APPENDIX D

Adapter Systems

D. ADAPTER SYSTEMS

This appendix presents information on Adapter Systems (AS) that may be used for commercial launches with the Breeze M. Currently, the following five adapter systems are available:

Table D.1 Payload Adapter Systems

Adapter System Type	Section
937VB-1168	D.1
1194VX-1000 (1194VS-1000)	D.2
1666V-1000	D.3
1664HP-1000	D.4

Information on the SC/AS mechanical interface, the structure's load-bearing capacity, and the characteristics of the AS interface ring are presented in Sections D.1 through D.4.

The typical SC/AS electrical interface is described in Section 4.2.

D.1 ADAPTER SYSTEM 937VB-1168

D.1.1 Adapter System Description

Adapter system 937VB-1168 comprises a frame, the 937VB separation system (developed by RUAG Aerospace Sweden AB), telemetry and ground measurement system sensors, thermal insulation, and electrical cables.

The AS mechanical interface to the SC comprises an AS interface ring, a clampband with 937VB separation system push springs, separation verification sensors, umbilical electrical connectors (as the mechanical part of the electrical interface), and a SC purge fitting (which is installed depending on the specific SC).

The AS frame is conical and constructed of three parts.

- The top part is a metal ring developed by RUAG Aerospace Sweden AB, intended for mating to the SC. The 937VB separation system and the separation verification sensor are mounted on it. Interface rings manufactured by other companies may be mounted instead, together with the 937VS or 937LPSU separation systems, which are described in Section 4.1.5. One or two scribe marks should be engraved on the side surface of the AS interface ring to control the clocking of the adapter with respect to the SC interface. Angular location of the adapter scribe marks should be the same as for the SC interface ring.
- The middle part is a metal spacer designed by KhSC. The spacer holds two brackets to secure the umbilical electrical connectors.
- The bottom part is a carbon composite spacer. It is of typical design and is also used in the 1194VX-1000 and 1194VS-1000 adapter systems.

Drawings of the 937VB-1168 AS, which include the mechanical interface, are shown in Figures D.1.1-1a through D.1.1-1e.

