



The Space Congress® Proceedings

1995 (32nd) People and Technology - The Case For
Space

Apr 26th, 2:00 PM - 5:00 PM

Paper Session II-A - Energy Block of International Space Station "Alpha"

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Anatoli I. Kiselev, "Paper Session II-A - Energy Block of International Space Station "Alpha"" (April 26, 1995). *The Space Congress® Proceedings*. Paper 28.

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ENERGY BLOCK OF INTERNATIONAL SPACE STATION "ALPHA"

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The international space station "Alpha" consists of the American, Russian, European and Japanese segments. Its integration in the orbit will take place in November, 1997 starting from the injection of 20-tonn energy block on the basis of the unified functional cargo block (russian abbreviation as EFGB) by means of the "Proton" LV. The EFGB is designed by the KHRUNICHEV State Research and Production Space Center (KSRPSC). The orbit hight with the inclination of 51.6 deg for EFGB is so selected that by the end of December, 1997 it can be decreased upto the hight (approx. 150 nautical miles) at which the first American module-NODE-1 of 14 tonns would be injected by the "Space Shuttle" SV and then integrated with the EFGB.

In April, 1998 it is planned to inject the service module (SM) of 20 tonns (also created by KSRPSC on the basis of the "MIR" space station basic block) by the "Proton" LV and integrate it with the couple EFGB + NODE-1. For that EFGB will provide the couple stabilization, its interorbital manuevres and play an active role during mating. Then the other blocks and modules will be attached in the specified sequence and the ISSA creation will be finished in 2002. In this case the operation orbit hight will be 220 - 240 nautical miles.

Besides the role described above, for all phases of assembly and operation of the station (not less than within 15 years) EFGB will be as a structural element and a part of inhabited environment as well as the ISSA information and energy systems. The EFGB provides power supply at the initial phase. For that it is equipped with the solar arrays (with capacity upto ... kW) and accumulators. The solar arrays should be closed after deployment of heat dissipation pannels on the American segment trusses.

As a part of the united pneumohydraulic system which includes SM and transport vehicles the EFGB provides the receipt and delivery of fuel.

The EFGB can be also used for the installation of specific scientific-research and experimental equipment as well as for storage of consumables and reserve equipment.

The unified functional cargo block (FGB) which forms the basis of the EFGB was designed by "Salyut" DB which is a part of KSRPSC now. The FGB was designed as the basis for the multipurpose SCs of heavy class. These SCs were intended for the extended autonomous flight, then as a main part of the space station as well as cargo vehicles for cargo delivery and space tugs for multipurpose modules delivery. For that the FGB provides the possibility to keep them active during docking as well as, if necessary, to stabilize and correct the station orbit.

The unified FGB is easily adaptive within the wide range: the supply of fuel on board stored in cylindrical tanks with bellows displacer can be varied from 1.5 t to 10 t and above dependently on the task to be sought. The FGB engines (2 pieces with the thrust of 400 kg each, 20 pieces with the thrust of 40 kg each and 16 pieces with the thrust of 1.3 kg each) united into a few "bunches" can be arranged on the core in different ways dependently on the task to be sought.

Generally the power supply system can be presented with the solar arrays of different type and buffer accumulators as well. For a short-duration flight the solar arrays are not necessary to be provided.

The entire internal pressurised volume of the core is 55 m³, 12 m³ of which are occupied with compartments and service systems (including docking equipment). The rest volume is meant for the payload arrangement as well as habitation area. If necessary the internal volume can be extended by 100 m³ by the core elongation both from the side of the smaller diameter (2.9 m) and the larger diameter (4.1 m) - for the vehicles of 20-tonn-class launched with the "Proton" LV.

If the load-lifting capacity of LV is higher the pressurised volume of the core could be accordingly bigger. (For example, the volume of the "Polyus" SC of 80 tonnes which was as the first payload for "Energy" LV was equal to 300 m³).

Manufacturing procedure for all the options of FGB core and cores of all vehicles of "Salyut" type, "MIR" basic block and SM ISSA are completely unified with the "Proton" LV core manufacture.

On the basis of the unified FGB a series of autonomous space vehicles of 20-tonn-class of "Kosmos-924, -1267, 1443 and - 1686" type has been created

as well as all the modules of "MIR" station including "Kvant" module for which the FGB was used as a space tug, but the other modules were docked by themselves. Their condition after the long-duration (upto 8 years) staying in the orbit gives grounds to predict with confidence the normal operation of the EFGB within 15 years.

On the basis of the unified FGB it is also suggested to create transportation vehicles to deliver to ISSA large batches of cargo (upto 10 - 11 t of net weight) inside the pressurised compartment as well as outside it.

After these vehicles accomplish their transportation task some of them could be incorporated into the station as a part of it for arrangement of scientific and service equipment. It is also advisable to reenter the transportation vehicles by means of the "Space Shuttle" SV.

On the basis of the tested FGB elements, such as propulsion plant, control system, service systems, a narrow specialized space tug can be created with the simpler configuration and for the smaller cost. It would be distinguished for its minimum fuel amount stored, reduced weight of the core with the length of 1.5 m and specialized for the arrangement of the equipment excluding solar arrays. Also it could be coupled with different launch vehicles of heavy and middle classes. Coupled with the "Proton" LV such space tug could inject the ISS into the orbit and mate the payload of ____ t (gross weight).

The high-reliable "Proton" LV could be considered as a transportation base for the in-orbit assembly and supplies for the ISS. It could be used by two ways:

- 3-stage option - to inject payload (upto 21 tonn) into the low orbits (200 - 400 km) with the orbit inclination of 51.6 or 65 deg;
- 4-stage option - to inject SCs of different purposes into the orbits of middle (from 500 km and above) and high

high, mainly the geostationary orbit (upto 80 % of all launches), as well as interplanet escape trajectories.

The "Proton" LV was designed and up to now manufactured by the Khrunichev State Research and Production Space Center. The "Proton" LV 1st, 11nd and 111rd stages operate on high-boiling self-reactive fuel components - nitric tetroxide and unsymmetrical dimethyl hydrazine. The engines of these stages (6 engines for the 1st stage, 4 engines for the 11nd one, and 2 engines - 1 cruise engine and 1 four-chamber pivoting engine - for the 111rd stage) were designed on the advanced system with reheating gasifier gas in combustion chamber with pressure of 15 - 16 MPa. These engines are in line with the level of advanced requirements of the next period of development.

The IVth stage operates on hydrocarbonic fuel and liquid oxidizer. This stage accepts multiple ignition in micro-gravity with long intervals (upto 24 hours), which ensures the injection of SCs directly to the specified point in the geostationary orbit. This will allow to simplify SC configuration without application of apogee propulsion plant. At the moment the IVth stage is developed to operate on hydrogen-oxygen propellant and ensure encreasing load-lifting capacity by more than 1.5 times.

Generation of control moments for the 1st and 11nd stages is attained by the engines gimbaling in tangential direction. On the 111rd stage the cruise engine is stationary and the control moments are caused by gimbaling four chambers of the pivoting chamber.

The control system is of autonomous, inertial type with triplicate redundancy.

The launcher is a high-automated facility. All the filling, drain, pneumatic and electric lines are connected on the end of the LV without ordinary umbilical tower and service mast.

To avoid the Earth-orbital environment pollution the 111rd stage is injected into the elliptical orbit with low perigee and then from the first half turn it falls down to the Ocean remote areas. In this case the velocity deficit upto the circular velocity (50 - 60 km/s) is compensated by the means of the SC injected.

Presently the "Proton" LV is modernized to increase the load-lifting capability and the available size of SCs injected as well as to improve the operational and ecological features.