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Space systems — Structural design — Determination of loading levels for static qualification testing of launch vehicles

Systèmes spatiaux — Conception des structures — Détermination des niveaux de chargement pour un essai statique de qualification des véhicules lanceurs

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Foreword

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International Standard ISO 14953 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Space systems — Structural design — Determination of loading levels for static qualification of launch vehicles

1 Scope

This International Standard specifies a procedure for determining the loading level of a qualification test of a launch vehicle structure and takes into account all the minimum allowable strength characteristics necessary for these structures.

This International Standard establishes the required resistance necessary for all mass-produced items to comply with product assurance criteria.

2 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

2.1
external mechanical loading
system of forces and moments external to a structure and brought to bear on that structure

2.2
safety factor
J
coefficient by which a limit load is multiplied

2.2.1
yield strength safety factor
J_E
ratio of the yield load of the material to the limit load

NOTE This coefficient is applicable only to metal structures.

2.2.2
ultimate safety factor
J_R
ratio of the allowable ultimate load to the limit load

2.3
overload
excess of internal distributed load used for certain calculations to account for design

3 Design of loading levels

3.1 General

Qualification tests shall be conducted on a flight-type structure. Because such structures are unlikely to include minimum values for all allowable characteristics, the loads used for design shall be corrected before use in

qualification tests. All areas of the launch-vehicle flight structure shown to be critical in probable failure modes shall be considered for the following correction which shall be used to determine qualification test loading.

3.2 Calculation of qualification test loading

The corrected external loading, P_Q, (force, moment, pressure) used for qualification tests shall be calculated from the following equation:

$$P_Q = P_{lim} \times J_C$$

where

P_{lim} is the external loading limit corresponding to the of the highest stress combination of external loads likely to occur simultaneously while in service (value used for design);

J_C is the corrected safety factor (see 3.3).

3.3 Corrected safety factor

The corrected factor, J_C, is given by the following equation:

$$J_C = \frac{J \times K_{min} \times K_{adj} + K_T}{K_\theta \times K_\sigma}$$

where:

J is the safety factor used for design (either for yield or for ultimate conditions);

K_{min} is the correction factor for thickness (see 3.4.1);

K_{adj} is the correction factor for adjacent structures (see 3.4.2);

K_T is the correction factor for thermal gradients (see 3.4.3);

K_θ is the correction factor for temperature (see 3.4.4);

K_σ is the correction factor for the moduli (see 3.4.5).

3.4 Correction factors

3.4.1 Correction factor for thickness, K_{min}

This factor takes into account the influence of the minimum thickness on the structure resistance; it is defined as the ratio of the thickness of the test specimen to the minimum allowable manufacturing thickness.

This correction factor is applicable only to metal structures. For other structures, use $K_{min} = 1$.

3.4.2 Correction factor for adjacent structures, K_{adj}

3.4.2.1 Generally speaking during static qualification tests, the influence of adjacent structures should be simulated. In this case, take $K_{adj} = 1$.

3.4.2.2 When the influence of adjacent structures cannot be simulated correctly by the test facility, use a correction factor K_{adj}. The authority in charge of the structure shall deduce this factor by comparing results of two calculations made from the theoretical model.