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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Upper Stages, Space Transfer, Entry and Landing Systems (3)

Author: Mr. Olexandr Kashanov
Yuzhnoye State Design Office, Ukraine, kashanov51@mail.ru

ENSURING OPERATING EFFICIENCY OF ILV SPACE STAGES PROPELLANT FEEDING
SYSTEMS IN DIFFERENT OPERATING CONDITIONS

Abstract

A stable tendency of creation of space stages (SS) capable of ensuring the possibility of making SC cluster launches by one launch vehicle (LV) by means of multiple ignitions of stage's main engine (ME) under micro gravity causes the necessity of ensuring continuity of liquid propellant components (PC) in ME feeding lines. Based on the long-standing experience of successful creation of space stages for various purposes, Yuzhnoye SDO developed the design of intra-tank continuity ensuring device (CED) for liquid PC at SS propellant tank outlet. To assess the CED effectiveness in different SS operating conditions, the NASU and SSAU ITM developed the scientific-methodical support system based on the methods of finite elements, liquid volume, and computer analysis technology (CAE systems) allowing to do the following with consideration for peculiarities of intra-tank space architecture: to determine the forms and parameters of PC free surfaces motion in stage's tanks; to reveal the flight modes which are potentially hazardous in respect of possibility of penetrating of pressurization gas or replacement gas dissolved in PC into ME propellant lines and to obtain quantitative evaluations of CED serviceability in those modes; to reveal ME ignition conditions accompanied by pressurization gas penetration into ME propellant lines, to obtain quantitative evaluations of degree of their impact on ME ignition stability; to determine the parameters of dynamic processes in stage's propellant feeding system during ME ignition and cut-off. The use of the developed intra-tank PC continuity ensuring device and scientific-methodical support system for determination of the parameters of gas dynamic environment in stage's tanks as a basis for selection of CED design parameters will allow creating the propellant feeding systems that are characterized by high degree of completeness of onboard propellant consumption and will provide the possibility of widening the range of target tasks to be accomplished by a stage and of developing the new and updated space stages test programs with rational scope and minimal cost.