RECENT DEVELOPMENTS IN STRUCTURAL VERIFICATION OF SPACECRAFT

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ABSTRACT

Structural verification is an essential and major part of the space flight hardware development process. The primary objective of structural verification is to ensure that the spacecraft can survive the loads to be encountered in its service life.

Over the past three decades, structural design and configuration of spacecraft have gone through many changes. The large, highly flexible structural systems of modern spacecraft, such as the Hubble Space Telescope and the Galileo, are subjected to structural verification requirements significantly different from those imposed on the structural design of the small and nearly rigid earth-orbiting satellites, such as the Pioneer and the Ranger, that were launched in the late 1950s and early 19,60s.' In the 1980s, the operation of the Space Shuttle added several new considerations, such as fracture control, for structural verification of payloads developed for manned space flights. It. was also in the 1.980s that the increasingly wider applications of advanced materials, notably the high-modulus graphite/epoxy composites, to primary load-carrying structures prompted the urgent need for verification criteria specifically established for nonmetallic structures. Finally, two important new trends have developed during the last two decades: (1) several new families of expendable launch vehicles have been put into commercial service by domestic and foreign operators, and (2) more space missions are being developed by joint efforts of different countries. These have added new considerations to structural verification of payloads developed for multiple launchers or for missions with international partners.

This paper will provide a summary discussion of recent developments in the structural design, analysis, and test verification requirements applied to NASA spacecraft. Because many of the verification requirements are defined in terms of design and test safety factors, considerations on the selection of safety factors and related issues will be addressed. The latest developments in Space Shuttle payload fracture control requirements and implementation methodologies will be discussed, The importance of early determination of the most cost-effective structural verification approach for a spacecraft and the influences of that approach on the design requirements and development program, along with test validation alternatives and rationale for selection, will also be covered.