force. In the case of the normal landing test, the tolerances on the pitch and angle of attack are examined by considering one of the basic equations in flight mechanics. It is well known that the pitch angle equals the sum of the flight path angle and AOA. This implies that if both pitch and AOA are +1.5º, the tolerance on the flight path angle is zero. The rate of climb equals the product of forward airspeed and the sine component of the flight path angle. The tolerances on airspeed and height should be shown compatible with this equation. The aim is to highlight the necessity of providing explanations, derivations, and the basis of the tolerances provided in the regulatory documents. Such details would be very useful to help develop objective 'engineering judgment', a term used frequently in the referenced documents.

Although the parameters to be plotted for each test are already listed in [1], ease of evaluation of a given test should dictate the key parameters and the order in which they are plotted. Given that results are now presented in electronic format, constraints on the number of pages no longer apply, hence more parameters may be plotted for clarity. For example, wind velocities should always be plotted, as it is reasonable to assume that perfect atmospheric conditions are seldom achieved during flight tests.

Another area that is addressed is specifications of dynamic control checks. Current tolerances on control outputs are in terms of time response characteristics. However, control loading systems used in flight simulators are generic and are adapted to the specific device by means of simple adjustments. They must follow ramp inputs with ideally zero error. Therefore, they are required to be of type-two systems ideally or at least a type-one system with integrator. The frequency domain characterization of type-zero system with sufficiently high steady-state gains or type-one system may be specified, along with adequate gain and phase margins. The systems could then be qualified independently based on the velocity error constant requirement. When integrated with flight simulators, only minimum adjustments would be required to meet QTG standards.

In summary, an appeal is made to the authorities to examine the QTG tolerances specified in the available standards, to provide more detailed guidelines for flight simulator designers, to revise the

plotted parameters and their order for ease of evaluation, and to define new specifications for all generic systems that can be qualified independently.

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