Figure D.1.1-1a: Adapter System 937VB-1168

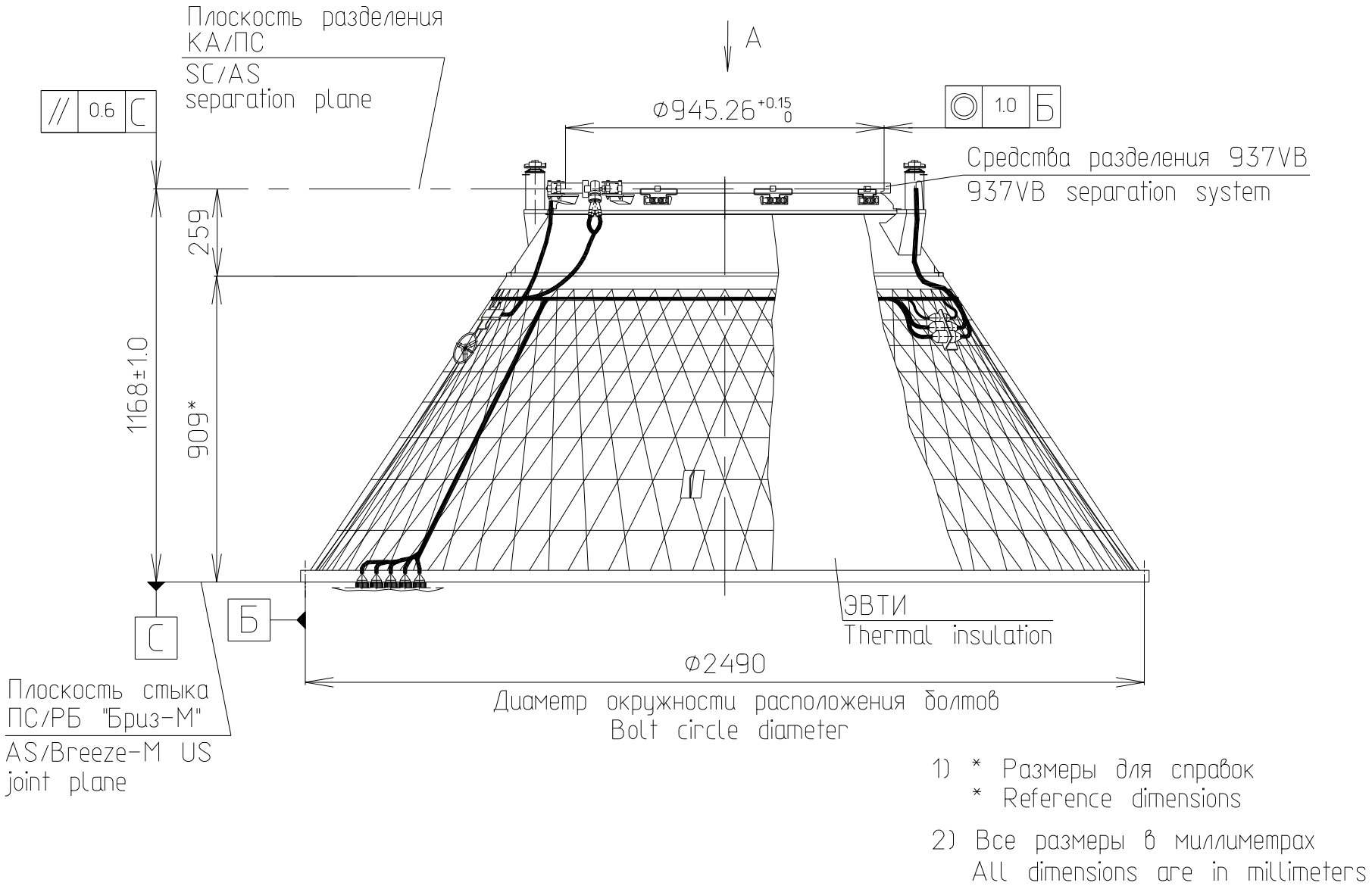


Figure D.1.1-1b: