Mounting requirements to launch devices with a SSC of “CubeSat” type

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Content

Introduction

Present document contains basic mounting requirements to launch devices with "CubeSat" type SSC as a piggyback load, which is placed on adapters, produced by SSC "Progress" JSC, are used for payload launch with the assembly of NF with a "Volga" US.

Present document is developed according to the Instruction N 536 of SSC "Progress" JSC dated 01.04.2015.

Two variants of accommodation of "CubeSat" type SSC are presented in the given document:

Variant 1 – usage of launch adapter, developed by SSC Progress JSC (235KS product), as launch device for SSC accommodation.

Variant 2 – usage of foreign launch devices for SSC accommodation.

An application on possibility of mounting and "CubeSat" type SSC launch services can be considered only after determination of special-purpose payload.

Final initial data on a SSC and launch devices are issued in SSC "Progress" JSC no less than 13 months before an ILV launch.

1 General information

1.1 “Volga” US is developed for use jointly with Soyuz-2-1a, Soyuz-2-1b, and Soyuz-2-1c LV, and provides payload injection into low circular orbits with an altitude up to 1500 km and into sun-synchronous orbits with an altitude up to 850 km as well.

1.2 “Volga” US provides solution of the following tasks:

- NF transfer from reference orbit to target orbit;
- stabilization and specified orientation of NF on passive and powered flight phases, and NF spinning if necessary;
- US state control during injection into orbit;
- submerge (or withdrawal) of an Upper Stage with an adapter from the target orbit.

1.3 To provide rigid connection of “Volga” US with a SC, adapters with SC separation devices are used.

1.4 An adapter, developed by SSC “Progress” JSC, provides a possibility in principle to mount a “CubeSat” type SSC launch device for SSC launch as a piggyback load, and SSC will be separated on the same orbit as a main SC at that.

1.5 Signal for actuation of launch device’s separation system is determined on the basis of non-impact condition.

1.6 Confirmation signal of a SSC separation can be received in current or subsequent to separation signal communication session.

1.7 SSC can be mounted on an adapter with the help of LA, developed by SSC “Progress” JSC (235 KS product) or foreign launch device.

2 Operating conditions

"CubeSat" type SSC operating conditions starting from its mounting on adapter correspond to host SC and "Volga" US requirements.

2.1 Assembly (dismantling) of launch device with a SSC is performed at UC Universal Processing Facility (UPF) under the following conditions:

- air temperature shall be from 10 up to 35 °C (temperature daily variations are no more than 10 °C);
- air pressure (100±6,7) kPa ((750±50) mmHg);
- relative air humidity - no more than 80 %.

2.2 Conditions during transportation of SSC with a launch device in the assembly with the UC to ILV PF and in the assembly with the ILV to a Launch Site and backwards in case of launch cancellation shall be as follows:

- air temperature from 10 up to 30 °C;
- air pressure (100±6,7) kPa ((750±50) mmHg);
- relative air humidity no more than 80 %;
- range of purity of constant-temperature air according to GOST ISO 14644-1-2002 is no worse than 8 ISO.

2.3 Maximal transportation speed in the assembly with the UC – 10 km/h, maximal transportation speed in the assembly with the ILV – 5 km/h. Maximal distance of single transportation in the assembly with the UC – 60 km, maximal distance of single transportation in the assembly with the ILV – 10 km.

Note: threefold transportation is allowed in case of launch cancellation.

2.4 ILV installation in Launch Facility shall be performed under the following conditions:

ILV installation in Launch Facility shall be performed in field conditions under the air temperature from minus 40 up to 45^0C with relative air humidity up to 100%.

Note: short-time air temperature decrease up to minus 49.9 °C no more than 2.5 days in a year at "Vostochny" spaceport is possible.

2.5 Conditions inside of APU in the assembly with the ILV at LS shall be as follows:

- air temperature from 10 up to 30 °C, temperature variation from minus 20 up to 30 °C during max. 3 hours is allowed;

- air pressure (100±6,7) kPa ((750±50) mmHg);

- relative air humidity max. 80 %.

