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REALIZATION OF TRANSPORT VEHICLES OPERATIONS TAKING INTO ACCOUNT  
OFF-NOMINAL SITUATIONS

**Abstract**

More than 15-years mission of the International Space Station (ISS) has been continuously supported by transport vehicles both manned and cargo ones. Currently, main role is played by Russian Soyuz transport manned vehicles and Progress transport cargo vehicles, which fulfill 10 missions per year or even more. The entire ISS mission plan realization depends on reliable execution of transport vehicles mission operations (transport operations).

At the same time, increase of transport operations number, their complexity, introduction of new transport vehicle modifications, generation of new ISS mission tasks cause not only high probability of off-nominal situations (ONS) but also a number of real ONS. Consideration of off-nominal situations including detection, overcoming, analysis and prevention of future ONS becomes the most important task to provide reliable execution of transport operations.

Using the experience accumulated during long-term ISS mission the paper presents basic principles of ONS consideration while performing transport operations, which are appropriate to be used for transport operations of modern and future space station missions:

- Required ONS consideration on different phases of transport operations preparation and realization,
- Use of various technologies of prevention and overcoming of ONS,
- Analysis of both real and possible ONS reasons,
- Development of flight control facilities, software and technologies to prevent ONS, etc.

Possible ONS are already taken into account on the phase of transport vehicle development (duplicate systems, back-up functions, margins in resources, etc.). Great deal of work to prepare transport operations is done before transport vehicles flight (nominal and back-up plans development, procedures simulation, control team and crew training, etc.).

On the operational phase it is important to consider ONS in mission planning, in case of real ONS, to predict its impact on the mission plan correctly, to provide appropriate updating of the mission plan. Additional problems are caused by specific features of transport vehicles flight: limited time of operations, crew safety requirements, simultaneous flight of several vehicles, etc.

As the total number of possible ONS is quite numerous, it is necessary to make certain assumptions, to take into account the most probable situations and situations with the most considerable consequences. ONS classification from different standpoints is presented in the paper.

The paper also gives recommendations on transport operations realization in case of ONS on the basis of lessons learned during flight control of transport vehicles in the ISS mission, which can be used in future transportation systems missions.