Presentation under Stage II
of Supplement № 3 to the Contract
for rendering technical assistance in preparation of Engineering Note

Design Details of Almaz Human Space Vehicle

CONTENTS:

I. Crew compartment (CC)

Crew compartment in the assembly shop

CC main parameters

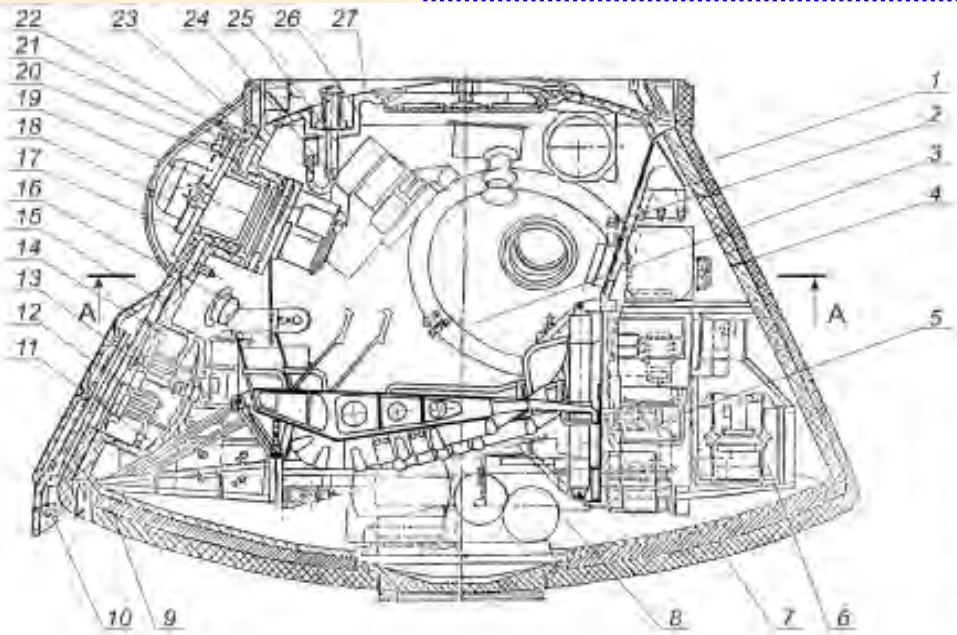
1	After landing weight	-Not more than 2.9 t
2	Maximum diameter	-2800 mm
3	Length	1820 mm
4	Crew	Up to 3 people
5	Seats	«Kazbek-U» shock isolated seats
6	Space suits	«Sokol-KV» ventilated suit
7	Free volume restricted by internal heat insulation surface	4.6 m3
8	Aerodynamic efficiency (when flying with NC)	0.25
9	Delivered cargo weight	100 kg
10	Design reliability	0.999

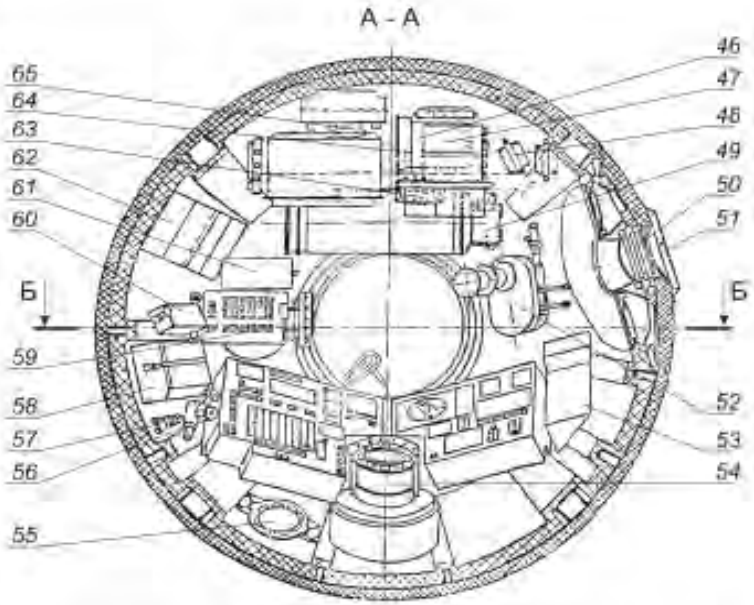
CC mass and inertia characteristics

Srl.N	Flight phase	Mass, kg	X, m	Y, m	Z, m	Ix, $kg.m^2$	Iy, $kg.m^2$	Iz, $kg.m^2$
1	Crew compartment (CC) before parachute deployment	3393	0.688	0.093	-0.006	2250	2610	2845
2	CC on the main parachute	2998	0.528	0.105	-0.006	2190	1825	2060
3	CC on the ground	2840	0.470	0.109	0.006	2170	1570	1805

Note: Coordinate system origin is at the cross point between the RRV and SM docking plane and the crew compartment symmetry axis.

Crew compartment layout





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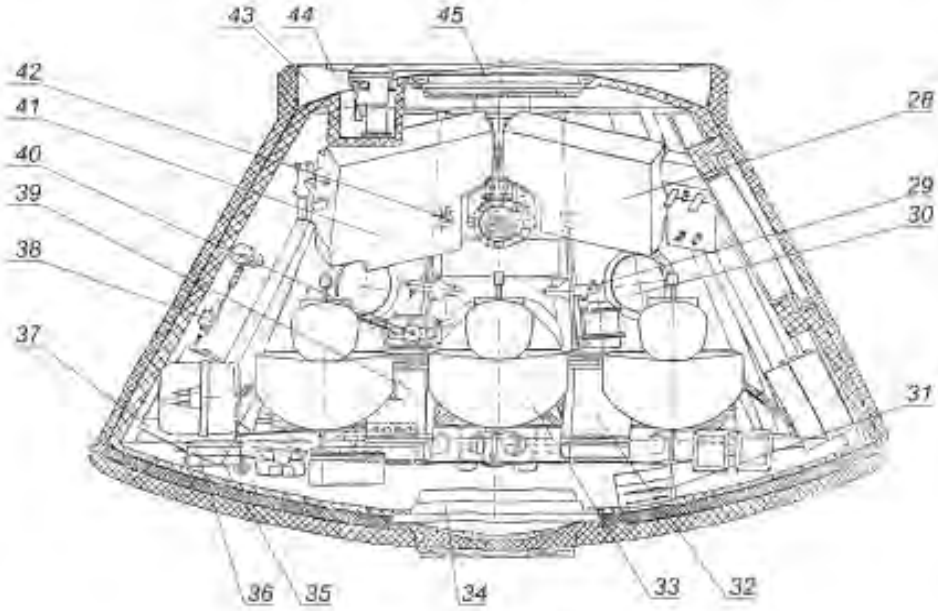
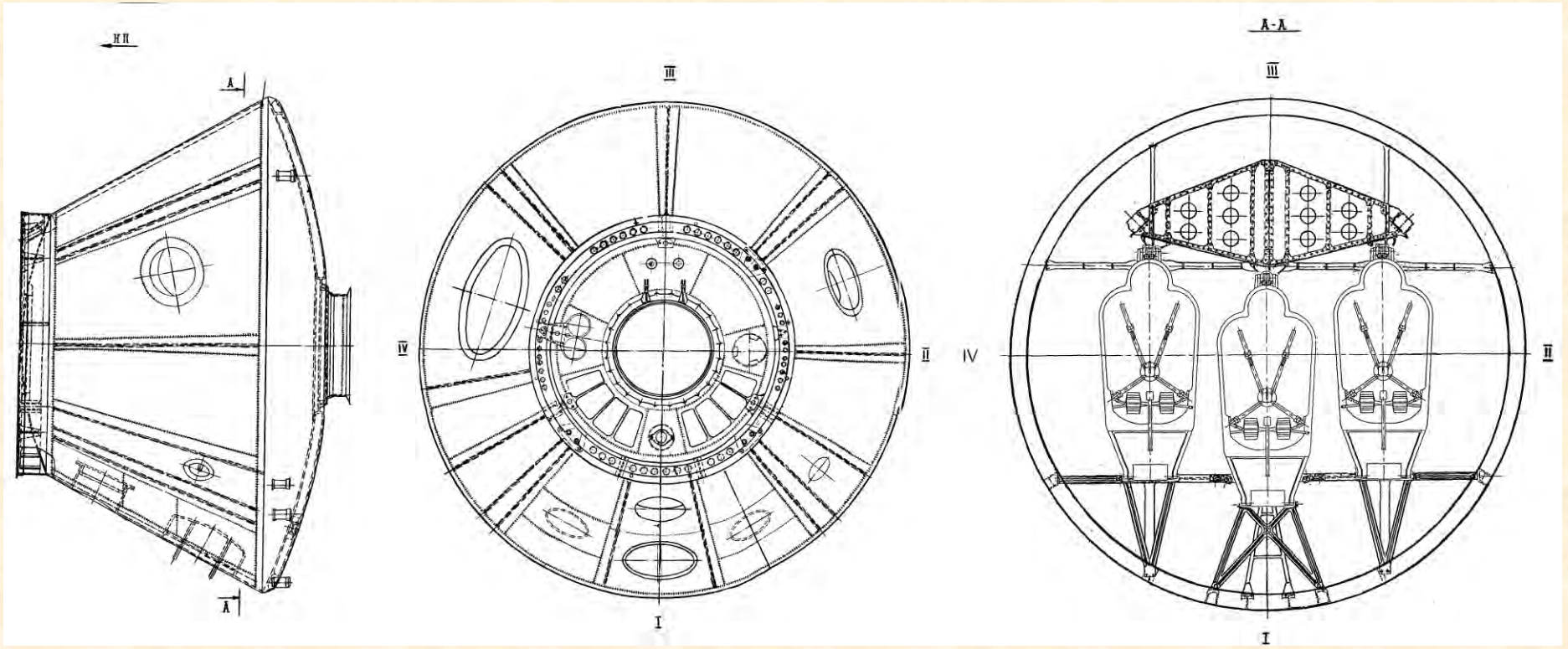
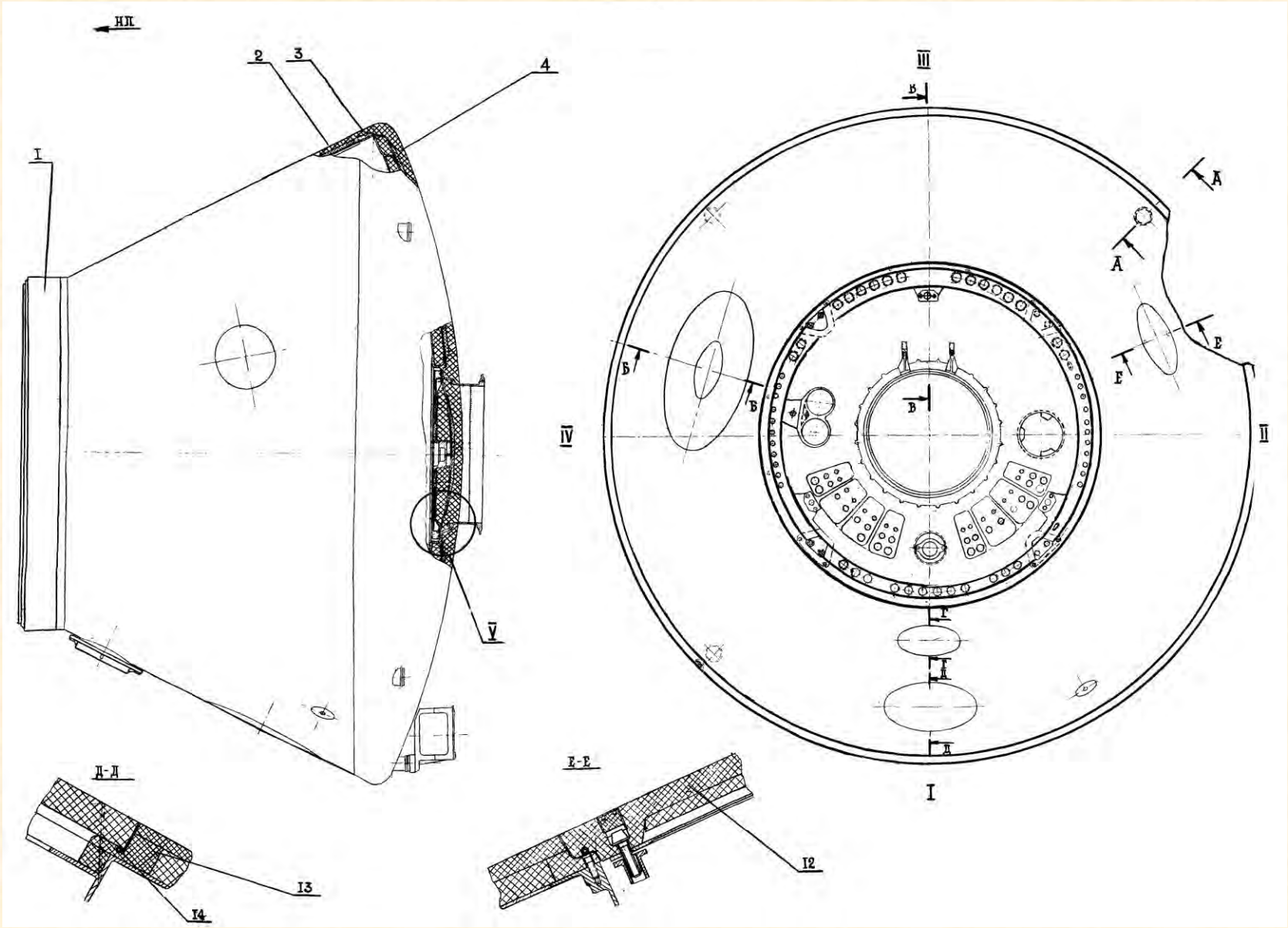


1 - CC body; 2 - entrance hatch; 3 - ground test panel;4- antenna feeder units; 5 - radio equipment “Aurora” for search and rescue; 6- OCC, 7- heat shield; 8 – soft units of survival kit; 9 – pyrolock;10 - RRV joint plate with orbital module; 11 – sealed panel CC recess; 12- communication bus; 13- pyro cutter; 14 pyro cutter recess cover;15 - communication line fairing; 16 - baroblock ; 17 – front fairing; 18 – heat insulation, 19- outer part of orienting device ОСК-3Р; 20- bracket; 21 – explosive bolt for attachment of ОСК-3Р device bracket; 22- spring pusher; 23 front fairing pyro release system; 24 – waveguide; 25 – traveling wave tubes of radar beacon “Planet”; 26- radar beacon antenna; 27- Planet beacon antenna cover; 28 – right pilot console; 29 – cutoff pyrovalve; 30 – barometric switch; 31- receiver of “Kaktus-4M” device; 32 – hard units of survival kit; 33 - seat; 34 – transfer hatch;35 – interconnection box; 36 – thermometer; 37 - descent automatic control unit; 38 - manual pump, 39- in-flight heater; 40 - distribution unit БР-1, 41 – left pilot consol; 42 – reverse valve; 43 - adapter; 44- frame No. 1 of the crew compartment; 45 emergency hatch; 46 - low frequency unit; 47-power distribution sensor; 48 - traveling wave coefficient sensor; 49 – recycling plant; 50 – window; 51 –window cover; 52 – plenum ventilation; 53 - oxygen supply unit; 54 – inner part of orienting device; 55 - removable screen; 56 – cutoff pyrovalve; 57 - manual vent; 58 – food and water supply unit; 59 – portable communication console; 60 – camera КР-75А; 61 – survival kits; 62- pyro unit; 63- relay switch; 64- filtering unit БФС-3; 63- relay switch, 65- relay switch РПА-74.