2.6 Rate of pressure variation shall be no more than 2 kPa/sec (15 mmHg/sec) within LV flight area, and rate of pressure variation can reach 4.7 kPa/sec (35 mmHg/sec) during 3s at that.

Velocity pressure at the moment of APU Nose Fairing's panels separation is 19.6±19.6 Pa (2±2 kgf/m²).

Density level of heat flow affecting launch device is calculated during analysis of specific launch mission.

2.7 Launch device with a SSC on orbit flight area are affected by the following conditions:

- zero gravity;

- ambient air pressure is no less than $0{,}13 \cdot 10^{-9}$ kPa ($1{,}0 \cdot 10^{-9}$ mmHg);

- temperature - from minus 150 up to plus 125°;

- ionizing radiation of outer space.

2.8 Requirements on mechanical effect modes for "CubeSat" type SSC under joint operation with universal LA on products, produced by SSC "Progress" JSC are given in Tables 1-8. Information about mechanical effect modes is preliminary and can be specified for certain launch with taking into consideration physical LA mounting place and operation conditions.

Mechanical effect modes are set at attaching points of "CubeSat" type SSC to universal LA and referred to every of three mutually perpendicular axes.

"CubeSat" type SSC and its structural components don't have to interfere by resonances within frequency band up to 25 Hz.

2.8.1 Mechanical effect modes on zero-lift trajectory of "CubeSat" type SSC with universal LA 235KS in case of LA mounting onto APU IB, developed by SSC "Progress" JSC, are presented in the following Tables:

- Tables 1, 2 on vibrations;
- Table 3 on linear acceleration;
- Table 4 on shocks.

Acoustic pressure with summarized mean-square level of 144.1 dB during 60 sec (reading of acoustic pressure level values is from $P=2\cdot10^{-5}$ Pa) has an effect on zero-lift trajectory of "CubeSat" type SSC.

Table 1 – Operational modes of wideband random vibration

Number of mode	Frequency, Hz							Duration, s
	20	50	100	200	500	1000	2000	
	Spectral density of vibration acceleration, $m^2\cdot s^{-4}\cdot Hz^{-1}$ (g^2/Hz)							
1	2,89 (0,03)	3,85 (0,04)	5,77 (0,06)	11,54 (0,12)	57,72-110,63 (0,6-1,15)	110,63-28,86 (1,15-0,3)	28,86 (0,3)	120
2	1,92 (0,02)	1,92 (0,02)	3,85 (0,04)	5,77 (0,06)	9,62 (0,1)	9,62 (0,1)	4,81 (0,05)	480
Note- spectral density of vibration acceleration between frequencies has linear variation in logarithmic scale of frequency and spectral density								

Table 2 – Operational modes of low-frequency vibrational load

Frequency sub-band, Hz				Vibration duration in every frequency sub-band, s
1-2	2-5	5-10	10-20	
Vibration acceleration amplitude, m/s^2 (g)				
4,9 (0,5)	9,81 (1,0)	9,81 (1,0)	14,7 (1,5)	120
Note – vibration acceleration in frequency sub-band has linear variation in logarithmic scale of frequency.				

Table 3 – Operational modes of linear accelerations, acting in both directions on every of three mutually perpendicular axes.

Acceleration, m/s^2 (g)	Duration of linear acceleration in every direction, s
98,1 (10)	600

Table 4 – Operational modes of shocks (in the form of spectrum of shock with a factor of merit Q= 10)

<table>
<tr><th rowspan="3">Number of mode</th><th colspan="7">Frequency, Hz</th><th rowspan="3">Number of shocks</th></tr>
<tr><th>50</th><th>100</th><th>200</th><th>500</th><th>1000</th><th>2000</th><th>5000</th></tr>
<tr><th colspan="7">Values of shock spectrum, m/s^2 (g)</th></tr>
<tr><td>1</td><td>245
(25)</td><td>736
(75)</td><td>1960
(200)</td><td>5890
(600)</td><td>17200
(1750)</td><td>24500
(2500)</td><td>24500
(2500)</td><td>3</td></tr>
<tr><td>2</td><td>98
(10)</td><td>294
(30)</td><td>885
(90)</td><td>3430
(350)</td><td>5900
(600)</td><td>5900
(600)</td><td>5900
(600)</td><td>8</td></tr>
<tr><td>3</td><td>687
(70)</td><td>1079
(110)</td><td>1766
(180)</td><td>3139
(320)</td><td>7848
(800)</td><td>19620
(2000)</td><td>19620
(2000)</td><td>1</td></tr>
<tr><td colspan="9">Note:
1) Shock spectrum values between frequencies have linear variation in logarithmic scale of frequency and shock's spectrum.
2) Mode 3 corresponds to shock, caused by LA mechanisms actuation, and has been developed on the basis of vibration acceleration measurements under LA mechanisms actuation with use of felt between pyro-pin and LA's case.</td></tr>
</table>

