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ON ASSURING THE RELIABILITY OF SPACE HARDWARE AT THE DESIGN STAGE

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This paper considers possible approaches to the solution of problems of space hardware reliability assurance at the design stage.

It is shown that in the reliability design of space hardware one must take into account the service loads on the basis of prescribed strength norms and other design norms, which are realized together with the rules of acceptance, operation, inspection, maintenance, and recovery. Design studies of space hardware reliability must assure specified reliability indices under existing restrictions.

A procedure of choosing the reliability indices of a space hardware object and components thereof is considered.

It is shown that one can use two approaches to justifying the values of reliability indices. One approach (demand) consists in assuring a certain minimum reliability level. The other approach (possibility) consists in assuring the maximum possible reliability indices of a space hardware object under specified or inherent restrictions on cost (price, mass, volume, etc.), while keeping the required reliability level not lower than that of its counterpart.

The paper characterizes approaches to assuring the reliability of space hardware at the design stage, which include: successive solutions of reliability assurance and control problems at the design stage, a work package on reliability standardization at the design stage, and the choice of reliability indices with the justification of their values.

The proposed approach is illustrated by the example of reliability assessment for some launch complexes.

Keywords: *space hardware, launch complex, reliability indices, redundancy, maintenance, confidence probability, development, flight tests.*

1. Hudramovich V. S., Sirenko V. N., Klimenko D. V., Daniev Yu. F., Hart E. L. Development of the normative framework methodology for justifying the residual resource of starting buildings constructions of space launch vehicles. *Strengths of Materials*. 2019. V. 51. No. 3. Pp. 333-340. <https://doi.org/10.1007/s11223-019-00079-4>
2. *Sixty Years in Rocket Production and Cosmonautics*. A. V. Degtyarev (Ed.). Dnipropetrovsk: ART Press, 2014. 540 pp. (in Russian).
3. Hudramovich V. S., Daniev Yu. F., Poshyvalov V. P. On approaches to rocket space complex strength standardization and reliability assurance. In: *Topical Problems in Mechanics*. M. V. Poliakov (Ed.). Dnipro: Lira, 2018. Pp. 216-224. (in Russian). <https://doi.org/10.15407/itm2018.03.112>
4. Degtyarev A. V., Pylypenko O. V., Gudramovych V. S., Sirenko V. N., Daniev, Yu. F., Klimenko D. V., Poshyvalov V. P. About the classification of launch equipment of the space launch systems for the strength standards justification. *Space Sci. & Technol.* 2016. V. 22. No. 1. Pp. 3-13. (in Russian). <https://doi.org/10.15407/knit2016.01.003>
5. Poshyvalov V. P., Daniev, Yu. F., Reznichenko L. V. System approach to complex system reliability assurance. *System Technologies*. 2017. No. 2. Pp. 27-34. (in Russian).
6. Biryukov G. P., Smirnov V. I. *Elements of Space-Rocket Complex Design Theory*. Moscow: MAI, 2003. 286 pp. (in Russian).
7. Biryukov G. P., Kukushkin A. V., Torpachev A. V. *Basics of Launch Complex Reliability and Security Assurance*. Moscow: MAI, 2002. 264 pp. (in Russian).
8. *Reliability and Efficiency in Engineering: Handbook*. In 10 volumes. V. S. Avduevsky (Chf Ed.). V. 5. Reliability Design Analysis. Moscow: Mashinostroyeniye, 1988. 316 pp. (in Russian).

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