Adapter System 937VB-1168

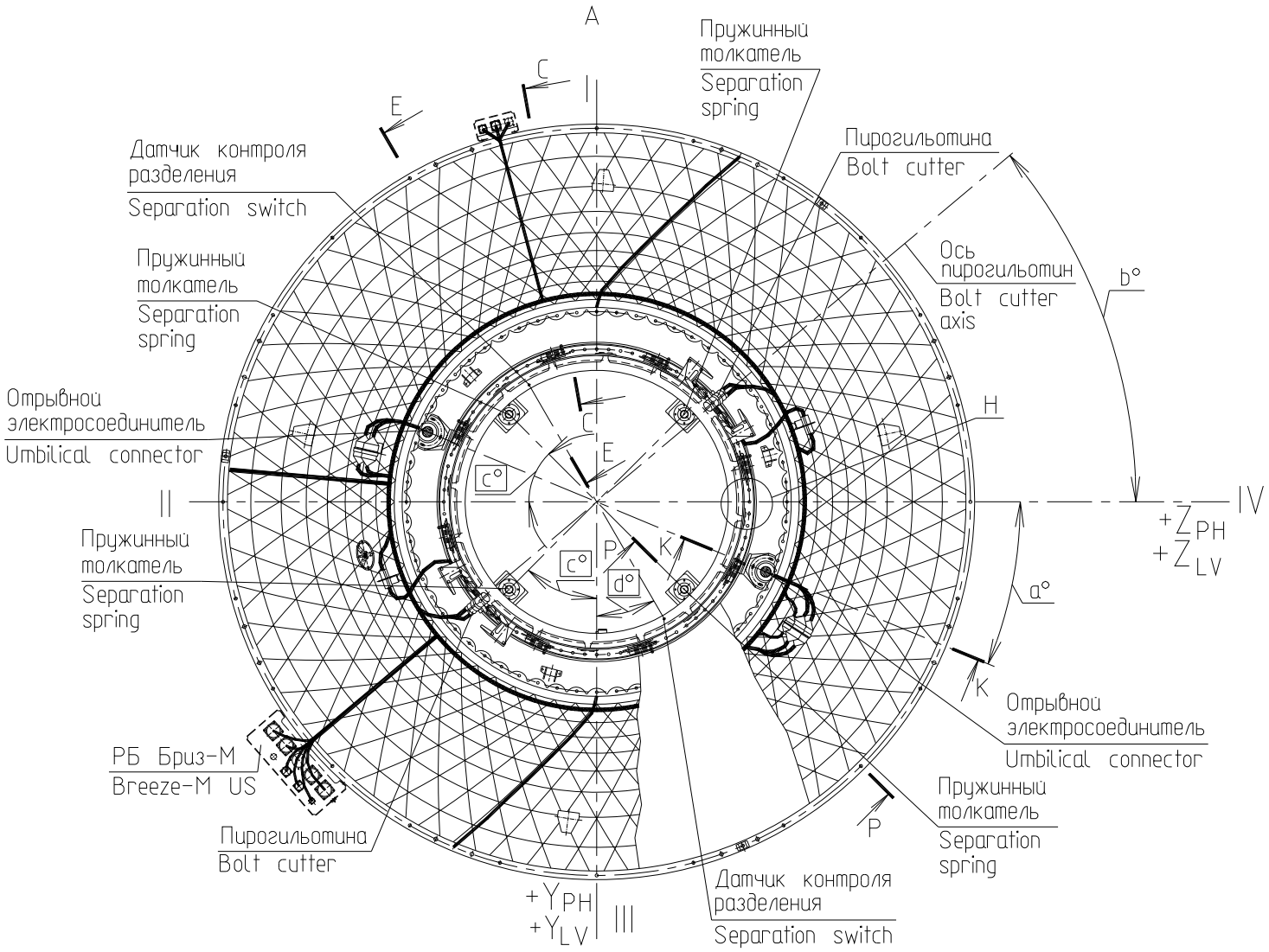
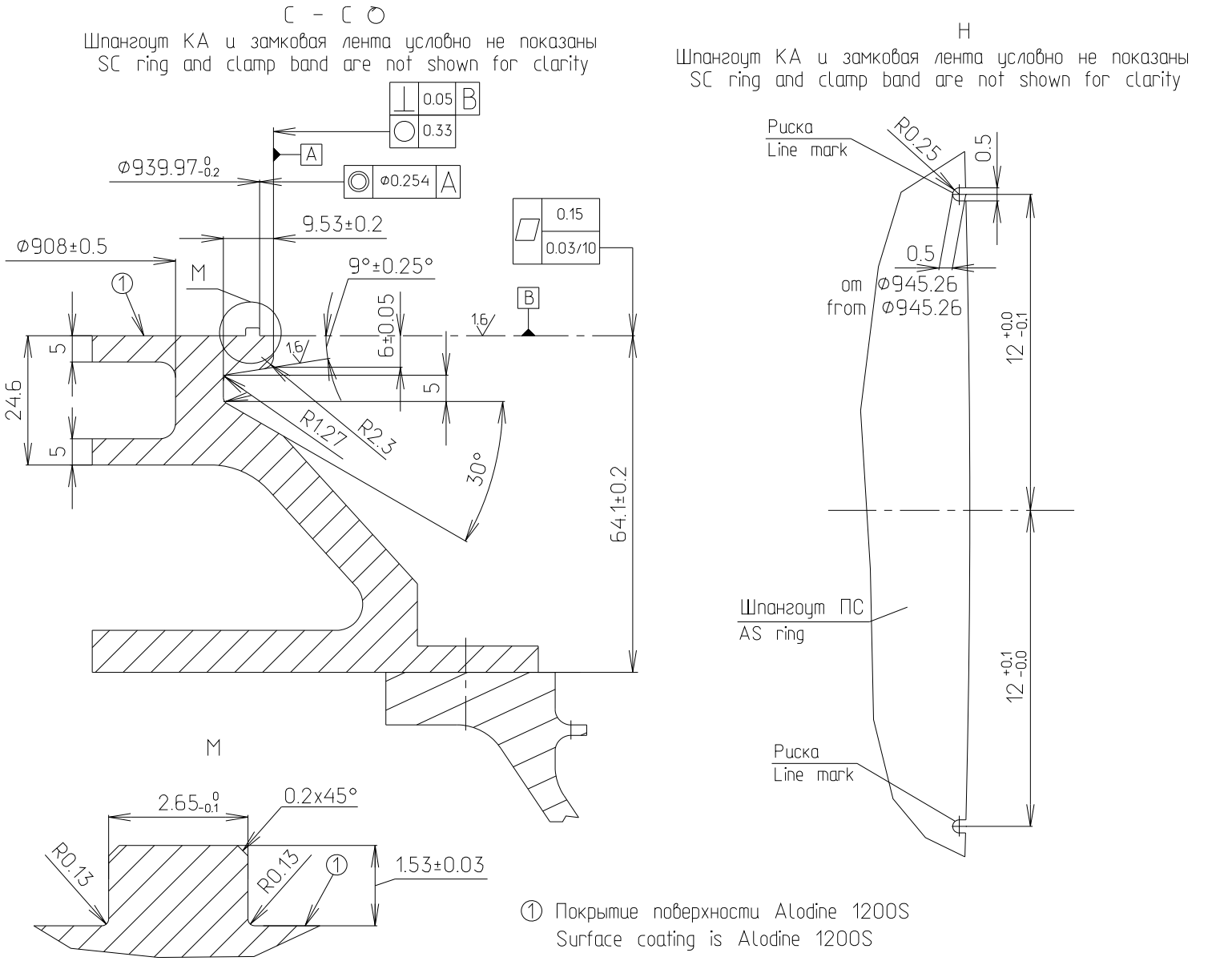