2.8.2 Mechanical effect modes on zero-lift trajectory of "CubeSat" type SSC with universal LA 235KS in case of LA mounting to the SC or PL adapter, developed by SSC "Progress" JSC, are presented in the following Tables:

- Tables 5, 6 on vibrations;
- Table 7 on linear accelerations;
- Table 8 on shocks.

"CubeSat" type SSC is subjected to acoustic pressure with summarized mean-square level of 144 dB during 60 s (reading of acoustic pressure level values is from $P=2\cdot10^{-5}$ Pa) on zero-lift trajectory.

Table 5 – Operational modes of wideband random vibration

Number of	Frequency, Hz							Duration, s
	20	50	100	200	500	1000	2000	
	Spectral density of vibration acceleration, $m^2 \cdot s^{-4} \cdot Hz^{-1}$ (g^2/Hz)							
1	1,92 (0,02)	3,85 (0,04)	5,77 (0,06)	7,69 (0,08)	7,69 (0,08)	2,4 (0,025)	0,962 (0,01)	120
2	0,48 (0,005)	0,48 (0,005)	0,77 (0,008)	0,96 (0,01)	0,96 (0,01)	0,77 (0,008)	0,48 (0,005)	480
3	0,385 (0,004)	0,385 (0,004)	0,385 (0,004)	0,385 (0,004)	0,385 (0,004)	0,385 (0,004)	0,192 (0,002)	2000
Note - spectral density of vibration acceleration between frequencies has linear variation in logarithmic scale of frequency and spectral density.								

Table 6 – Operational modes of low-frequency vibrational load

Frequency sub-range, Hz				Vibration duration in every frequency sub-band, s
2-5	5-10	10-20	20-40	
Vibration acceleration amplitude, m/s^2 (g)				
9,81-19,6 (1,0-2,0)	19,6 (2,0)	19,6-29,4 (2,0-3,0)	29,4 (3,0)	120
-	-	4,9 (0,5)	4,9 (0,5)	240
Note – vibration acceleration in frequency sub-band has linear variation in logarithmic scale of frequency.				

Table 7 – Operational modes of linear accelerations, acting in both directions on every of three mutually perpendicular axes.

Acceleration, m/s^2 (g)	Duration of linear acceleration in every direction, s
98,1 (10)	600
4,9 (0,5)	1500
1,96 (0,2)	Non regulated

Table 8 – Operational modes of shocks (in the form of spectrum of shock with a factor of merit Q= 10)

Number of mode	Frequency, Hz							Number of shocks
	50	100	200	500	1000	2000	5000	
	Значения спектра удара, м/с^2 (g)							
1	98 (10)	294 (30)	981 (100)	3920 (400)	9810 (1000)	9810 (1000)	7850 (800)	4
2	98 (10)	294 (30)	785 (80)	2450 (250)	4900 (500)	4900 (500)	2940 (300)	7
3	49 (5)	147 (15)	490 (50)	1670 (170)	3430 (350)	3430 (350)	1960 (200)	5
4	687 (70)	1079 (110)	1766 (180)	3139 (320)	7848 (800)	19620 (2000)	19620 (2000)	1

Note:

1) Shock spectrum values between frequencies have linear variation in logarithmic scale of frequency and shock's spectrum.

2) Mode 4 corresponds to shock, caused by LA mechanisms actuation, and has been developed on the basis of vibration acceleration measurements under LA mechanisms actuation with use of felt between pyro-pin and LA's case.