CC body design





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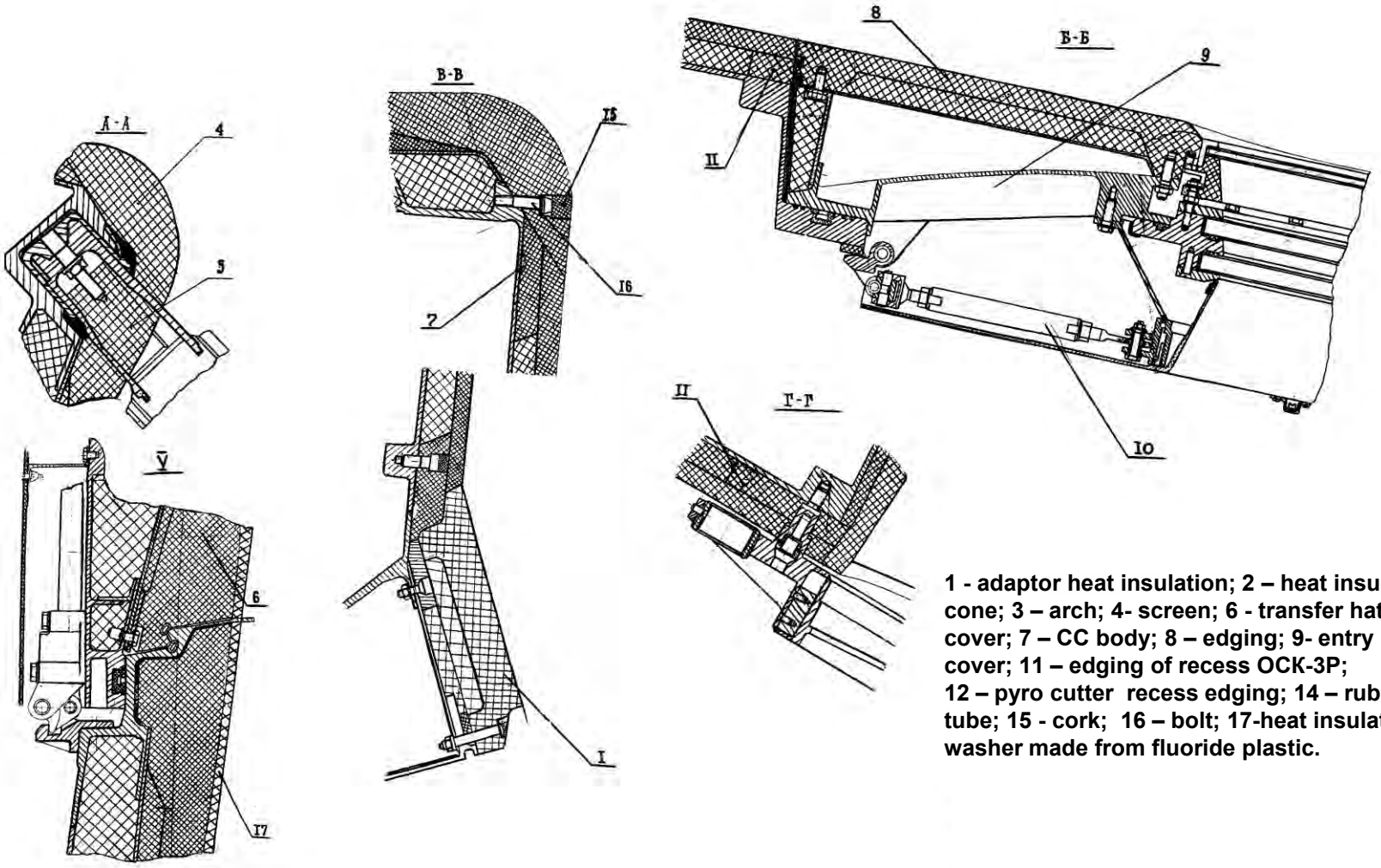
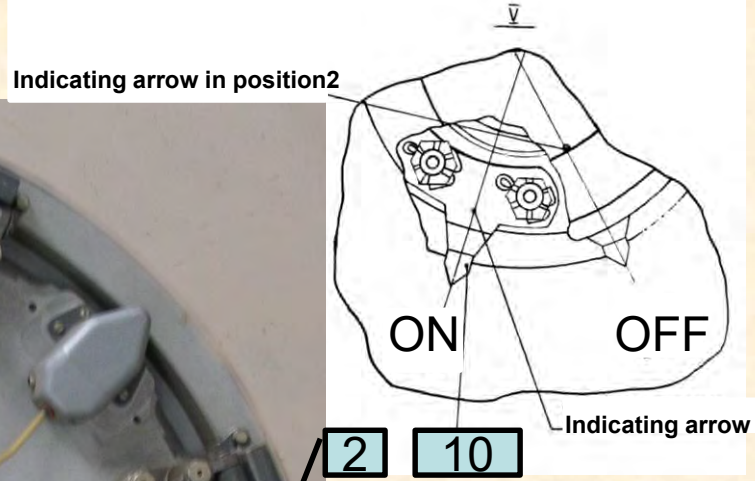
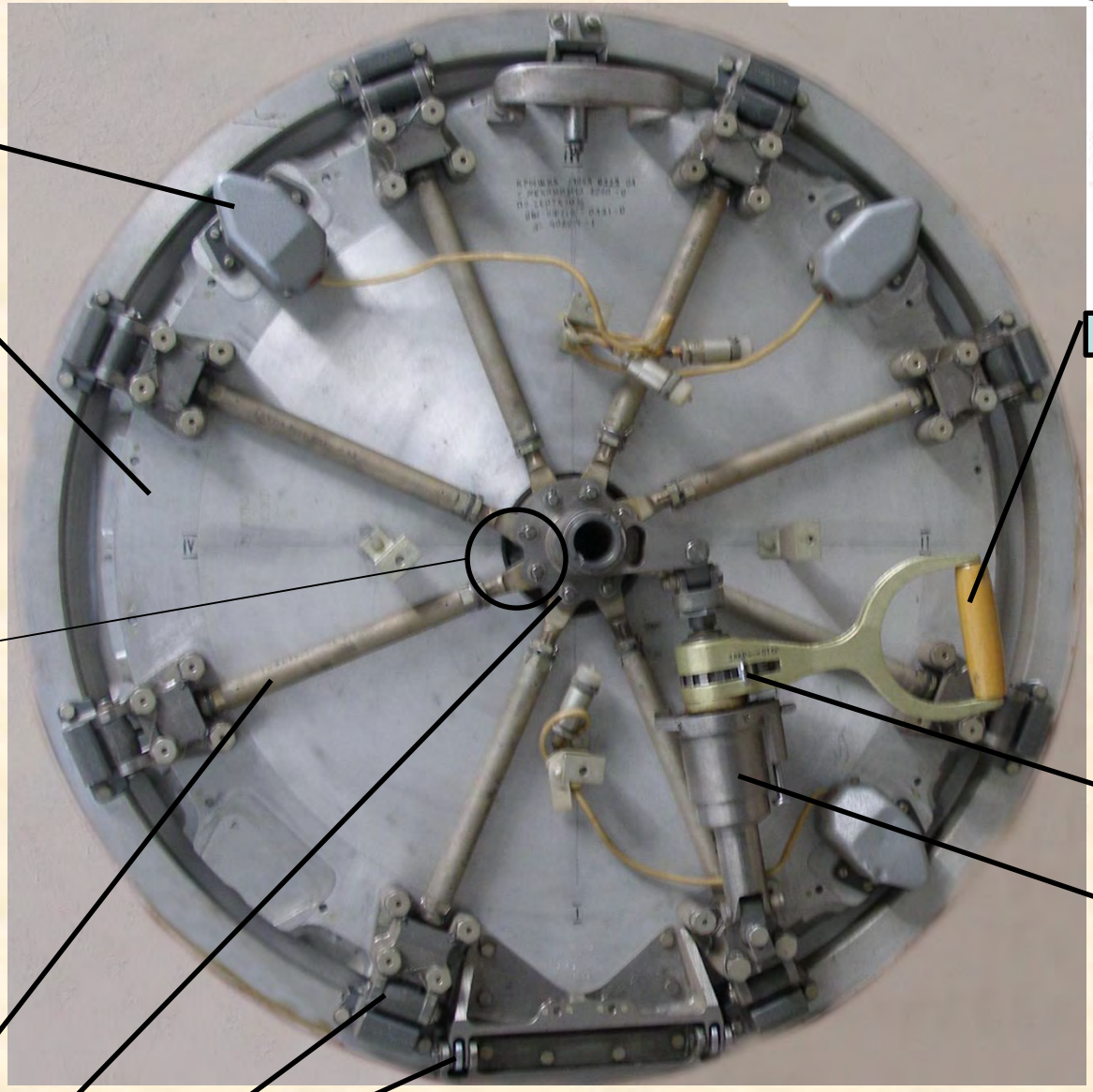


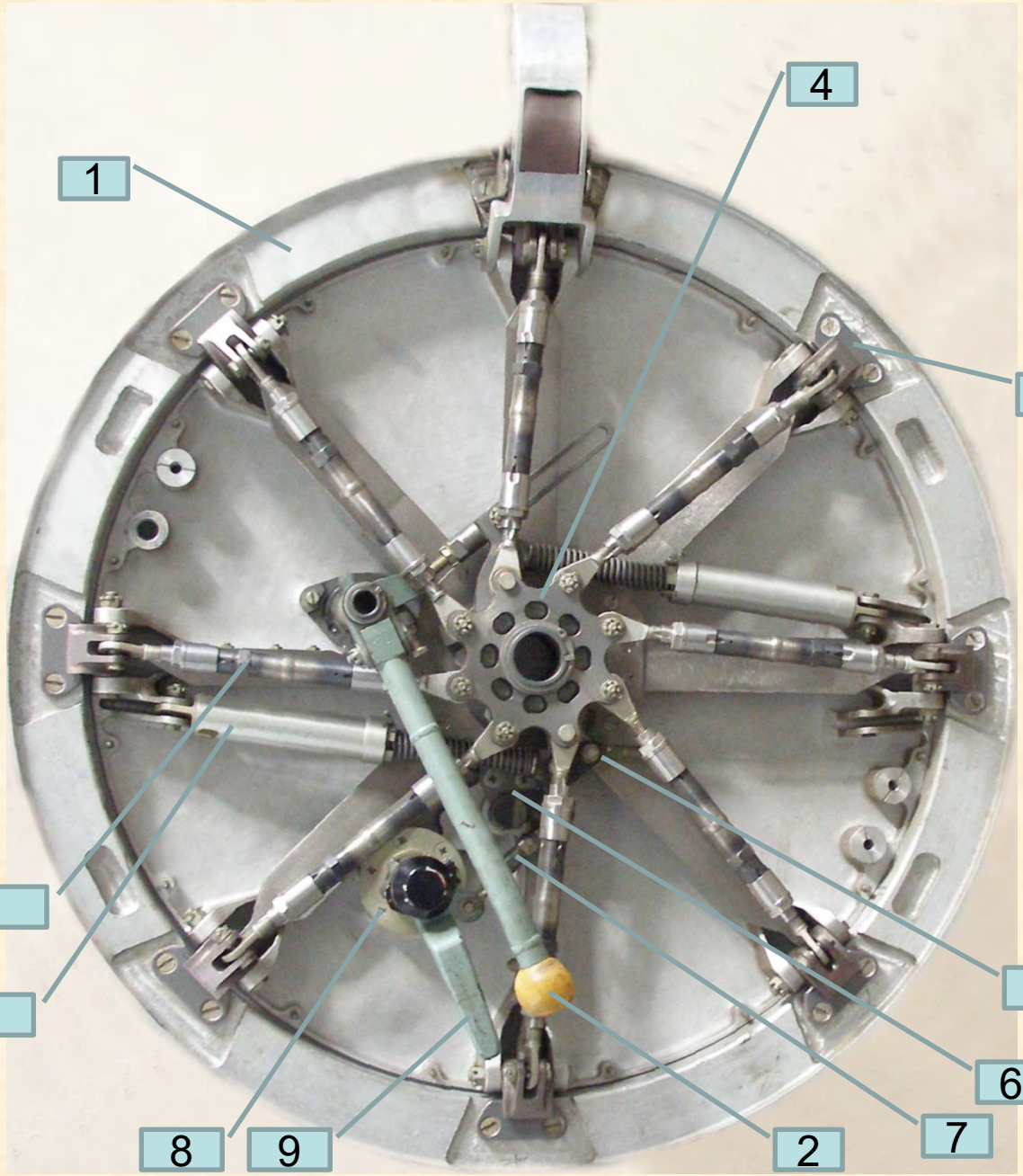
1 - adaptor heat insulation; 2 – heat insulation cone; 3 – arch; 4- screen; 6 - transfer hatch cover; 7 – CC body; 8 – edging; 9- entry hatch cover; 11 – edging of recess OCK-3P; 12 – pyro cutter recess edging; 14 – rubber tube; 15 - cork; 16 – bolt; 17-heat insulation washer made from fluoride plastic.

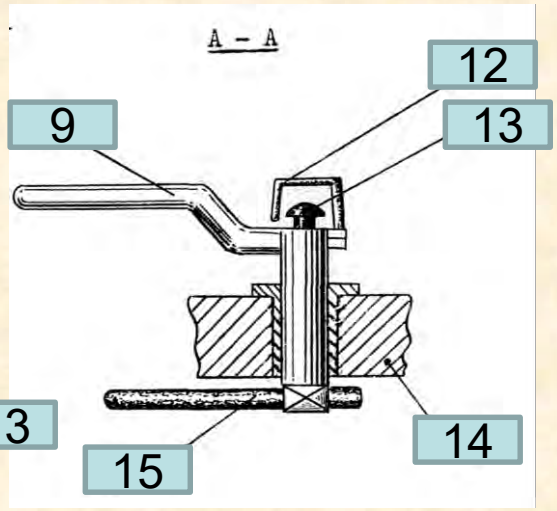
Transfer hatch mechanism





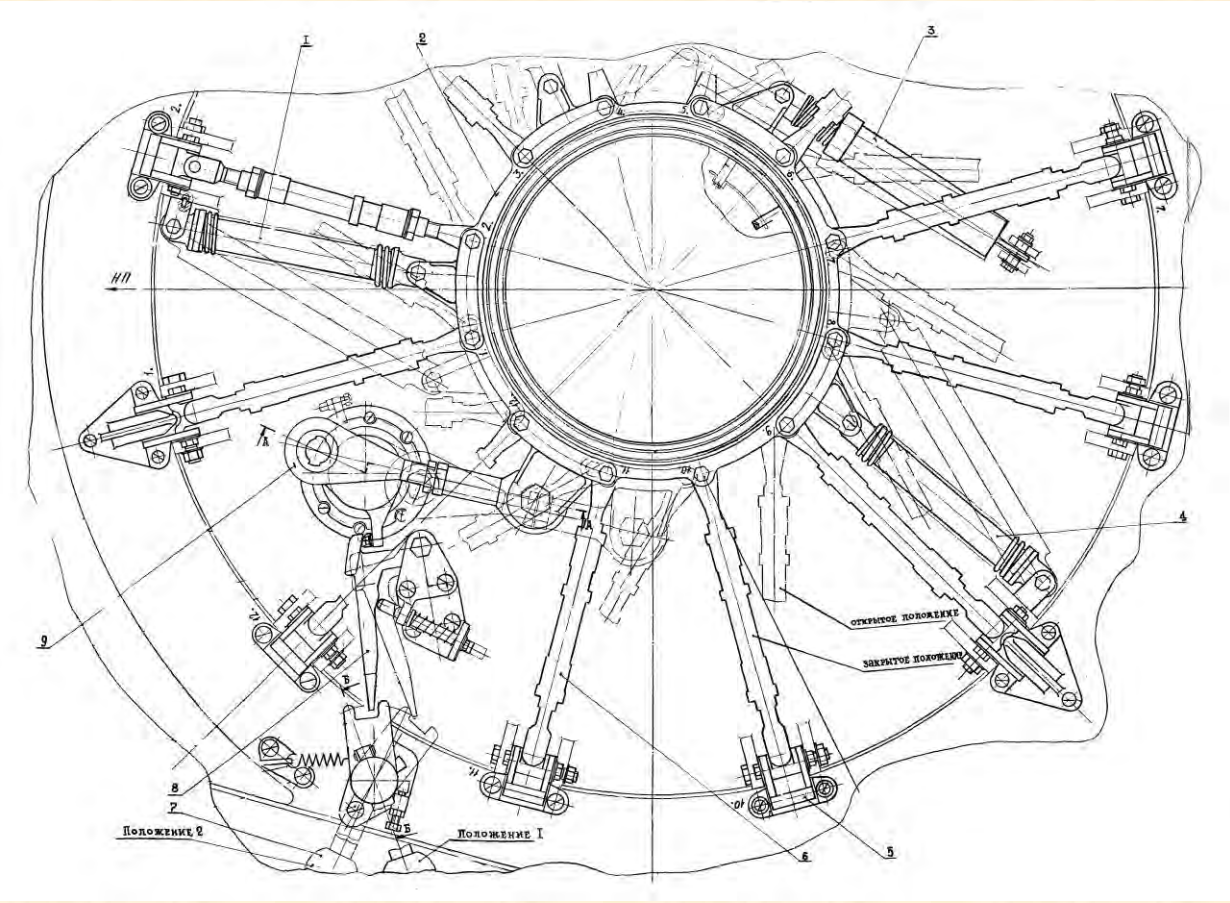
1 – transfer hatch; 2 – handle;
3 – switch; 4 – drive; 5 – loop;
6 – cum; 7 – asterix ;
8 – linkage; 9 – limit switch;
10 – indicating arrow.

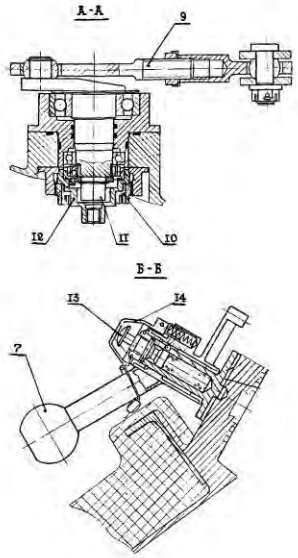




1 – emergency hatch; 2 – lever;
3 – cum; 4 – asterix; 5 – rest;
6 – rocker; 7- linkage;
8 – bush; 9 – rocker;
10 – pusher; 11 - linkage;
12 – cap; 13 – button;
14 – hatch door; 15 – handle.