Figure D.1.1-1c: Adapter System 937VB-1168



① Покрытие поверхности Alodine 1200S
Surface coating is Alodine 1200S

Figure D.1.1-1d: Adapter System 937VB-1168

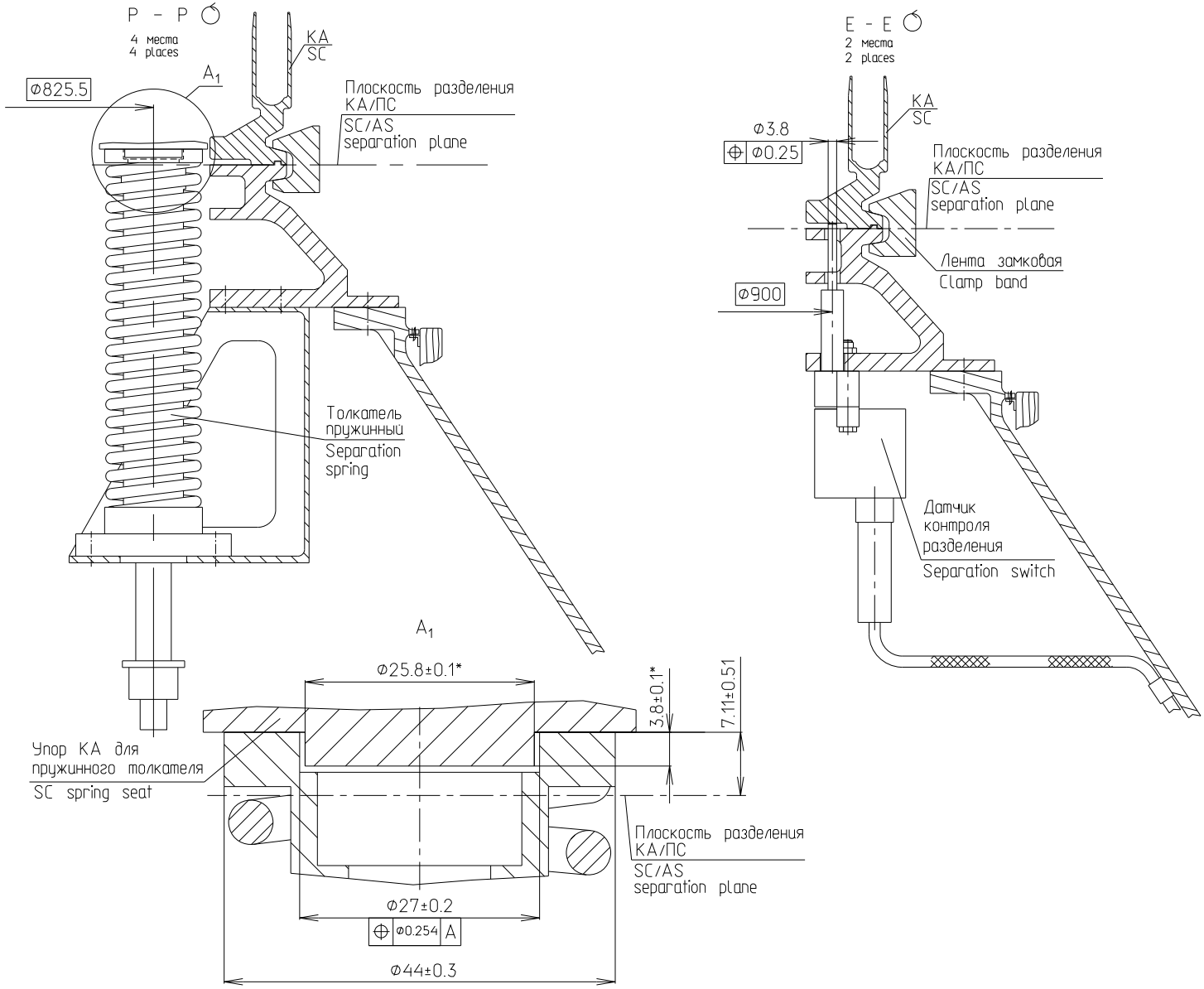
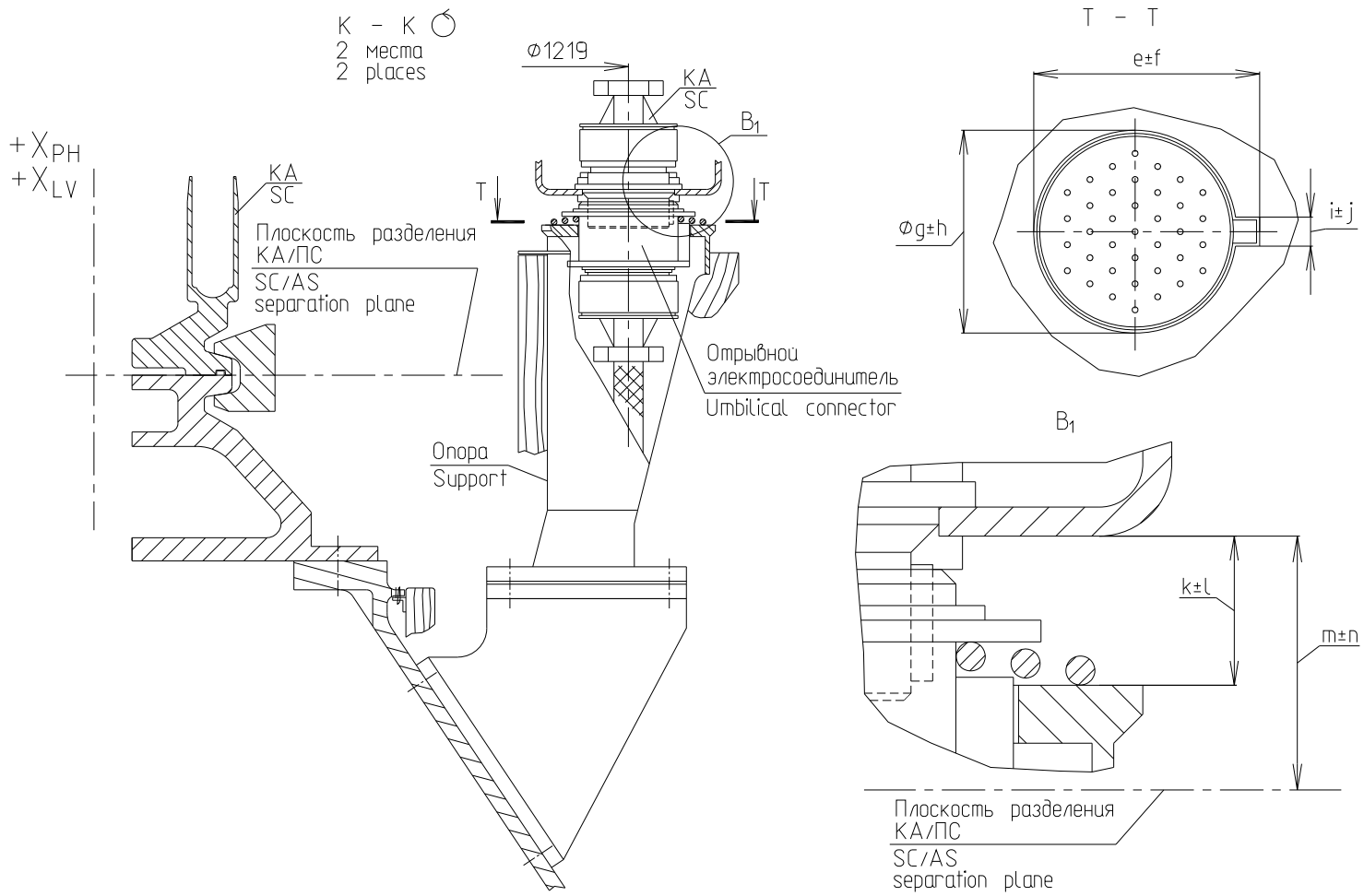