2.8.3 SSC testing is recommended to conduct with taking into consideration "qualification" factors – it really improves reliability and completely corresponds to ground processing practice, adopted at the present time in space industry and abroad.

Operational modes, which have been given in Sections 2.8.1 and 2.8.2, shall be increased (multiplied) on qualification factors during SSC qualification tests on mechanical effect modes. Recommended values of qualification factors are presented in the Table 9.

Table 9 – Qualification factors

Mechanical effects	Qualification factor
Linear acceleration	1,3
Wideband random vibration	2,25
Low-frequency sinusoidal vibration	1,3
Spectrum of shocks	1,0
Acoustic pressure	+3 dB with duration of 120 s

3 Mechanical interface

3.1 Variant 1 – use of Launch Adapter, developed by SSC “Progress” JSC (235KS product), for SSC accommodation. SSC overall size and mass shall be in conformity with Specification «Munakata, Riki «Cubesat design specification rev. 13» The cubesat program», California Polytechnic State University, 2009, and at that:

- overall size 1U, 1.5U, 2U, 3U, 3U+;

- mass from 0,8 up to 6,0 kg:

- 1U, 1.5U   0,8 ÷ 2,2
- 2U   1,5 ÷ 3,0
- 3U, 3U+   1,0 ÷ 6,0.

3.2 Variant 2 – use of foreign launch devices for SSC accommodation.

3.2.1 Overall drawings shall contain information about mechanical interface of launch device.

Launch device structure as well as SSC structure shall keep its operability during and after external factors exposure, given in the present document with consideration of the following:

- requirements of p. 2.8 are assigned for launch devices with the exception of mode 3 of the Table 4 and mode 4 of the Table 8;

- requirements on SSC mechanical effect modes shall be defined by developer of launch device.

Launch devices shall keep its integrity after actuation till “Volga” US orbital flight completion.

Launch device and its structural components, attachment points shall not have resonance at frequencies of no more than 25 Hz.

Launch device structure shall be convenient in operation, including mounting (dismantling) works with a SC adapter, and shall provide perfect safety during storage, transportation, testing, mounting (dismantling) works. Launch device structure shall not block free access for instruments to SC’s adapter attachment elements.

Launch device structure shall exclude confusion of electrical connectors during its coupling with the mating parts.

Electrical connectors (non-flight ones) shall have protective caps or plugs to prevent self-loosening.

Process structural elements, which are removed during launch device preliminary operating procedures, including electrical connectors' protective caps, shall be red color, marked and have captive fasteners. The red marks on other elements of launch device are not allowed.

To protect from static electricity launch device shall have a bonding stud with a SC adapter.

"Bonding stud – launch device case" intermediate resistance shall not exceed 200 $\mu\Omega$ (if the case is made of magnesium-base alloy, the resistance shall be no more than 300 $\mu\Omega$).

Regular launch device or its MDU shall be delivered to SSC "Progress" JSC in order to test connectivity with a SC adapter and MLI.

Note: MDU shall correspond to a flight model of launch device in external shape, mass, coordinates of center of mass, attachment point structure, structure, changing its overall dimensions after mounting on a SC adapter, electrical connectors and theirs position on the launch device.

For production of launch device structure shall be used such materials, that can provide allowable contact pairs with elements of a SC adapter structure.

Fastening of SC adapter Multi-Layer Insulation to the launch device case (hook and loop fasteners gluing) shall be allowed.

For electrical connection of launch device with a SC adapter, launch adapter producer shall produce cables with Russian cables' terminals from the SC adapter connection side.

3.2.2 Launch device with a SSC during ground processing and during the flight in the assembly with the UC shall not require power supply from US, with the exception of voltage pulse, supplied to launch device for actuation of SSC separation system.

Launch devices with a SSC shall have warranty periods and warranty lives to provide its operation in the assembly with the UC.

Detailed description of deployment of solar panels and others movable elements of a SSC structure after its removal from the launch device shall be provided for calculation of non-impact SSC separation from adapter.

Overall drawing of launch device shall contain:

1) Dimensions to determine launch device configuration.

2) MCIP (starting and finite values if they change during operation) with limit deviations.