Entry hatch mechanism





Entry hatch mechanism

1 – pusher; 2- asterix; 3- pusher;

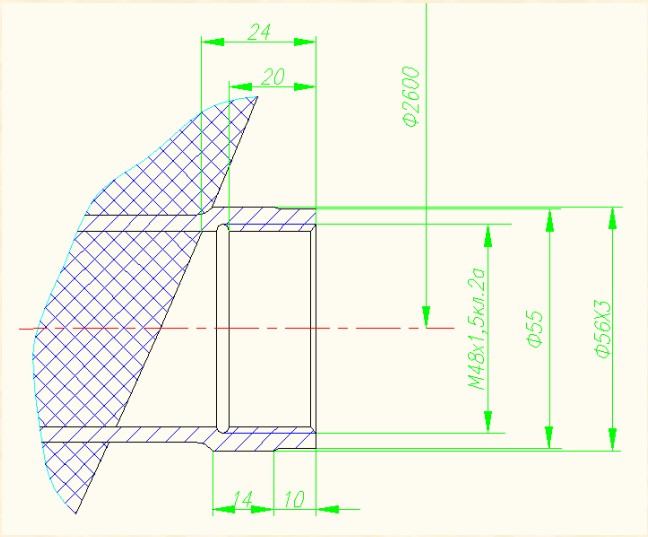
4 – pusher; 5 – cum; 6 – linkage;

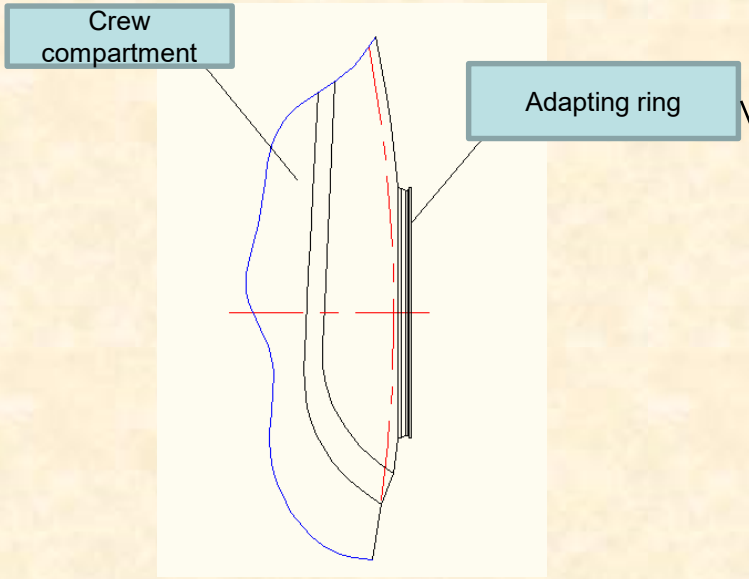
7 – handle; 8 – rocker;9 – linkage;

10 – nut; 11 - shaft; 12 – lid;

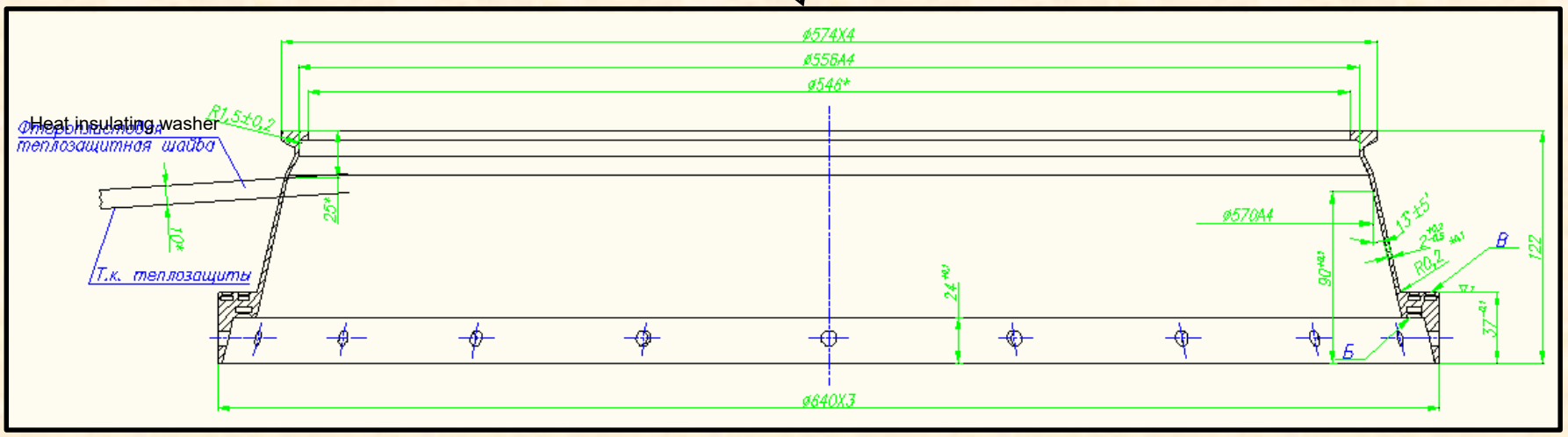
13 - button; 14 – cap.

The crew compartment is docked with the orbital module by four load bearing sleeves





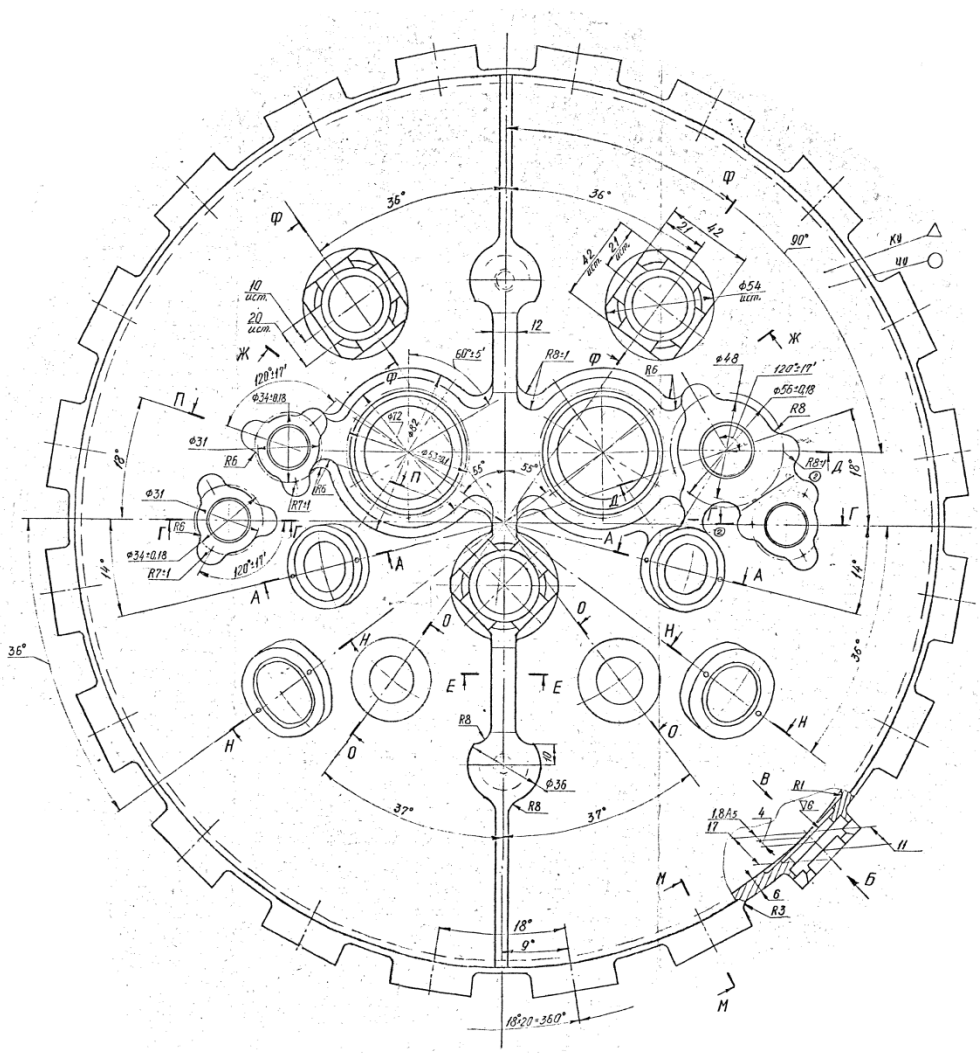
Bellow is attached to RRV by adapting ring of the transfer hatch



Through the sealed plate located in a special recess the following is connected to the crew compartment:
-four pipelines of 14x1 mm for the thermal conditioning system;
-three pipelines of 8x1 mm for the pressure control system and the suit ventilation and cooling system.

For connecting the cables of the crew compartment to the cables of the orbital module on this plate there are the following items:
-twenty electrical feedthrough connectors PC-50;
-two high voltage electrical feedthrough connectors.

Crew compartment structural elements



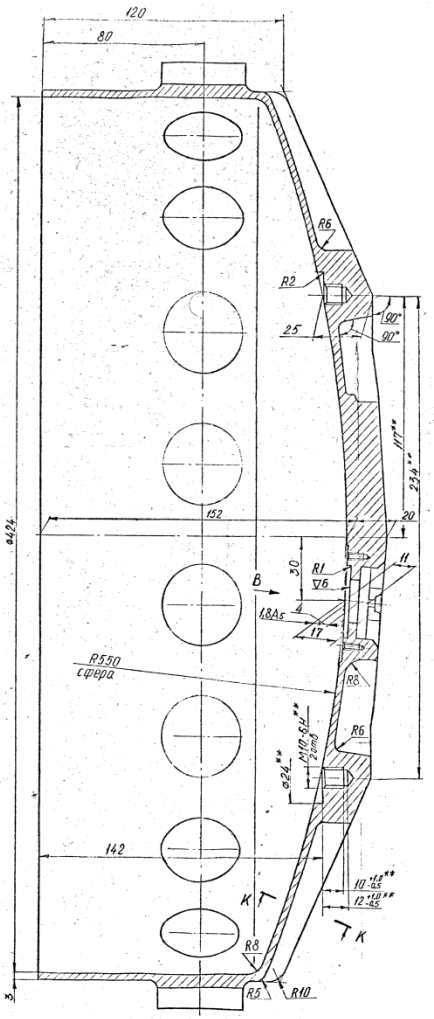


Diagram of load bearing attachment of NC to CC.

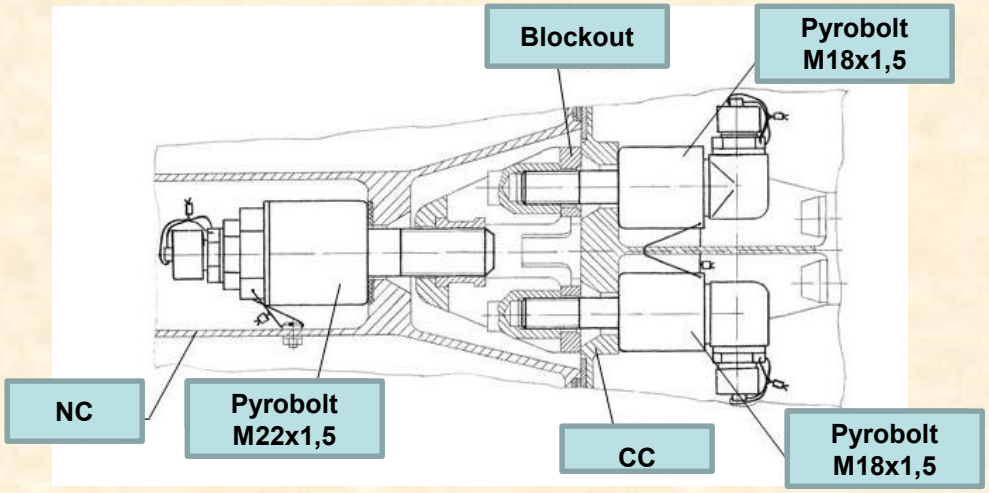
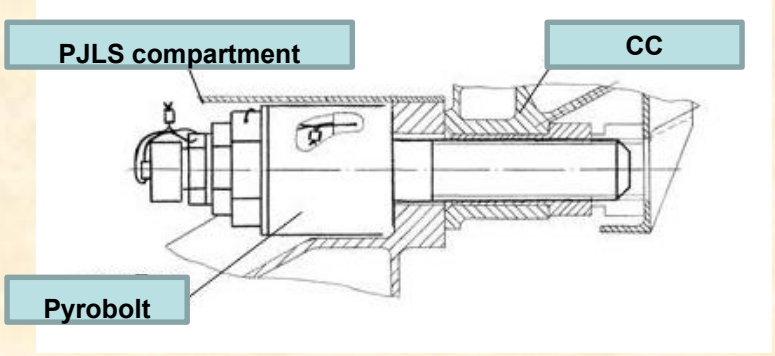


Diagram of load bearing attachment of PJLS to CC.

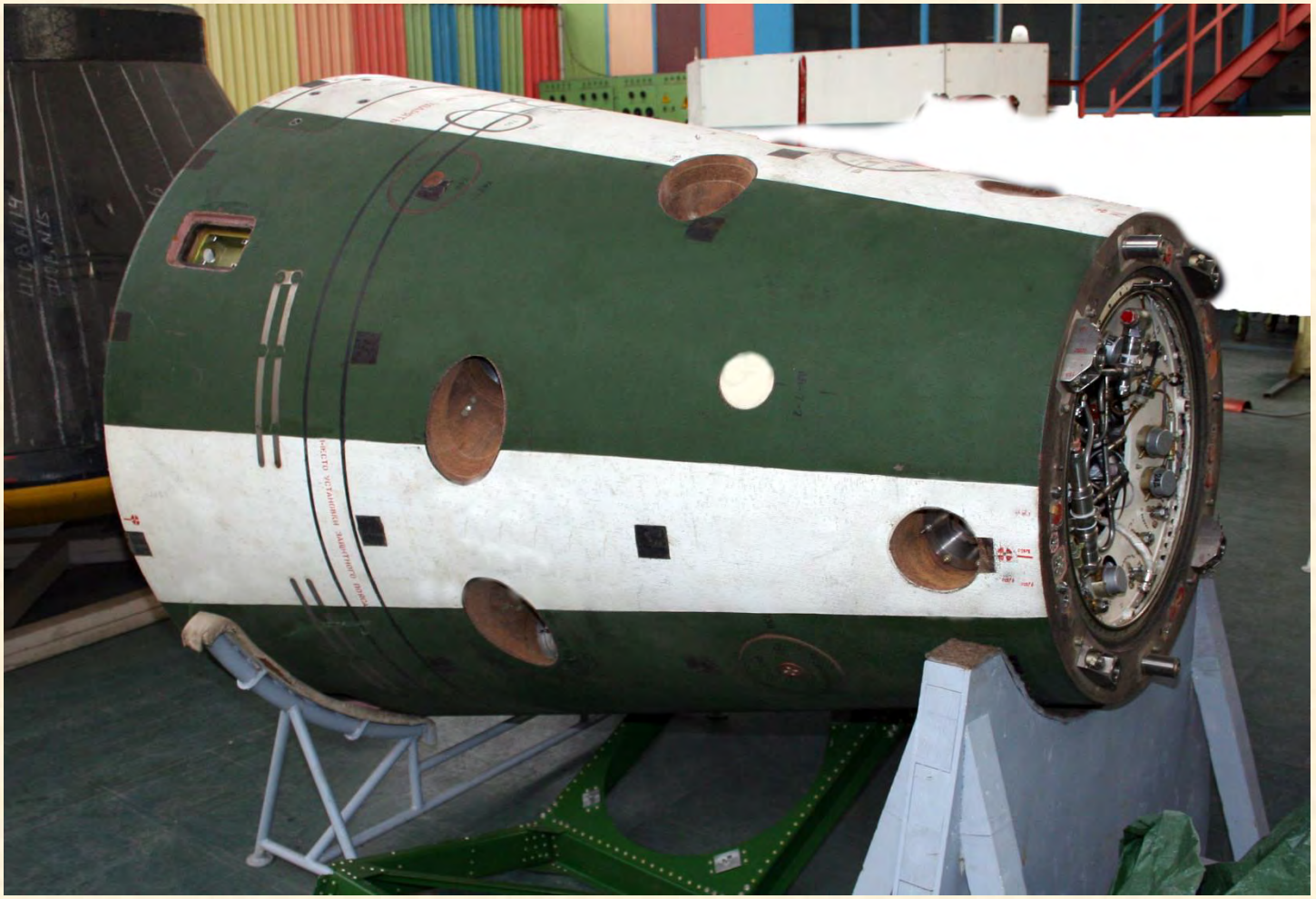


CC cables are connected with NC cables by fifteen umbilical connectors PC-50 and six high frequency umbilical connectors BP.

CC cables are connected with PJLS compartment cables by four umbilical connectors PC-50 and two high frequency umbilical connectors BP.

