Graduated justification methodology by multilevel severe tests

Arnaud URIEN, Jean-Michel LARRIEU - SAFRAN Herakles

In a product development program, a successful equipment test is an important milestone. However, as budgets tighten, tests are often more expensive than calculations, and test programs are increasingly reduced. This is especially true in the development of solid rocket motors, whose trials are often destructive ("one shot" product).

In this context, the severe tests are preferred because they can justify design margins, and therefore a reliability with respect to a failure scenario, by performing a reduced number of trials. The principle of the severe test is to test the product under conditions where the predominant functional parameter is outside its nominal range, demonstrating the robustness of the product in case of success. The proven reliability is then deduced from the applied severity coefficient.

Current severe tests methods (the GTPS 11F method for example) are only applicable to a set of tests at the same level of severity, with the risk that a test failure calls into question the product qualification.

The methodology presented here is applicable to a set of tests with different severity levels, each successful test allowing to improve the demonstrated reliability in terms of its severity coefficient.

This method opens the way to a logic of graduated justification through multilevel severe tests, where each test, more and more severe, complements the previous ones and shows an additional margin. In case of failure of a test, the reliability demonstrated by the previous tests is not questioned because the level of severity that led to the failure is higher.

This logic has been implemented on a solid rocket motor in order to demonstrate security requirements at firing at the end of life. Two severe firing tests have been carried out, with severity coefficients in the most severe conditions of 1.6 and 1.7 which is representative of the end of life for the first one, and with increased aging for the second.

An application example of this methodology on a composite case’s pressure resistance will be presented in detail, and will show the interest of this logic.