3) Arrangement, coordinates and connector's type, position of aligning keys for russian electrical connectors, marking of electrical connectors according to electrical circuit.

4) Coordinates and dimensions of mounting points (bonding studs) with tolerances, nonflatness in mounting points of launch device (shall be max. 0.2 mm).

5) Required axes position of launch device relatively to SC adapter's axes or remark: "Launch vehicle position in relation to SC adapter's axes is insignificant".

6) Launch device's center of mass position in respect to mounting bores and mounting surface with limit deviation; starting and finite positions, if it changes during processing work.

7) Arrangement and name of launch device's elements required an access to as part of a SC adapter.

8) Indication of extreme limiting positions of moving parts, which can change the overall dimensions of launch device.

9) Dimensions of SSC separation zone.

10) Position, coordinates, material and dimensions of bonding stud, value of transient resistance “bonding stud – launch device case”. Phrase: “To measure transient resistance, local removal of coating from case is allowed with its further restoration” or point out a place without coating for transient resistance measuring.

11) Arrangement, names and numbers of processing elements to be removed during launch vehicle preparing works.

12) The phrase: “When mounting/dismantling working with the launch device, use the manual….. [title, number]”.

13) Names, dimensions, mass and service area of launch device’s parts, to be removed and installed on launch device after launch device mounting on a SC’s adapter.

14) Material and coating of a case and attachment points of the device.

15) If heat removal to SC adapter structure through the launch devise’s surface is required, it surface shall be indicated with respective name, dimensions, heat removal area, type of heat-conducting paste, heat flux density (W/m^2), and maximal heat flux through this surface (W).

16) Indication of permissible temperature range of mounting surface on SC’s adapter, A_S and ε factors of outer and internal exposed surfaces of launch device, thermal insulation locations.

17) Information about permissibility to cover a launch device with thermal insulation, indication of places are not allowed for thermal insulation covering, position and dimensions of attaching points of SC’s adapter thermal insulation to launch device (fasteners gluing).

3.2.3 Overall drawings of cables shall contain:

- cabling with indication of its length;

- mass with limit deviation;

- connectors types and marks;

- cross-section dimension;

- mounting requirements in assembly with the SC’s adapter (tolerable bending radius, distance between attaching points including).

3.2.4 Consolidated MCIP of launch device and SSC with limit tolerances shall be presented in the SSC ID.

4 Electrical interfaces

4.1 Variant 1 (ref. Introduction) – SSC should not have electrical coupling with LA, US, TCE, SSC.

4.2 Variant 2 (ref. Introduction) – general requirements to electrical interfaces.

4.2.1 Circuits of launch devise's control commands and telemetry commands shall be galvanically isolated from launch device's case and against each other.

4.2.2 Electrical resistance value of insulation circuits of interconnection between launch device and US systems with respect to US case (SC's adapter) and between any electrically separated circuits shall be no less than 20μΩ under standard climatic conditions.

4.2.3 Insulation of electrical circuits of interconnection between launch device and US systems on all operational stages shall provide electric strength, sufficient for prevention of breakdown.

4.2.4 Acceptance of control command from US and its subsequent transferring to US telemetry system in launch device shall be controlled.

4.2.5 Electrical performances of pyro-devices control circuits:

– actuation current in pyrocartridge circuit (one circuit) – 2÷5 A;

– voltage supplied to pyrocartridges – 27 (+5/-1,5) V;

– permissible quantity of pyrocartridges actuated simultaneously (by one command) – max.8 pieces;

– duration of pyrocartridge command – 150±60 ms.

Maximal number of pyrocartridge command depends on requirements of main (mission) PL and total amount of piggyback SC.

4.2.6 Maximal number of parameters from SSC, which can be controlled by telemetry system, depends on requirements of main (mission) PL. Total amount of parameters from all SC should not exceed 18 numerical, 2 analogous, and 4 temperature.