II. Nose compartment (NC)

NC in the assembly shop



NC main parameters

1	NC weight with the charged liquid propulsion system	633 kg
2	Overall dimensions: - length - least diameter - most diameter	 1840 mm 800 mm 1550 mm
3	Maximum thrust of the longitudinal separation motor (LongSM) along the motor axis	3600 kgf
4	Weight of charged LongSM with propellant	7.15±0.3 kg
5	Maximum thrust along the axis of the lateral separation motor (LatSM) nozzle	10000 kgf
6	Weight of LatSM with propellant	17.7±0.5 kg
7	Reliability of NC separation	0.9964

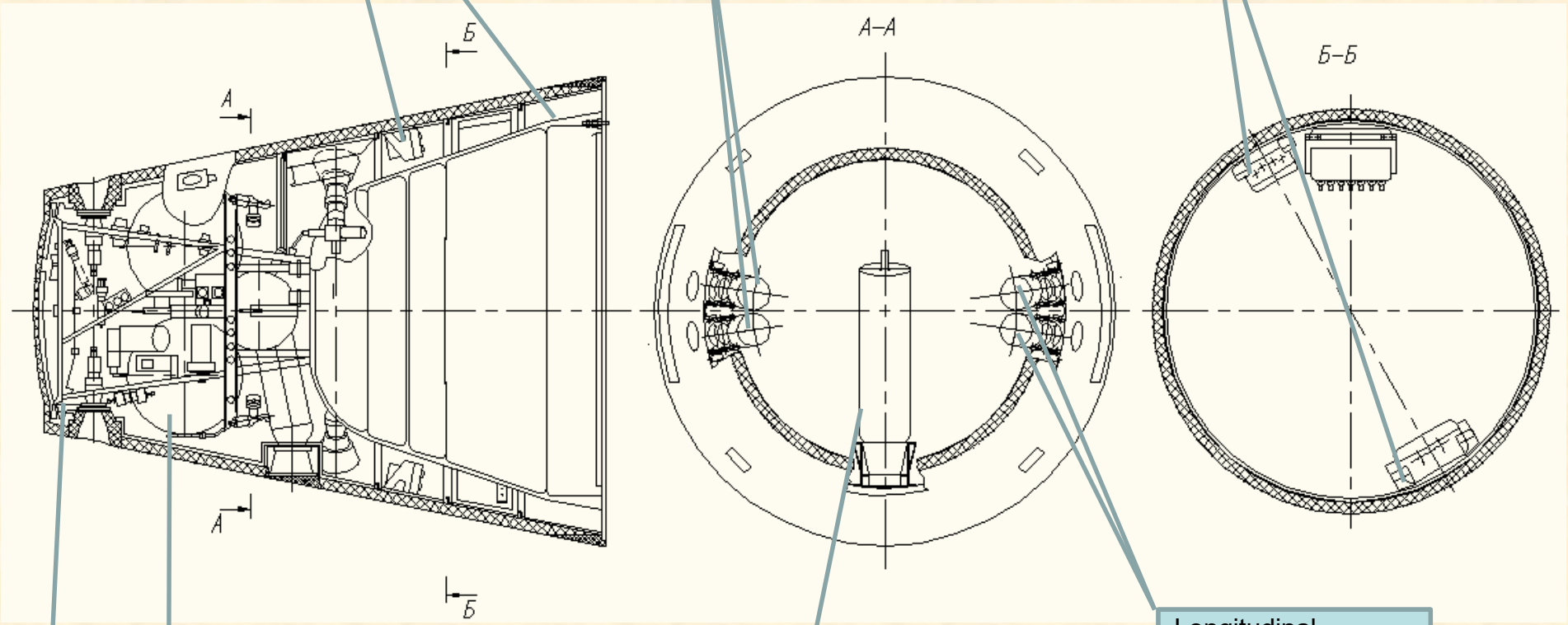
NC equipment layout

Protective jacket

Longitudinal separation solid propellant motors

Fuel consumption system

Automatic unit

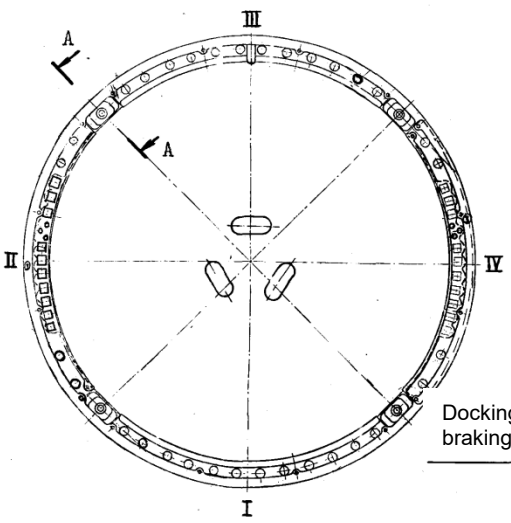


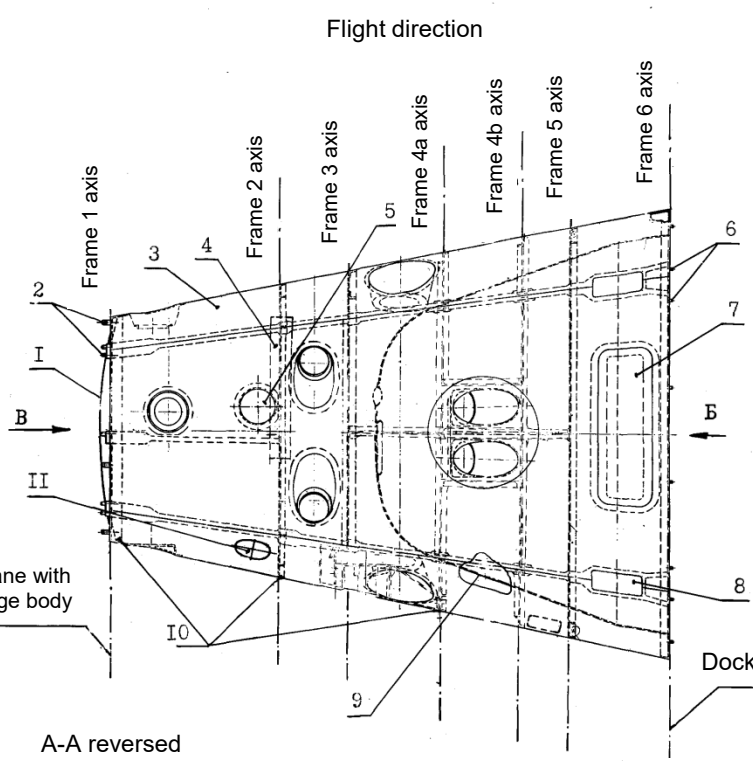
Liquid motor for attitude and aerodynamic efficiency control

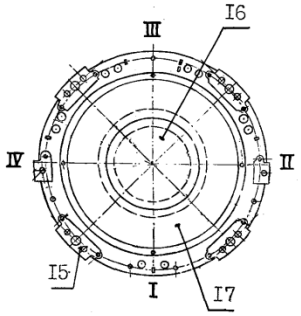
Drainage system

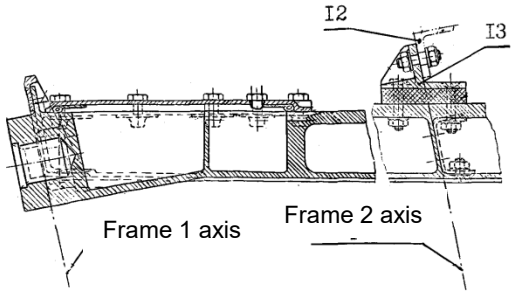
Lateral separation solid propellant motor

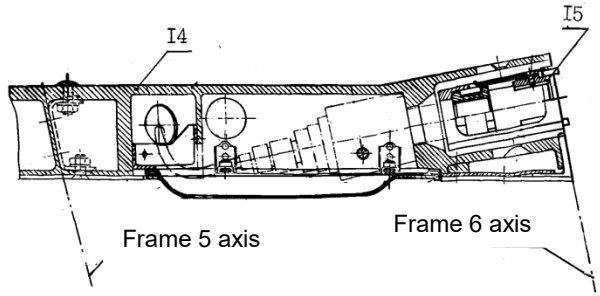
Longitudinal separation solid propellant motors





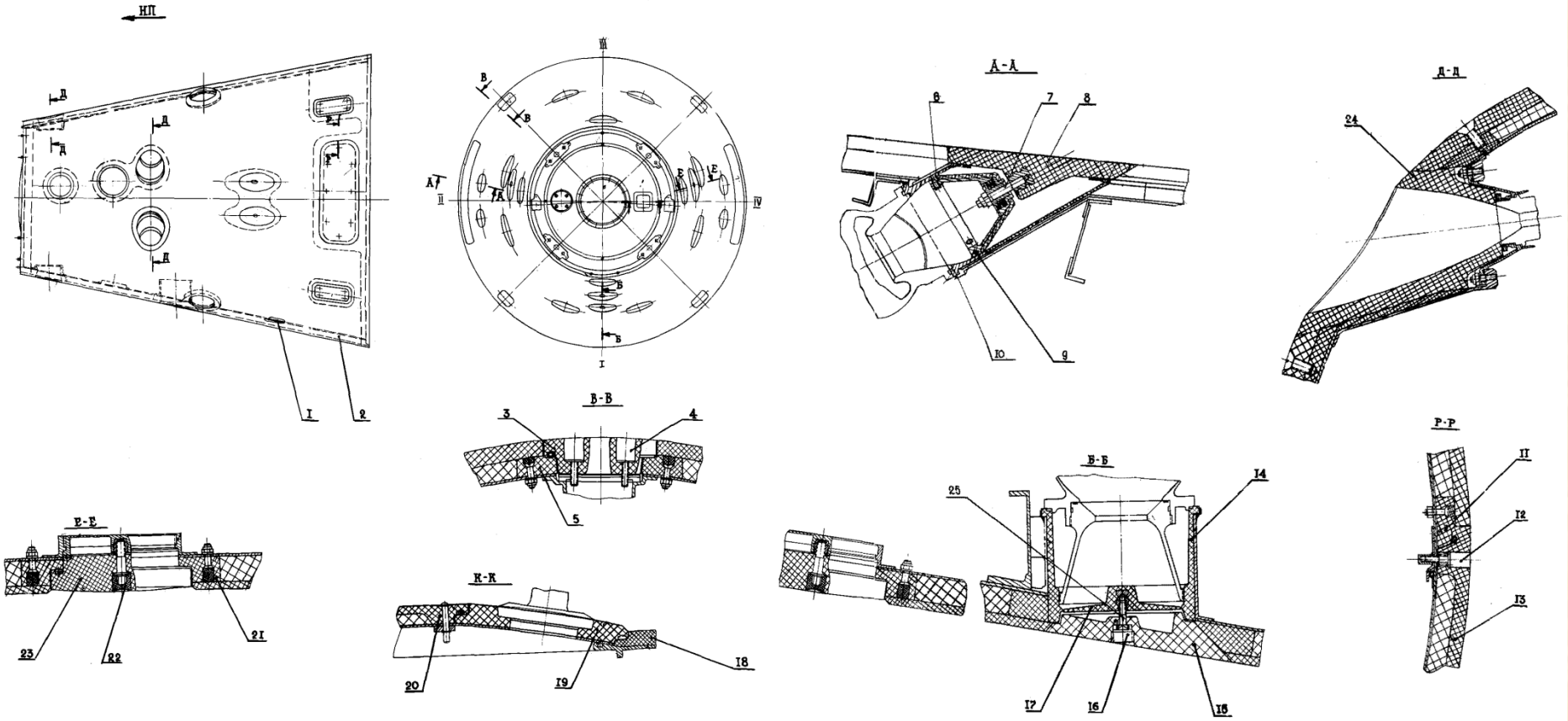






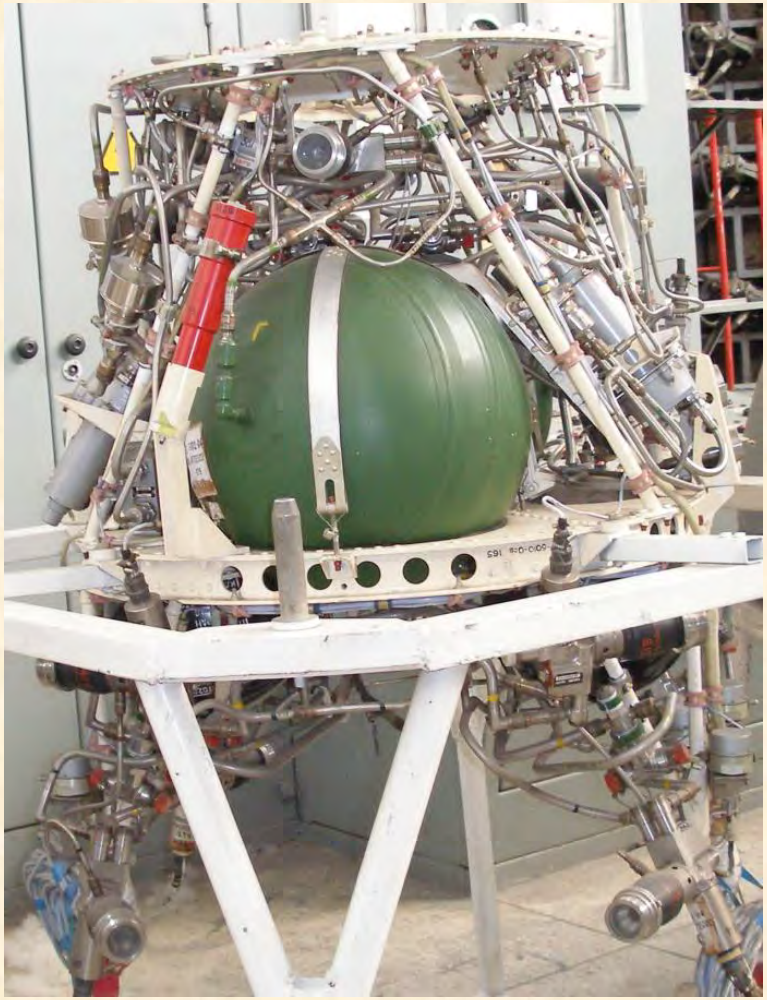
1 – bottom; 2 – pin; 3 – skin; 4 – load; 5 – access hatch to the fuel system; 6 – pin; 7 – access hatch to plug connectors; 8 – access hatch to pyro bolts; 9 – jacket; 10 – frame; 11 - access hatch to fuel consumption indicator; 12 – motor attachment frame; 13 – fitting; 14 – beam; -15- pyro bolt pocket; 16 – mounting hatch for antenna ПА- 22; 17- mounting hatch for motor 11 Д435

NC heat insulation



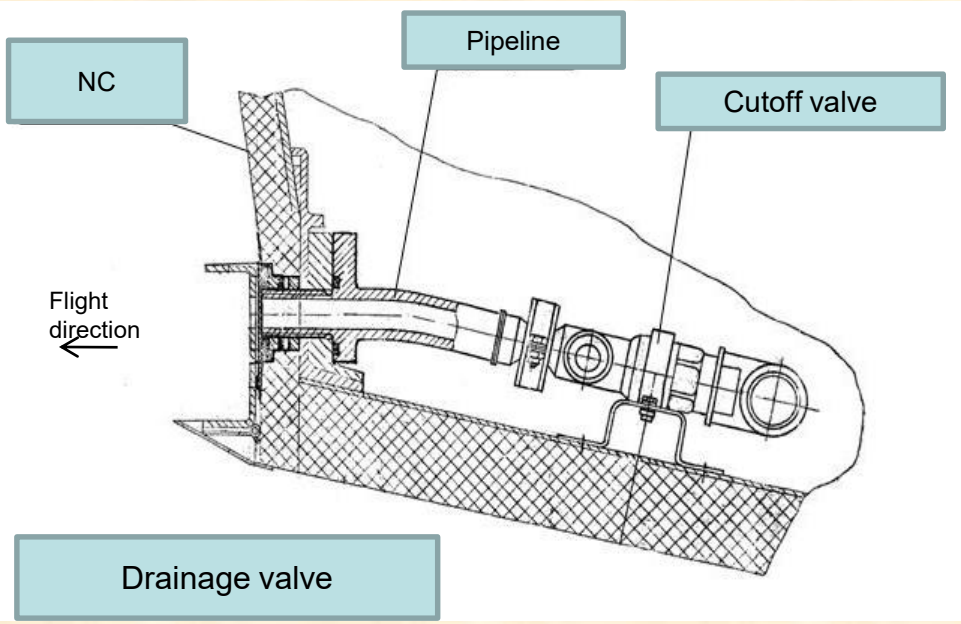
1- section body; 2 – NC heat insulation; 3 – lid;
4 – heat insulating bolt; 5- insert; 6 – pin;7 stud;
8 – closure; 9 – cone; 10 – nozzle; 11- edging;
12 – heat insulating bolt; 13 – lid; 14 – nozzle;
15- closure; 16 – plug;17 – membrane; 18 – heat insulating washer;19 heat insulating ring; 20 –lid;
21- edging; 22 – heat insulating bolt; 23- lid; 24-nozzle; 25 - bolt.

Propulsion system for attitude and aerodynamic efficiency control

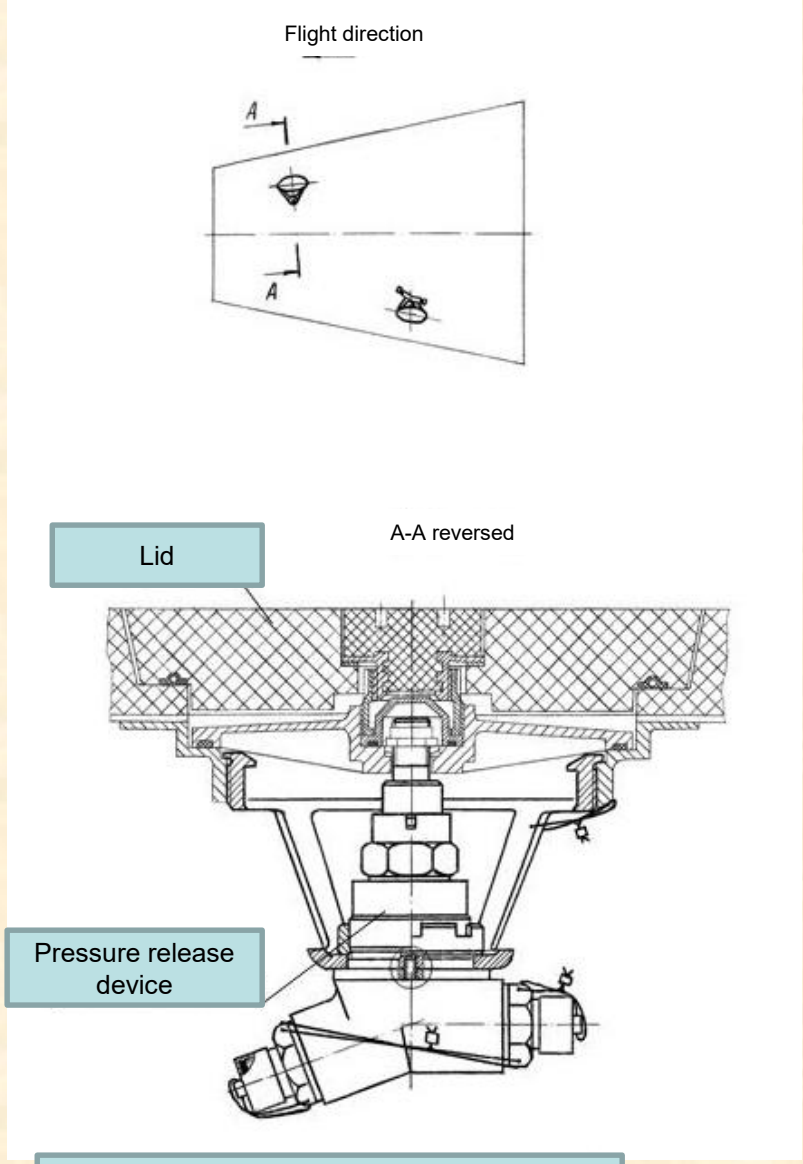


1	Propulsion system thrusters	12 liquid propellant thrusters (three clusters of four thruster)
2	Thruster nominal thrust	196N (20kgf)
3	Total thrust pulse	Not less than 100000Nsec (10000 kgfsec)
4	Fuel weight including: -oxydizer -fuel	62 kg 41.4 kg 20.6 kg
5	The fully charged system weight	Not more than 191 kg
6	Range of operational orbit altitudes	220-0 km
7	The fuel tank volume	27.5 kg
8	Operational pressure in gas bottles	34.3 MPa (350 kgf/cm2)

NC pressure equalization system

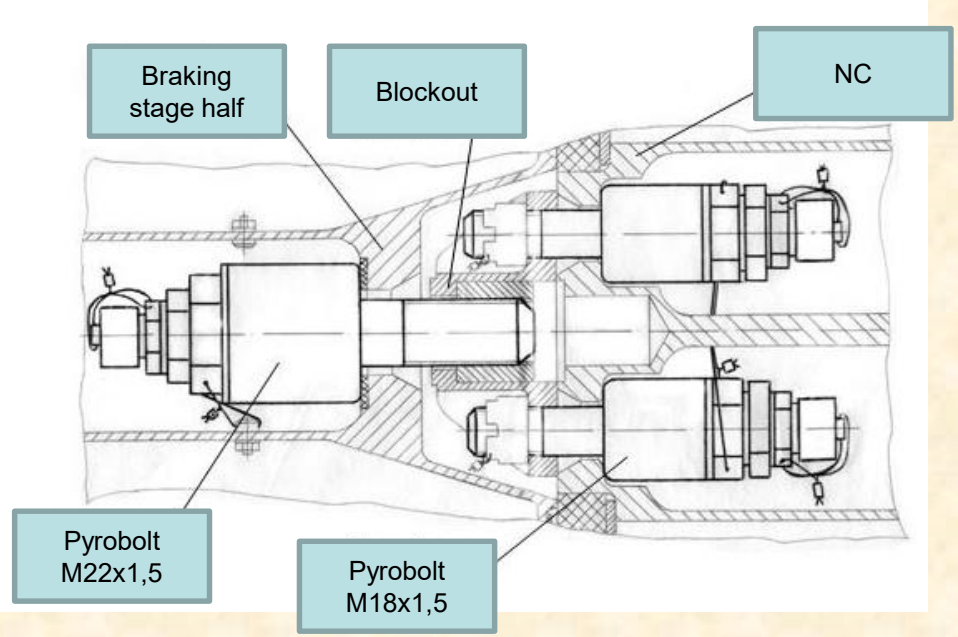


Drainage valve

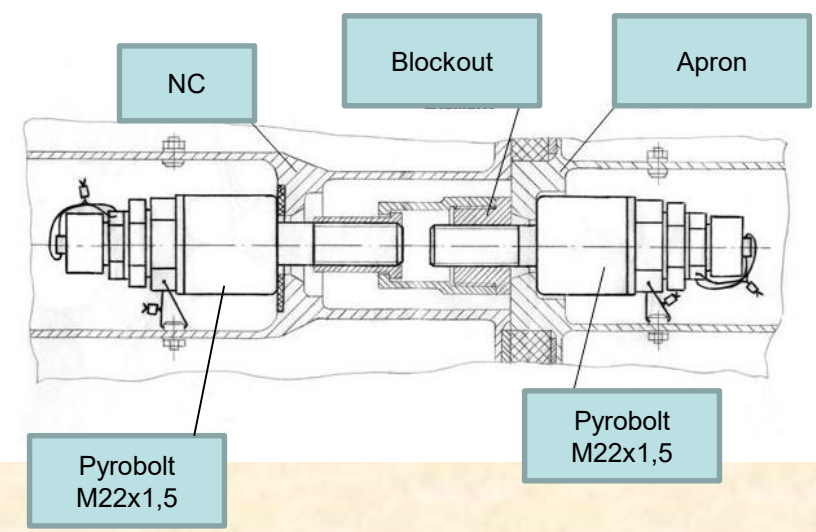


Pressure release devices

Load bearing attachment of NC to the braking stage half.



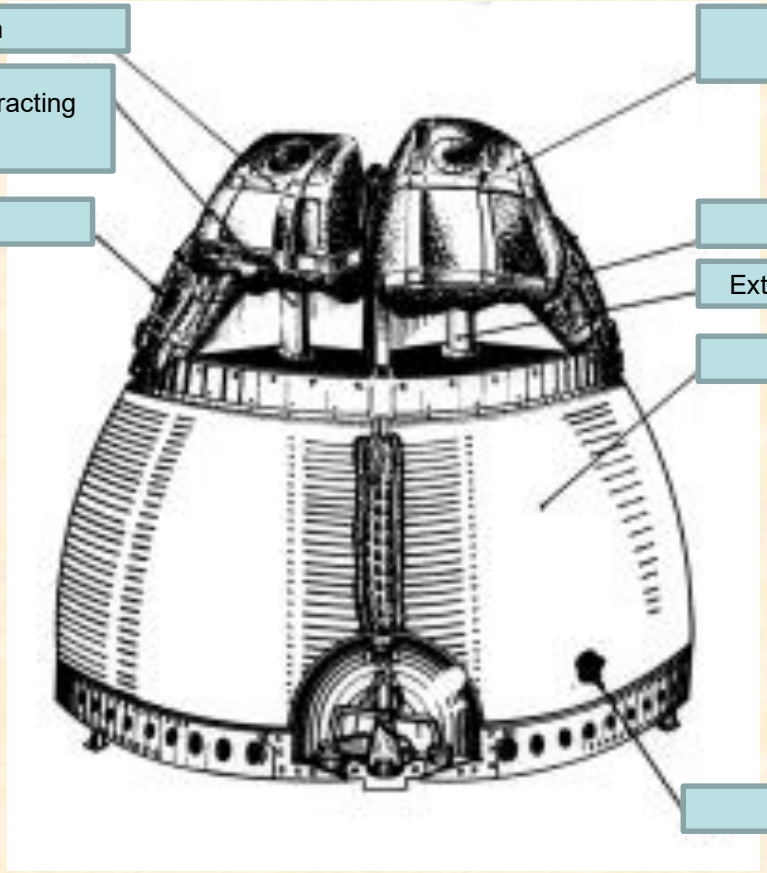
Load bearing attachment of apron to NC.



NC cables are connected with PJLS cables by four umbilical connectors РСБО-50 and two high frequency umbilical connectors ВР.

III. Parachute and jet landing system (PJLS) compartment

PJLS compartment

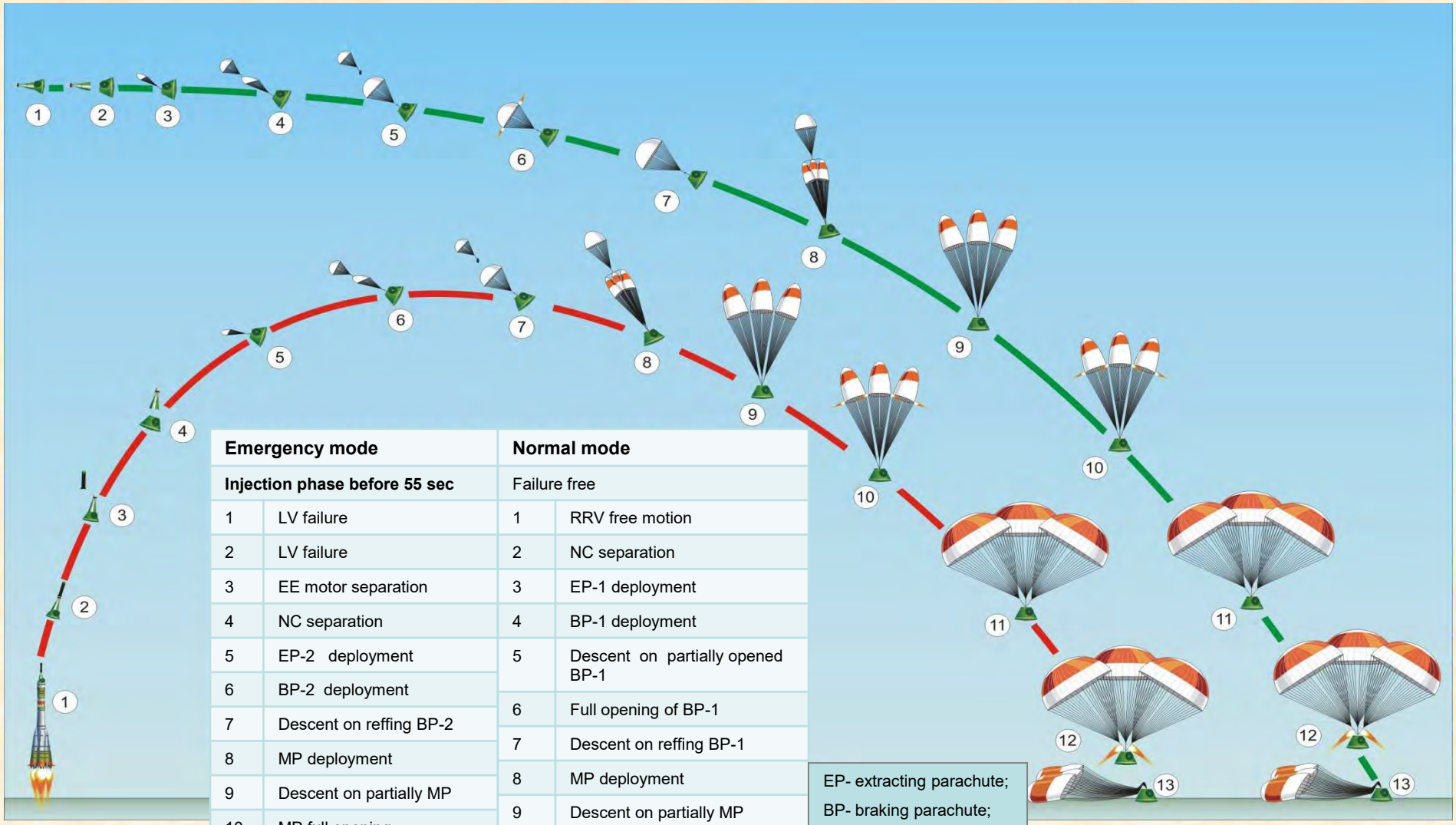


Basic parameters of PJLS

1	Mass	503 kg
2	Volume	700 cubic dm
3	Altitude range for deployment start	1000-10000 m
4	Dynamic pressure range at deployment start	50-1240 kg/m2
5	Maximum rotation rate around RRV longitudinal axis	200 deg/sec
6	RRV landing altitudes range	0-1500 m
7	Number of main parachutes	3
8	RRV descending speed on main parachutes : -nominal at H=0 -maximum at H=0 -maximum at H=1500 m	 6.3 m/sec <9 m/sec <9.45 m/sec
9	Landing speed after the soft landing system operation start	0-5 m/sec
10	Operational temperature range in the compartment	from minus 40° to plus 50°

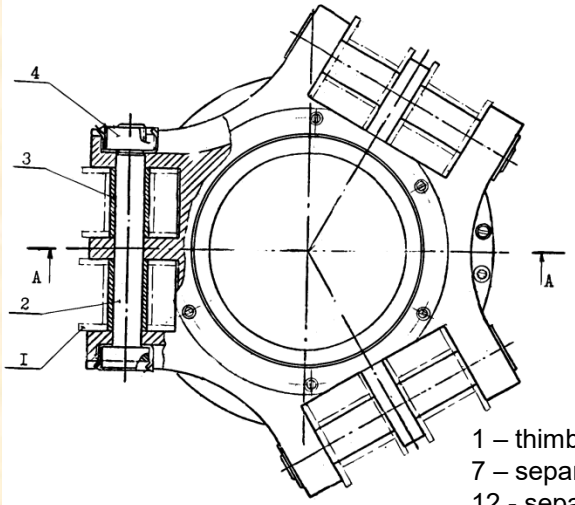
1. Parachute system composition :
-The primary extracting module with the main extracting parachute of 1 m² area;
- redundant extracting module comprising two redundant extracting parachutes of 1 m² and 6 m² area;
- the primary braking module with braking parachute of 18 m²;
- redundant braking module with redundant braking parachute of 22 m² area;
- three primary modules with the main parachute of 590 m² area in each module.
2. Parachute system weight is not more than 350 kg.
3. Nominal vertical speed of descending on three main parachutes is not more than 6.5 m/sec.

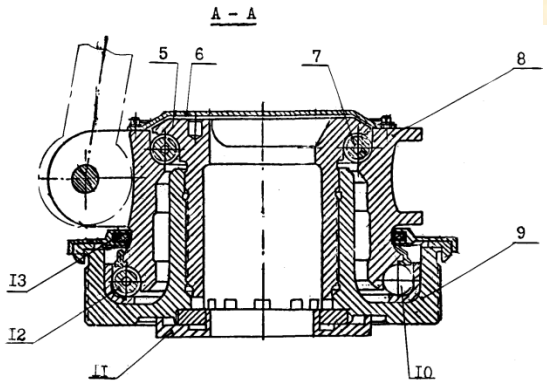
PJLS operational concept



Emergency mode		Normal mode	
Injection phase before 55 sec		Failure free	
1	LV failure	1	RRV free motion
2	LV failure	2	NC separation
3	EE motor separation	3	EP-1 deployment
4	NC separation	4	BP-1 deployment
5	EP-2 deployment	5	Descent on partially opened BP-1
6	BP-2 deployment	6	Full opening of BP-1
7	Descent on reffing BP-2	7	Descent on reffing BP-1
8	MP deployment	8	MP deployment
9	Descent on partially MP	9	Descent on partially MP
10	MP full opening	10	MP full opening
11	Descent on fully opened MP	11	Descent on fully opened MP
12	Soft landing motors ignition	12	Soft landing motors ignition
13	Landing	13	Landing

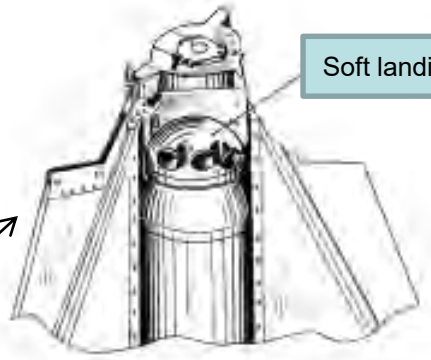
EP- extracting parachute;
BP- braking parachute;
MP- main parachute





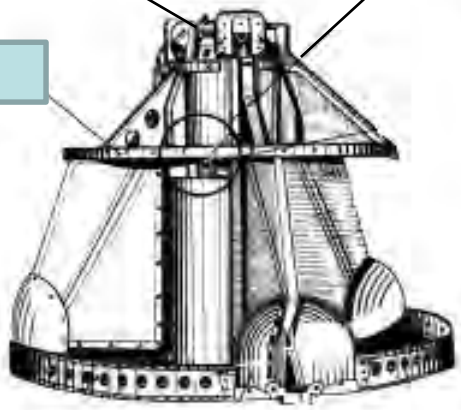
1 – thimble; 2 – bolt; 3 – bush; 4 – nut; 5- bush; 6- lid;
7 – separating bush; 8 – rotor; 9 – body; 10 – ball; 11- lid;
12 - separating bush; 13 – felt gasket.