4.2.7 Sensors to be controlled by telemetry system shall be as the following types:

а) analogous generator sensors in the form of circuits with output voltage from 0 to 6.3 V with interrogate current of no more than 20 µA and sensor's output resistance of no more than 1 kΩ. Growth of the sensor's output resistance up to 10 kΩ is allowed under increase of error measurement;

б) analogous parametric correlation sensors (potentiometers, voltage dividers) with output resistance from 1 up to 4 kΩ and interrogate current of no more than 20 µA, powered by (6,3±0,15) V system's voltage;

в) incremental parametric sensors in the form of electronic switch with open collector with output resistance in closed position ("logical 1") from 0 to +1 V;

г) incremental parametric sensors in the form of relay contact or switch with output resistance of no more than 100 Ω in position of "logical 1" and no less than 100 kΩ in position of "logical 0";

д) incremental generator sensors (microcircuit outputs, circuits with output resistance up to 1 kΩ and etc.) with output voltage from minus 1 to plus 0.7 V in position of "logical 1" and from plus 2.2 to plus 10 V in position of "logical 0";

е) analogous parametric sensors in the form of thermoresistors with output resistance from 0 to 200 Ω with interrogate current of no more than 2.5 µA.

4.2.8 Certain number of parameters from a SSC to be controlled by telemetry system, as well as control commands, which can be assigned for SSC and launch device control, are defined by SSC "Progress" JSC based on examination results of appropriate proposals from a customer.

5 Electromagnetic Compatibility Requirements

5.1 Launch device requirements

5.1.1 Launch device shall be stable against electromagnetic field with a level of 10 V/m according to the GOST R 51317.4.3-2006 (GOST 30804.4.3-2013). Confirmation of requirement fulfillment shall be performed according to the GOST R 51317.4.3-2006 (GOST 30804.4.3-2013).

5.1.2 Launch Adapter shall keep its operability under conductive noise exposure with the following levels:

U = 1 V, within frequency band from 0.03 to 150 kHz;

U = [1-0.49·lg(f/0,15)] V, within frequency band from 0.15 to 10 MHz, where f – frequency in MHz;

U = 0.1 V, within frequency band from 10 to 300 MHz.

Fulfillment of noise requirement should be confirmed according to the GOST 92-4802-83.

5.2 SSC Requirements

5.2.1 For Variant 1 (ref. Introduction) SSC should be switched off on injection stage. SSC switching on shall be actuated by separation command.

5.2.2 SSC electromagnetic radiation levels during SSC preparing works at Launch Site, on injection stage, before and after separation command (no less than 5 minutes after separation command) shall not exceed the values given in the Table 10.

Table 10 – allowable levels of SSC electromagnetic radiation at SSC/Adapter interface

Frequency band, MHz	Field strength, dBµV/m
0,01-1237	120
1237-1254	30
1254-1400	120
1400-1550	80
1550-1640	19
1640-1800	80
1800-18000	120

5.3 RED developers should provide the Operating Company with the public notice on RED frequency assignment from the International Frequency Circular (BR IFIC).

5.4 Electromagnetic Compatibility Requirements of launch devices and SSC should be confirmed by EMC tests, which shall be performed by developers of launch device and SSC.

EMC requirements fulfillment should be presented in the Report on testing results.

6 Reliability requirements

6.1.1 In case of a SSC launch device failure, the main Payload and "Volga" US shall keep its normal operability.

6.2 Launch device failure effect criticality analysis (FMECA) should be carried out (for European developers – according to IEC-812).

7 Safety Requirements

7.1 The Launch device and SSC safety shall be guaranteed by the design concepts, operational technologies at ground testing stage and operational documentation according to OTT 11.1.4-88 part 6.

7.2 The Launch device and SSC shall be fire- and explosion-proof against self electromagnetic radiation, shall not represent danger for a SC and service maintenance staff.

7.3 Materials, used in Launch devices and SSC shall not exude toxic substances.

7.4 Environmental safety of Launch devices, SSC and TE shall be provided according to the GOST R 52985-2008, GOST R 52925-2008. SSC and Launch device Final Readiness Reports (FRR) shall contain special part with conclusion about sufficiency and propriety of measures for the given requirements fulfillment.

7.5 Launch devices and SSC shall meet the requirements of the United Nations Committee guidelines on space debris mitigation ((LADC-02-01, 12.04.2002).