Swivel



Soft landing motor

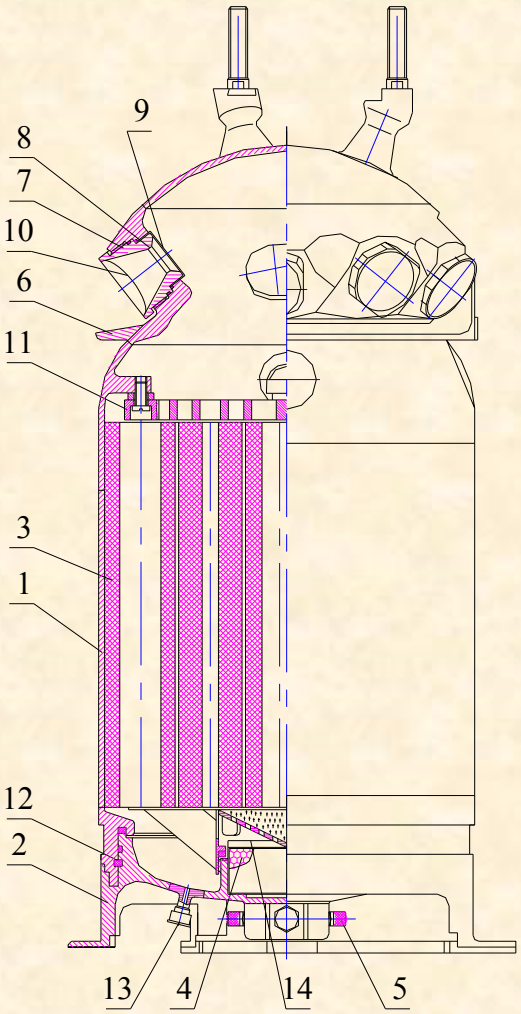
Release mechanism



PJLS frame

Soft landing motor parameters

Soft landing motor

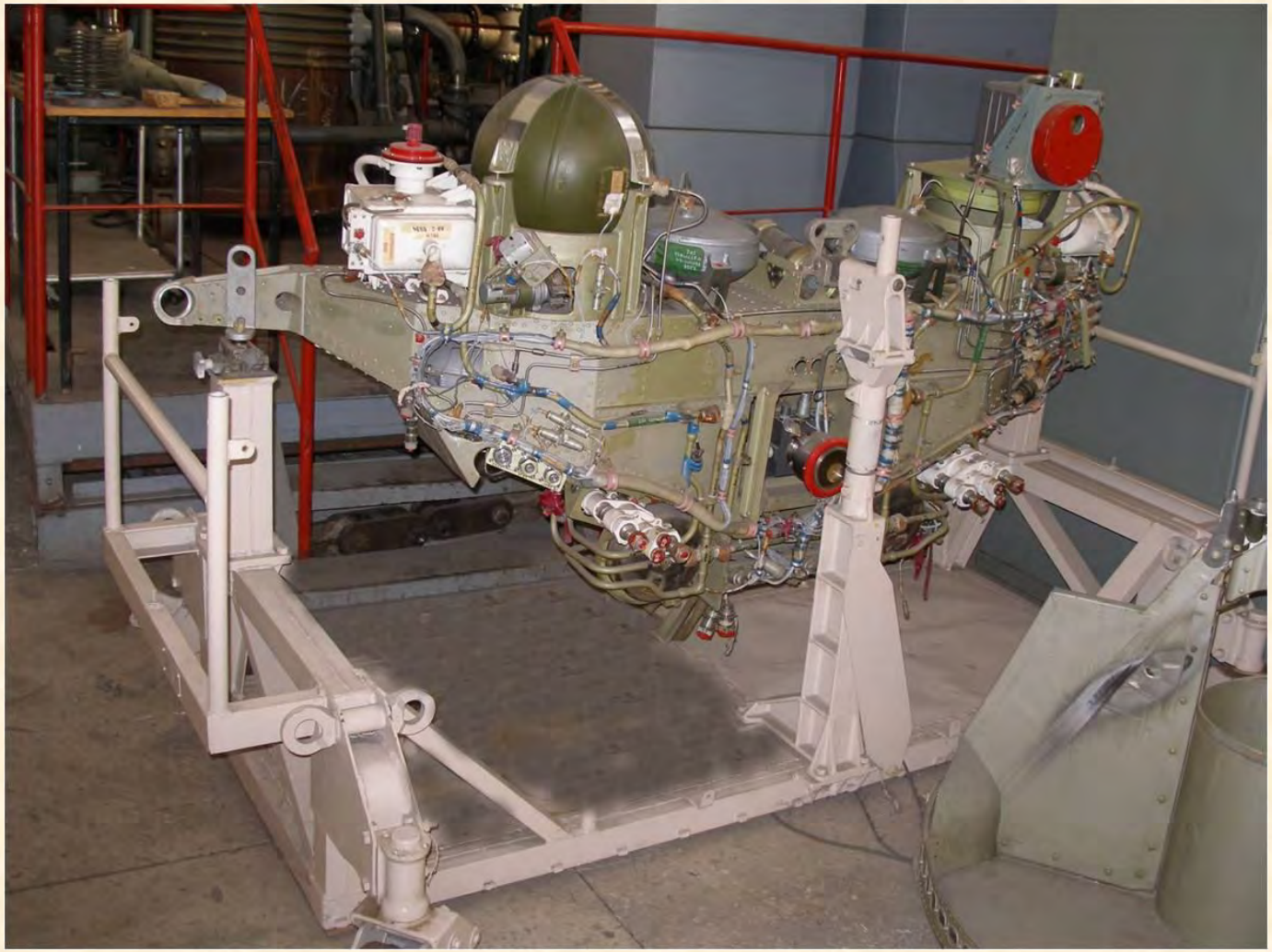


1	Total thrust pulse	2250-2500 kg•f
2	Maximum thrust along the motor axis	15000 kgf
3	Operational time	0.29-0.49 sec
4	Thrust stabilization time	Not more than 0.03 sec
5	Operational temperature range	From minus 30° to+30°
6	Maximum operational pressure in the combustor	Not more than 250 kgf/cm2
7	Motor weight with propellant	76.3 ± 1.5 kg
8	Propellant grain weight	18.3 ± 0.1 kg
9	Angle between the nozzle and the motor axes	52°
10	Angle between the thrust vector and motor axis in plane I-III	3°± 15'

1- body; 2- lid; 3- grain; 4- igniter; 5 – pyro cartridge; 6 – gas deflectors; 7- nozzle unit; 8 – nozzle; 9 – membrane; 10 –plug; 11 grid; 12 – keys; 13 - connecting pipe; 14 – igniter chamber.

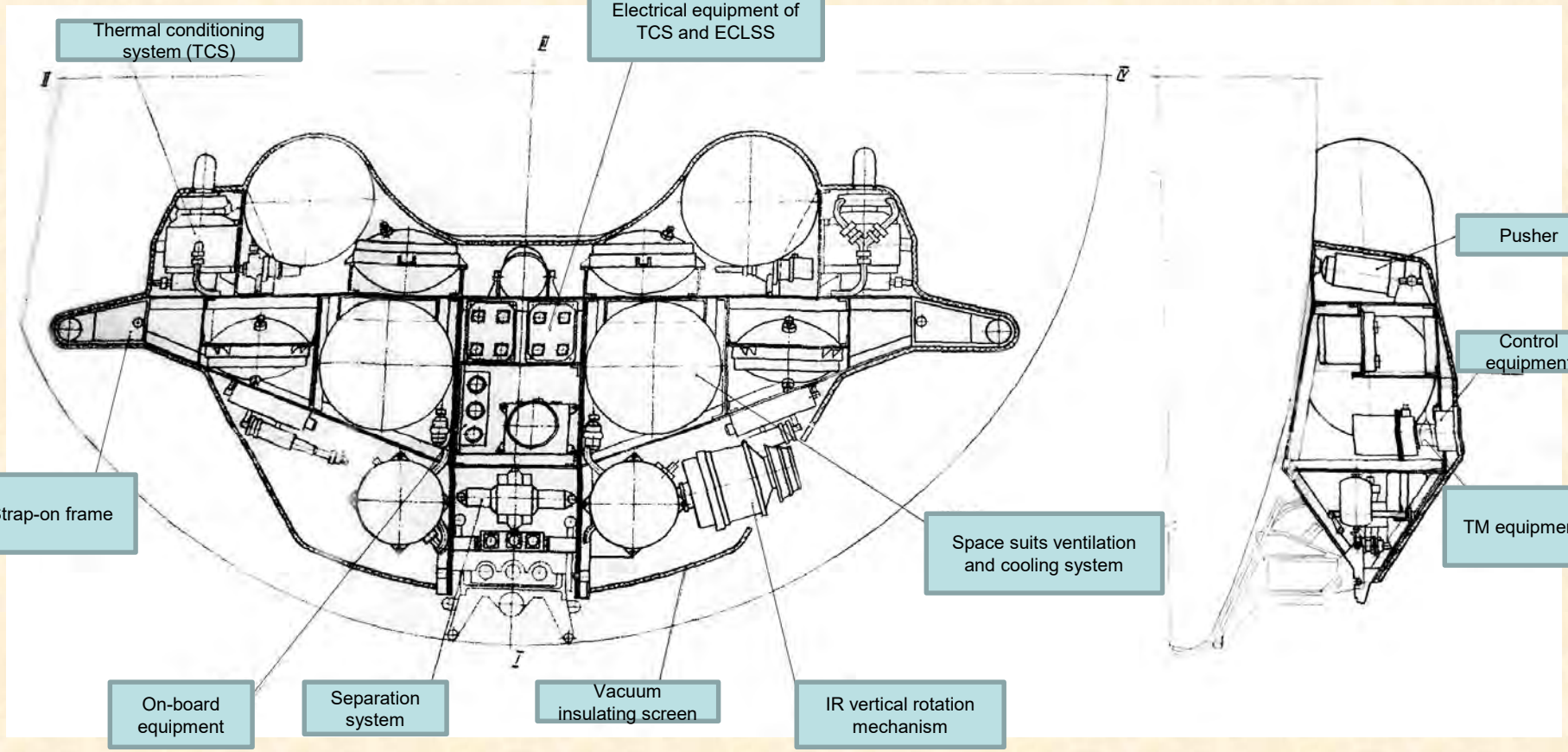
IV. Strap-on

Strap-on module in the assembly shop



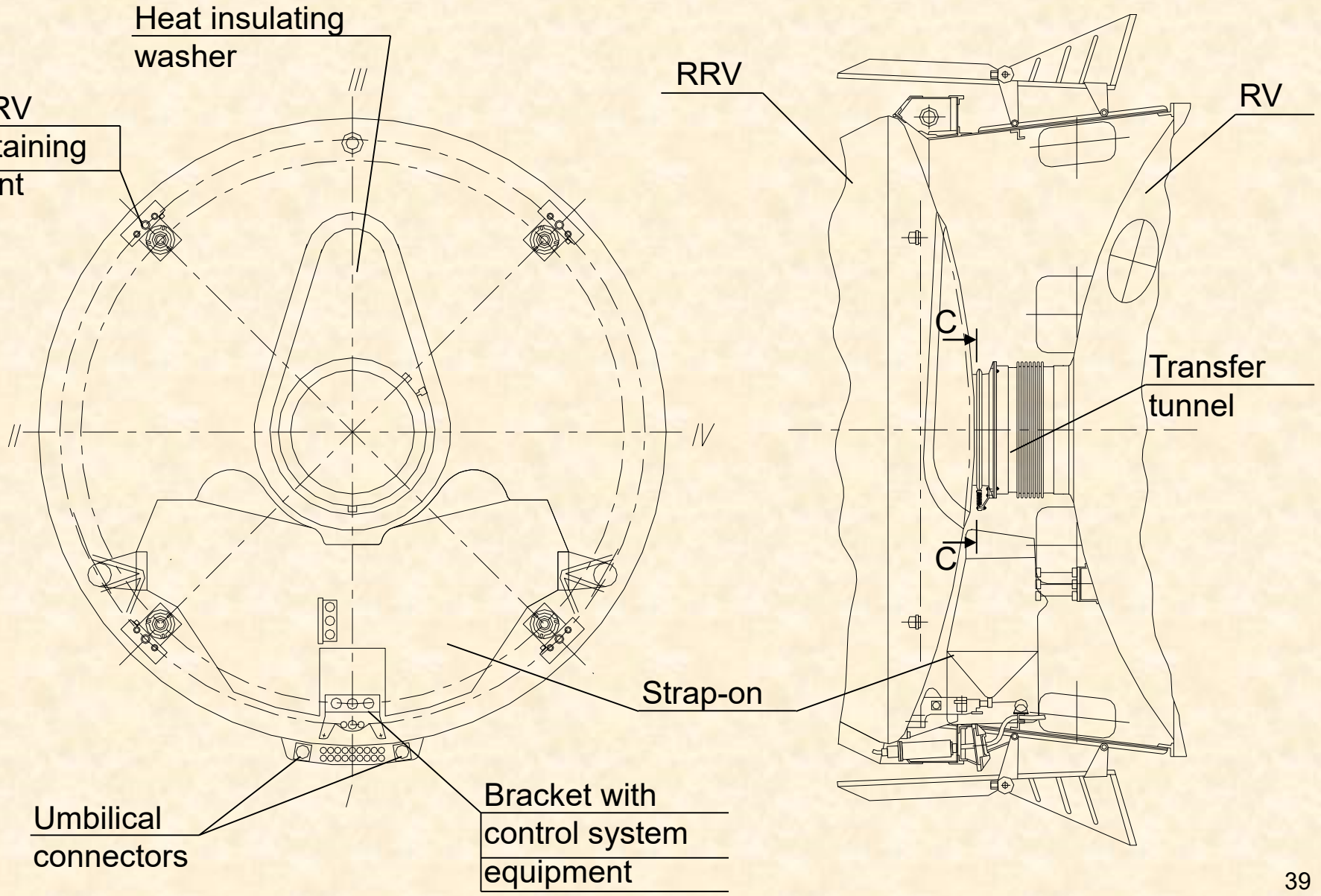
1	Weight	250 kg
2	Temperature of RRV thermal conditioning system coolant	10-12º
3	CC pressure at which the space suits get pressurized and their ventilation and cooling system starts working from the strap-on bottles	465 ± 30 mm Hg
4	Pressure in one oxygen tank	400 Atm
5	Operational load on the strap-on mechanism for separation from the crew compartment	2300 kgf