7.6 In Conclusion about sufficiency and propriety of environmental safety measures of Launch device, SSC and TE should be indicated:

– list and quantitative characteristics about hazardous and dangerous for natural environment agents, contained in Launch devices and TE;

– implemented in Launch devices, SSC and TE engineering, technological and etc. measures and solutions on elimination (reduction) of their damage effect on all operational stages of Launch device and SSC, including emergency situations with Launch devices and SSC and abort flight as well;

– conclusion (Statement) on conformance to standard-technical documentation and sufficiency of provided measures and solutions to ensure environmental safety during Launch device, SSC and TE operation.

7.7 SSC and Launch device shall have bonding in two points as minimum. Transient resistance, measured in bonding points (measuring probe shall be applied within 2,5 sm from bonding points) should be no more than $1{,}2 \cdot 10^{-3}\,\Omega$ if direct contact.

8 Ground preparing works with Launch device and SSC in the assembly with the UC

8.1 Installation of LA with a SSC in the assembly with the UC shall be performed by SSC "Progress" JSC.

SSC and LA of home or foreign production shall meet the following requirements:

а) "CubeSat" type SSC and LA should be provided by the SSC developer straight to Operating Company in the assembled condition (in package of SSC developer).

б) If "CubeSat" type SSC and LA will be delivered separately to Operating Company, assembling works shall be performed by SSC developer. If LA, developed by SSC "Progress" JSC, is used, works on SSC accommodation into LA shall be performed by SSC developer.

в) All necessary tests with a SSC before its mounting in the assembly with the UC shall be conducted by the SSC developer.

8.2 Structure and mass-center properties of LA with a SSC shall provide its manual mounting in the assembly with the UC.

8.3 After mounting of LA with a SSC in the assembly with the UC the following tests should be conducted:

а) no-voltage testing in pyrocartridge control circuit and its regular coupling;

б) testing of pyrocartridge control circuits with connected pyrocartridges by the method of safe current flow;

в) checkout of initial state of "Volga" US with assembled "LA + SSC" according to telemetry data.

9 Documents to be provided

9.1 SSC developer should provide the following documents:

- certificate of approval to space activity – for foreign SSC developer;
- liability certificate of SSC registration in National Authority Organization;
- SSC launch approval certificate;
-certificate on SSC frequency registration in the International Telecommunication Union;
- certificate of SSC readiness to the ground prelaunch, launch by ILV, and flight operations;
- data packet on SSC readiness, approved the above mentioned certificate on the SSC readiness to the ground processing;
- SSC general view and performances certificate;
- SSC assignment and mission task certificate;
- certificate on SSC flight electrical connections;
- SSC non-defense application certificate (usually it is presented in certificate on SSC frequency registration in the International Telecommunication Union);
- certificate of SSC safety (risks assessment including) on all stages: prelaunch processing, launch and flight in the assembly with the ILV till separation from LV;
- data packet on SSC safety, approved the above mentioned certificate on the SSC safety;
- environmental safety certificate.

Integration of certificates on relative subjects is allowed.

The above mentioned documents should be provided officially with an accompanying letter.

9.2 Order of foreign scientific equipment usage in a SSC is defined by the GOST R 51508-99, and the GOST RO 1410-002-2010.

9.3 SSC developer should provide a Statement on SSC readiness to launch in advance 1.5 months before the launch.

Abbreviations

US – Upper Stage
NF – Nose Fairing
OD – Overall Drawing
MDU – Mass Dummy Unit
SPA – Spare Parts and Accessories
ID – Initial Data
FRR – Final Readiness Report
SC – Spacecraft
UC – Upper Composite
TE – Testing Equipment
TCE – Test and Checkout Equipment
CC – Control Command
SSC – Small Spacecraft
ITU – International Telecommunication Union
MCIP – Mass-Center Inertial Properties
PL – Payload
IB – Intermediate Bay
MT – Mission Task
ILV – Integrated Launch Vehicle
LV – Launch Vehicle
RED – Radio Electronic Device
APU – Assembly Protective Unit
LS – Launch Site
LS – Launch System
PF – Processing Facility
LA – Launch Adapter
UPF – Universal Processing Facility
MLTI – Multi Layer Thermal Insulation
EMC– Electromagnetic Compatibility
OC – Operating Company