assembly Strap-on module

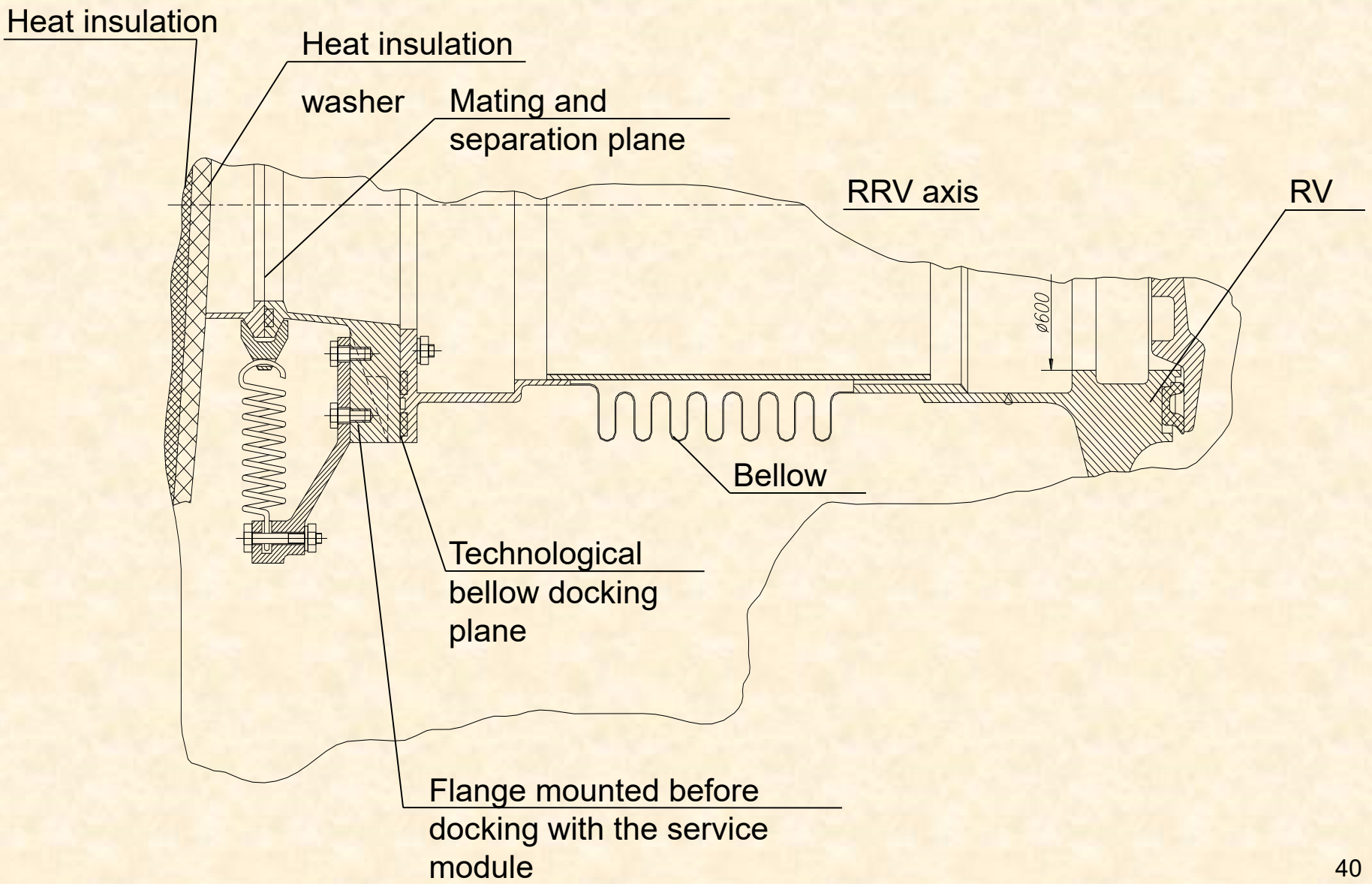


V. System for RRV attachment and separation from the adjacent section of Almaz complex

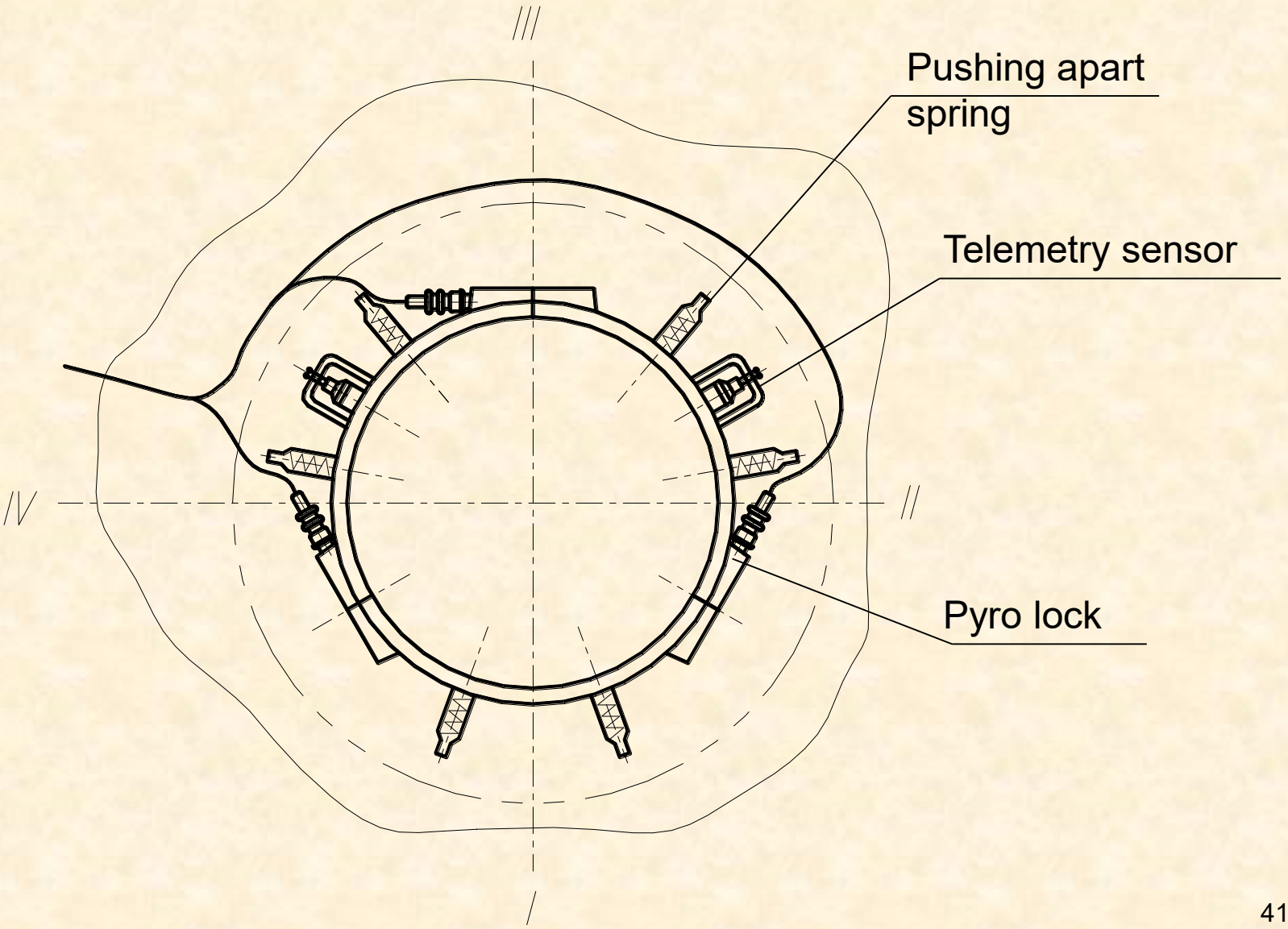
JOINT between RRV and replenishing vehicle (RV)

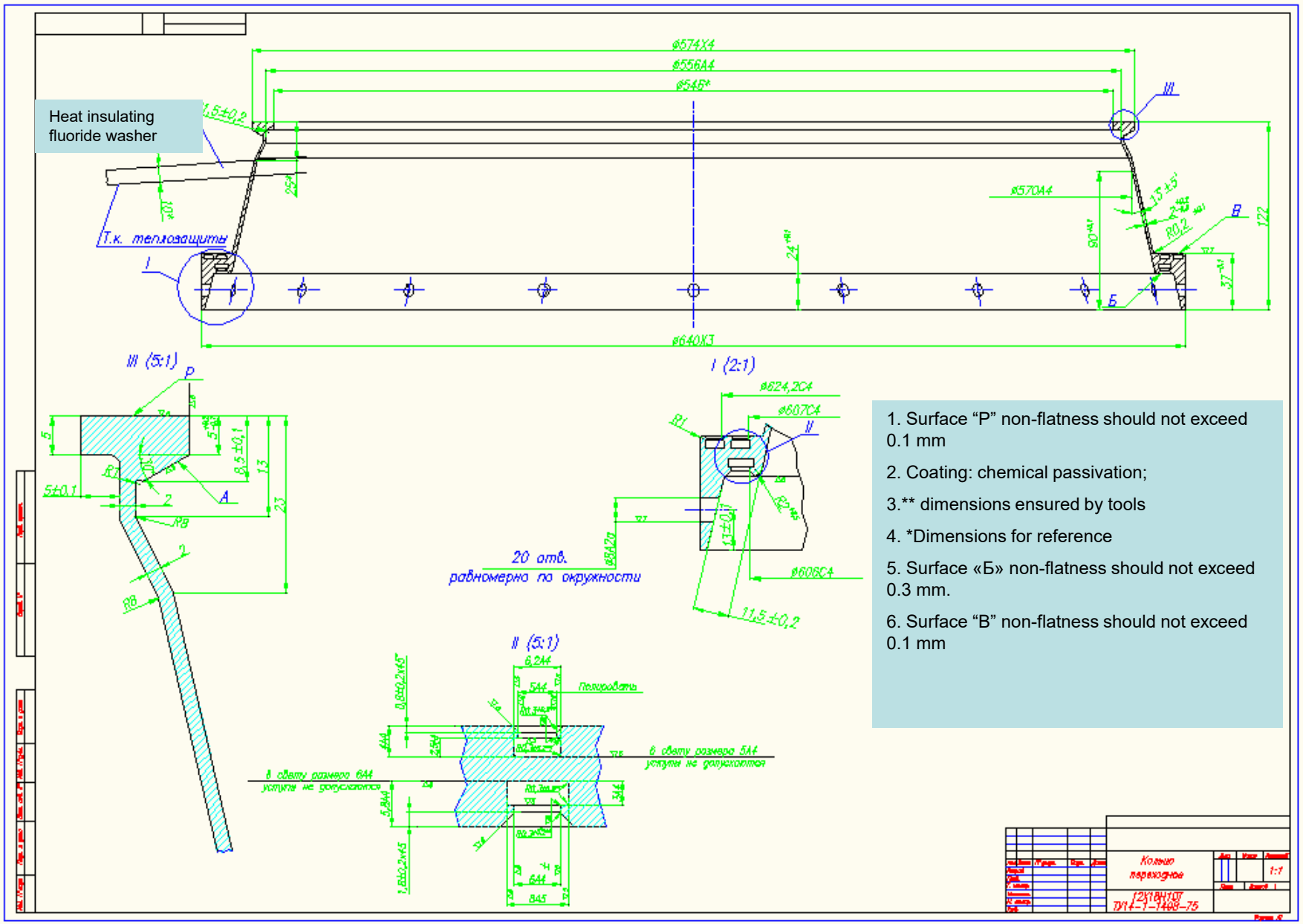


Transfer tunnel



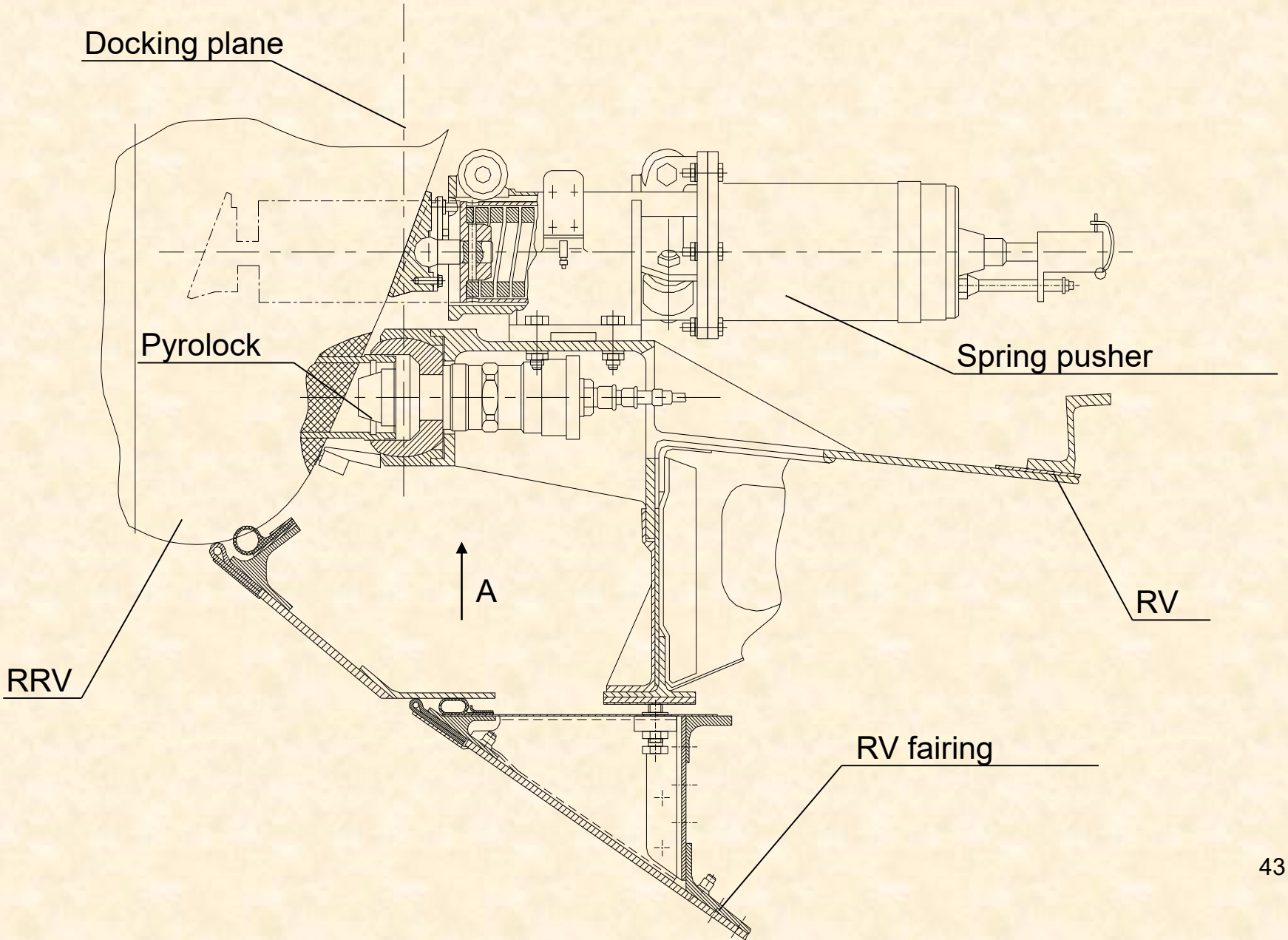
C-C



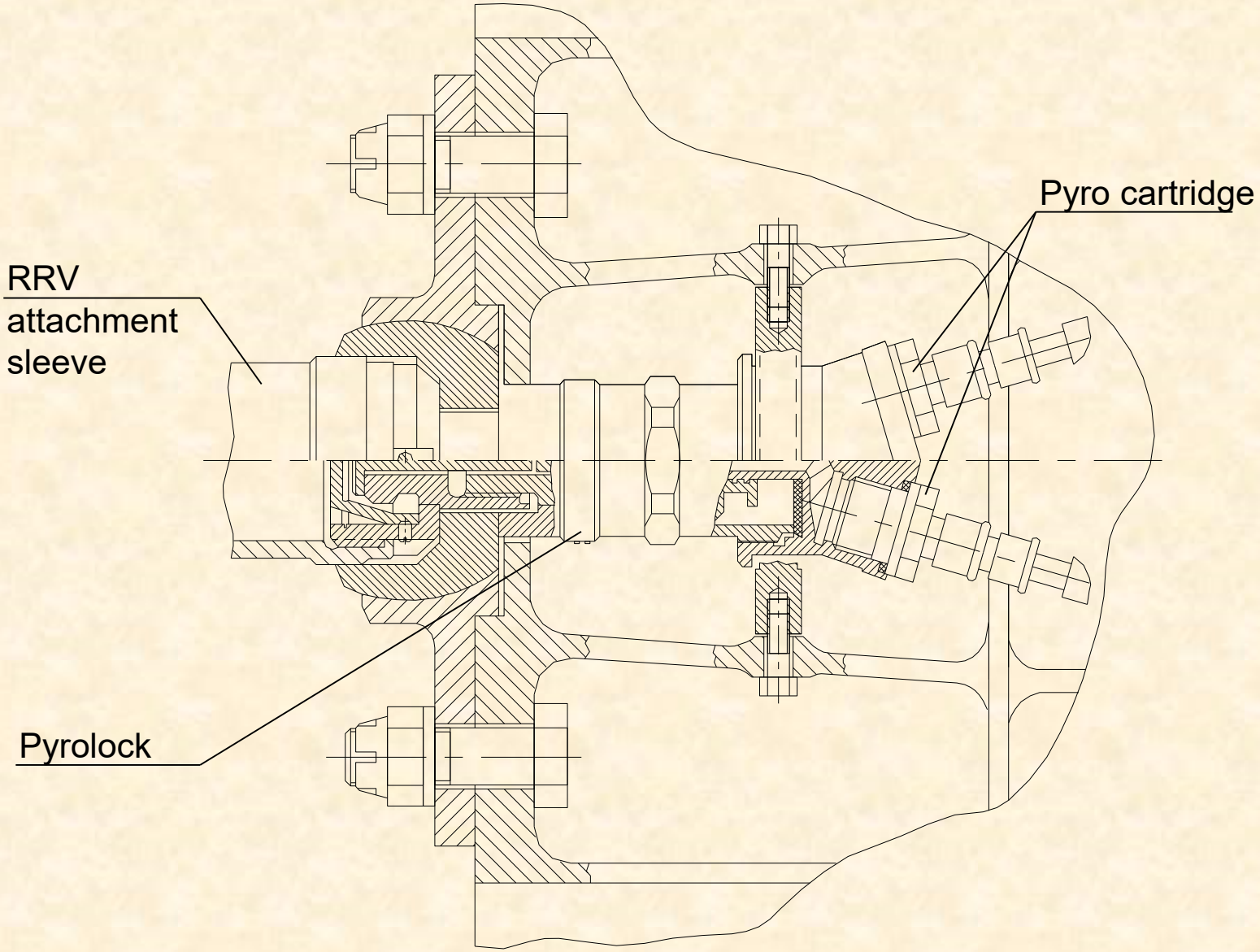


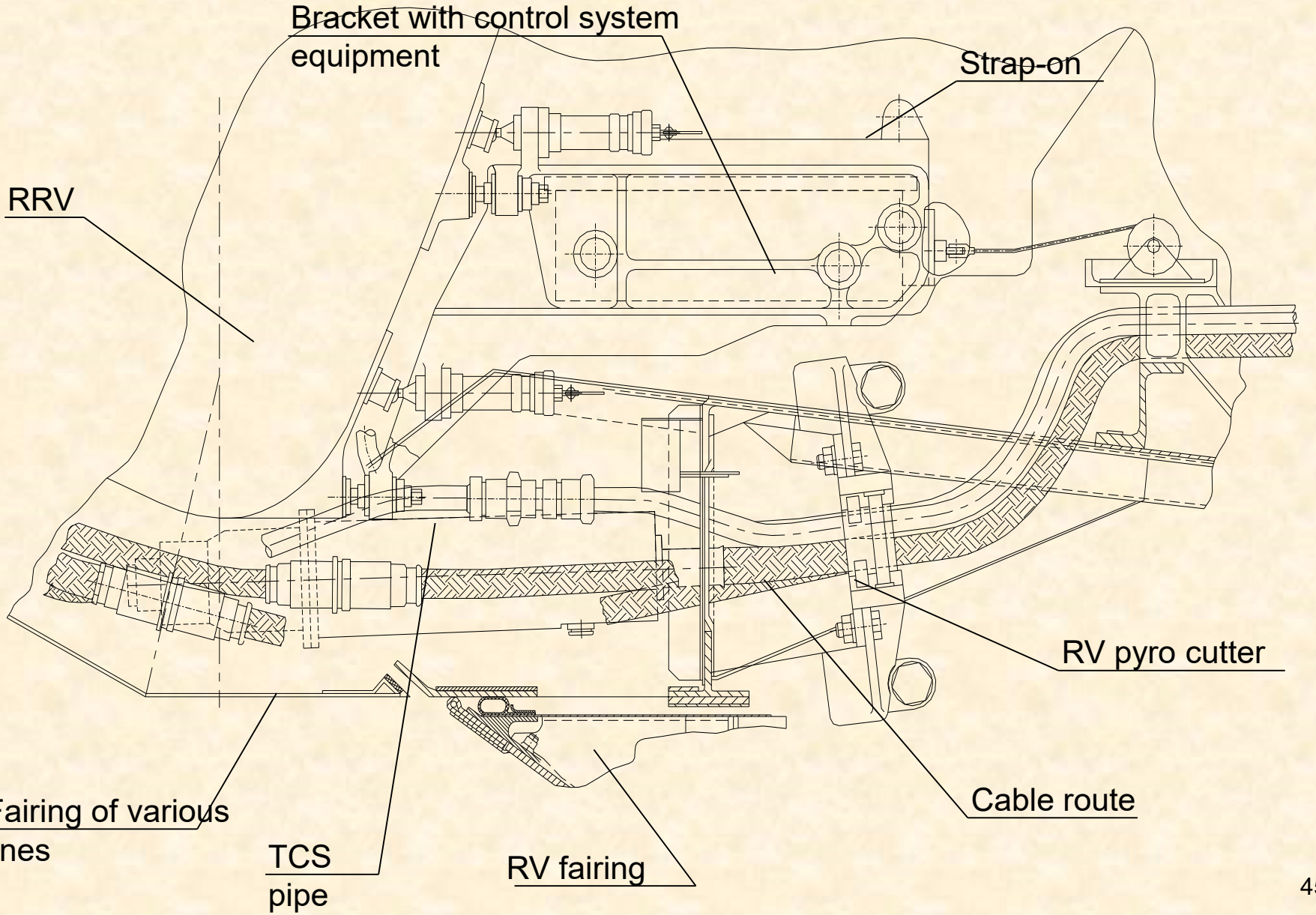
1. Surface “P” non-flatness should not exceed 0.1 mm
2. Coating: chemical passivation;
3.** dimensions ensured by tools
4. *Dimensions for reference
5. Surface «Б» non-flatness should not exceed 0.3 mm.
6. Surface “B” non-flatness should not exceed 0.1 mm

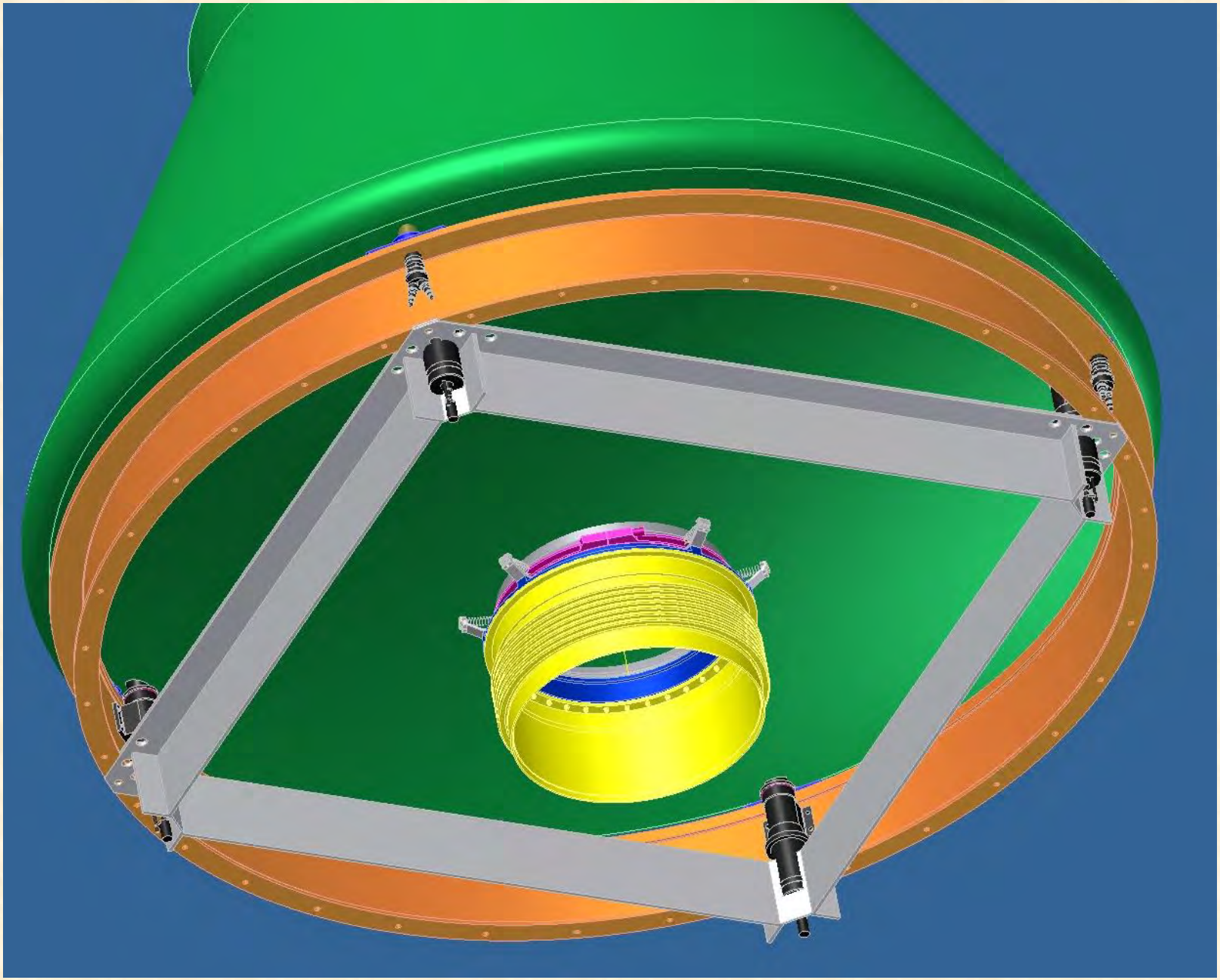
RRV attachment joint

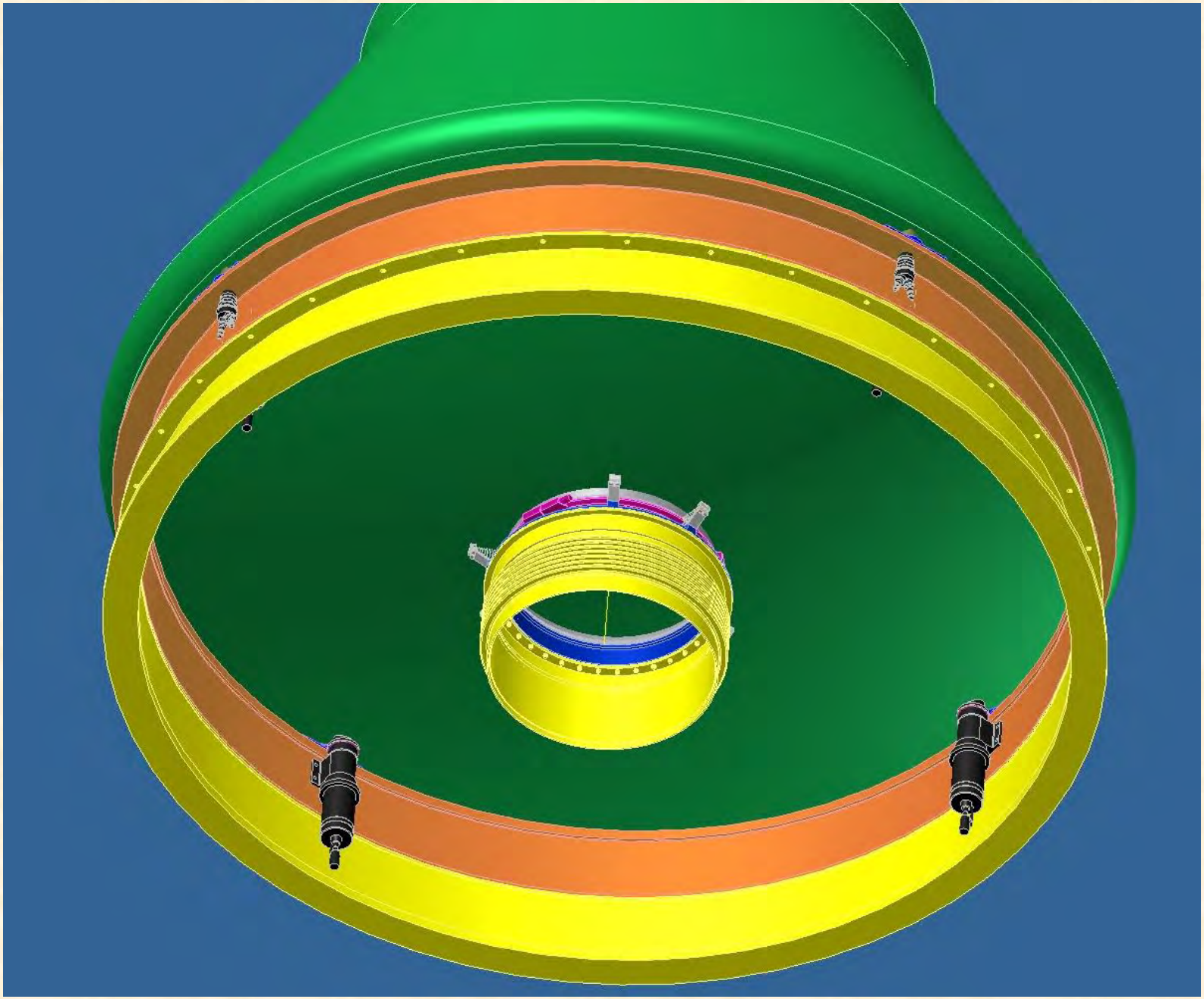


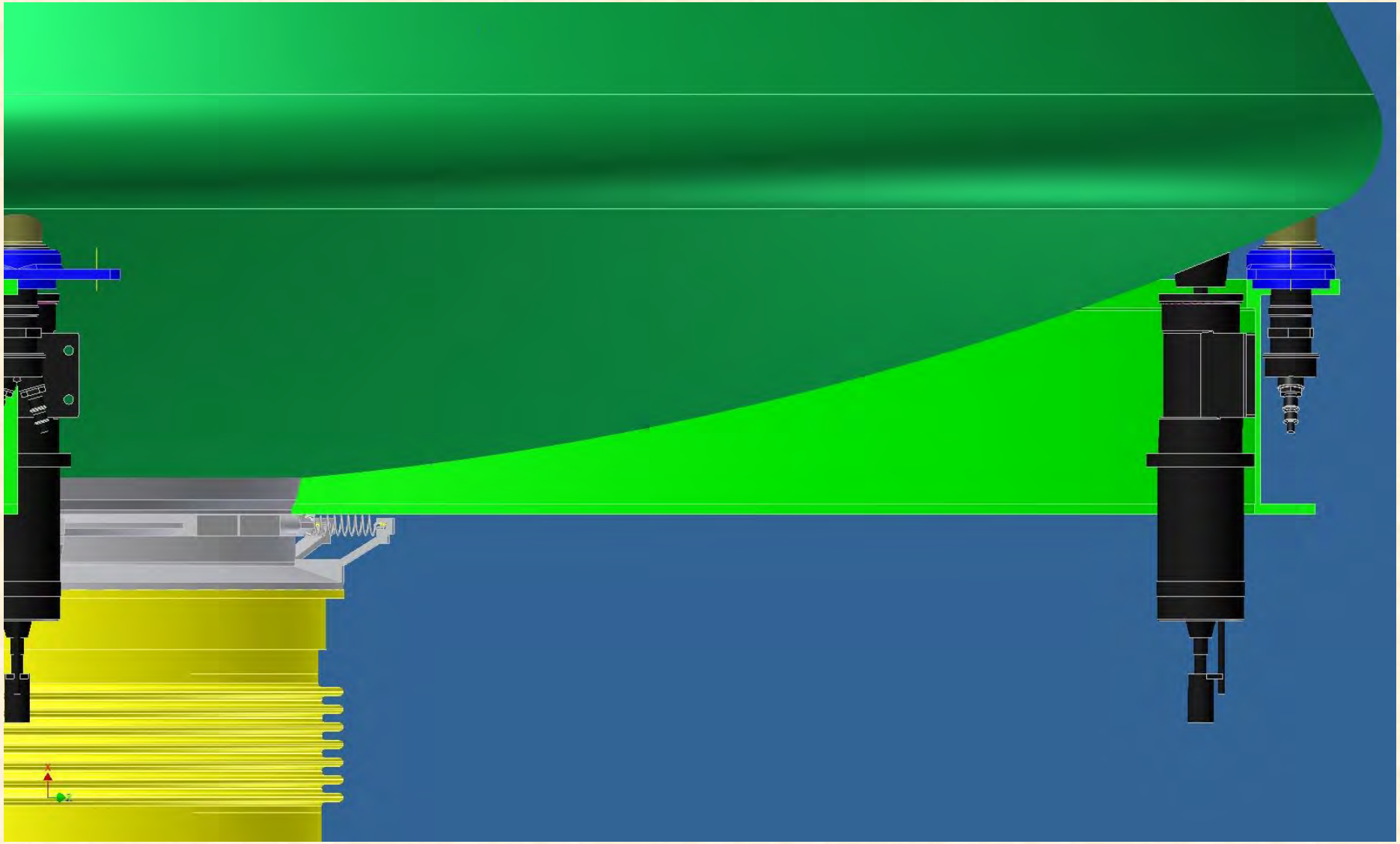
View A



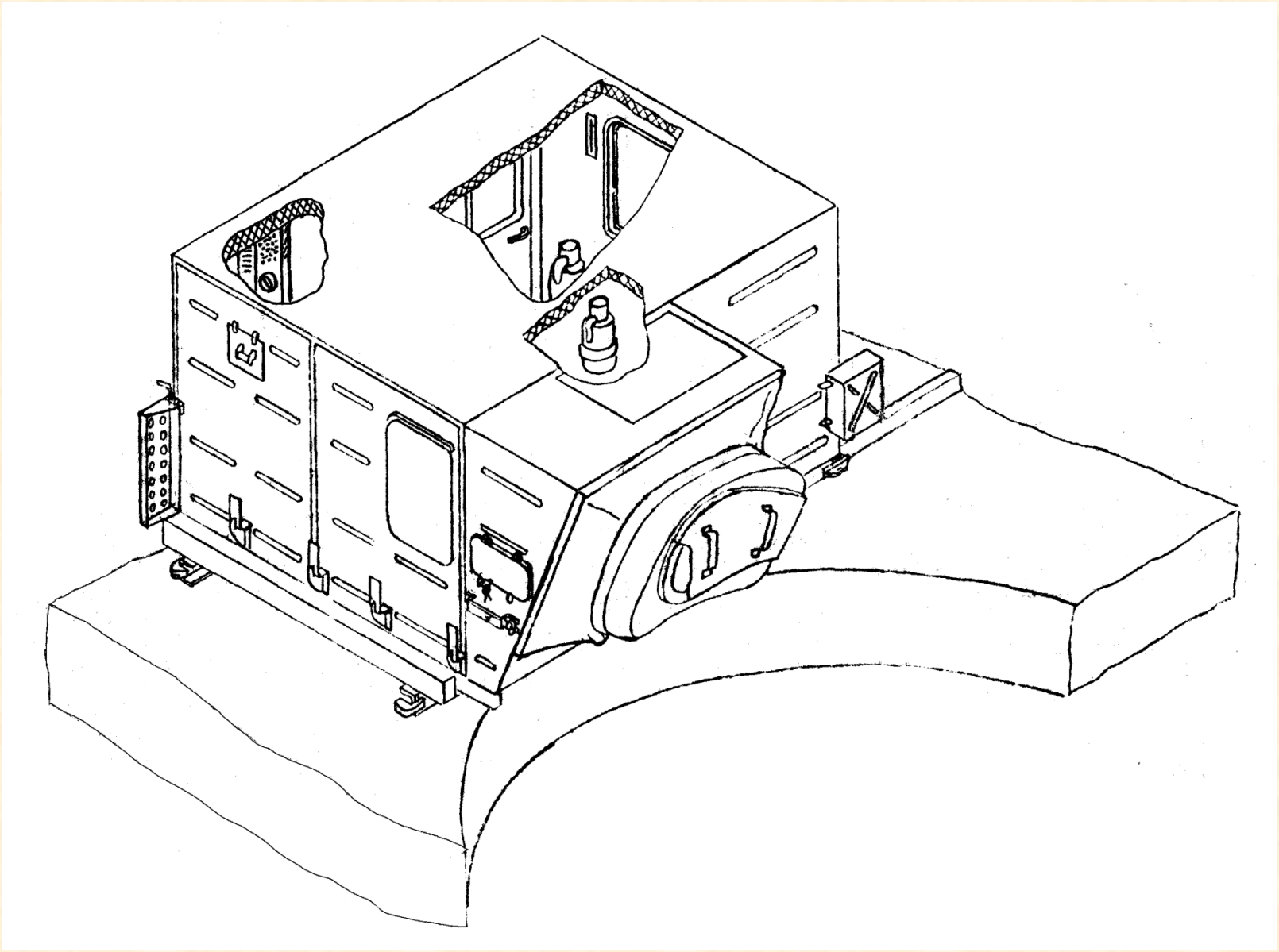

Bracket with control system equipment
Strap-on
RRV
RV pyro cutter
Fairing of various lines
TCS pipe
RV fairing
Cable route







Кабина посадки



Descent by parachutes