Figure D.1.1-1e: Adapter system 937VB-1168



e,f,g,h,i,j,k,l,m,n предоставляются подрядчиком по КА в зависимости от конкретного отрывного электросоединителя
e,f,g,h,i,j,k,l,m,n are provided by SC cotractor depending on specific umbilical connector

Положение электросоединителя может регулироваться в плоскости Z_{PH} – Y_{PH} и вдоль оси X_{PH}
Umbilical connector location can be ajusted in Z_{LV} – Y_{LV} plane and along X_{LV} axis

Соединитель продувки КА может быть установлен на опоре в зависимости от конкретного КА
SC purge fitting can be mounted on support depending on specific SC

D.1.2 Load-Bearing Capability

The load-bearing capability of the AS structure is based on the allowable load determined after testing. The AS will hold down a SC having a maximum mass of 3740 kg, whose CG is located 1.375 m above the separation plane. This structural load-bearing capability is determined for standard interface ring characteristics, specified in Table D.1.3, and geometrical parameters, specified in Figure D.1.1-1c. Quasi-static accelerations used in the calculation are shown in Section 3.4.1. It is assumed that the circumferential linear load is uniformly distributed in the separation plane. A potentially non-uniform linear load will reduce the allowable distance to the CG for a SC of the given mass.

The shown values of load-bearing capacity should be used only for preliminary evaluation of AS strength. During the early phase of SC integration with the LV, it will be necessary to perform a CLA to verify strength when loading the AS structure and the separation system.

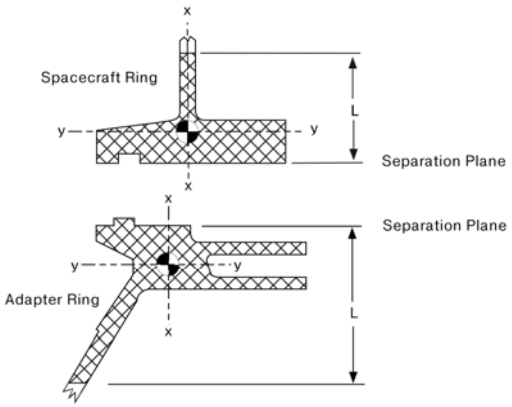
D.1.3 Interface Ring Characteristics

The SC and AS interface rings and the separation system are designed to transfer loads from the SC to the AS during ground operations and in flight. The outer contours of the rings are designed to mate with the separation system clampband. A description of the SC and AS interface ring cross sections and materials are shown in Table D.1.3-1. Figure D.1.3-1 shows the reference frame axes used to analyze the characteristics of the interface ring geometrical cross sections.

Table D.1.3-1: Characteristics of SC and AS Interface Rings

Ring Characteristic	SC Ring	AS Ring
Height of effective cross section (L)	25 mm	25 mm
Cross-section area (A)	466 mm^2 ± 10%	579 mm^2
Moment of inertia (I_{XX})	44629 mm^4 ± 10%	51550 mm^4
Moment of inertia (I_{YY})	18802 mm^4 ± 10%	42350 mm^4
Modulus of elasticity (E)	70.3 x 10^3 MPa	-

Figure D.1.3-1: SC and AS Interface Ring Cross Sections



D.2 ADAPTER SYSTEM 1194VX-1000 (1194VS-1000)

D.2.1 Adapter System Description

Adapter system 1194VX-1000 comprises a frame, the 1194VX separation system (developed by RUAG Aerospace Sweden AB), telemetry and ground measurement system sensors, thermal insulation, and electrical cables.

The makeup of adapter system 1194VS-1000 is the same, except that the 1194VS separation system (developed by RUAG Aerospace Sweden AB) is used instead of the 1194VX separation system.

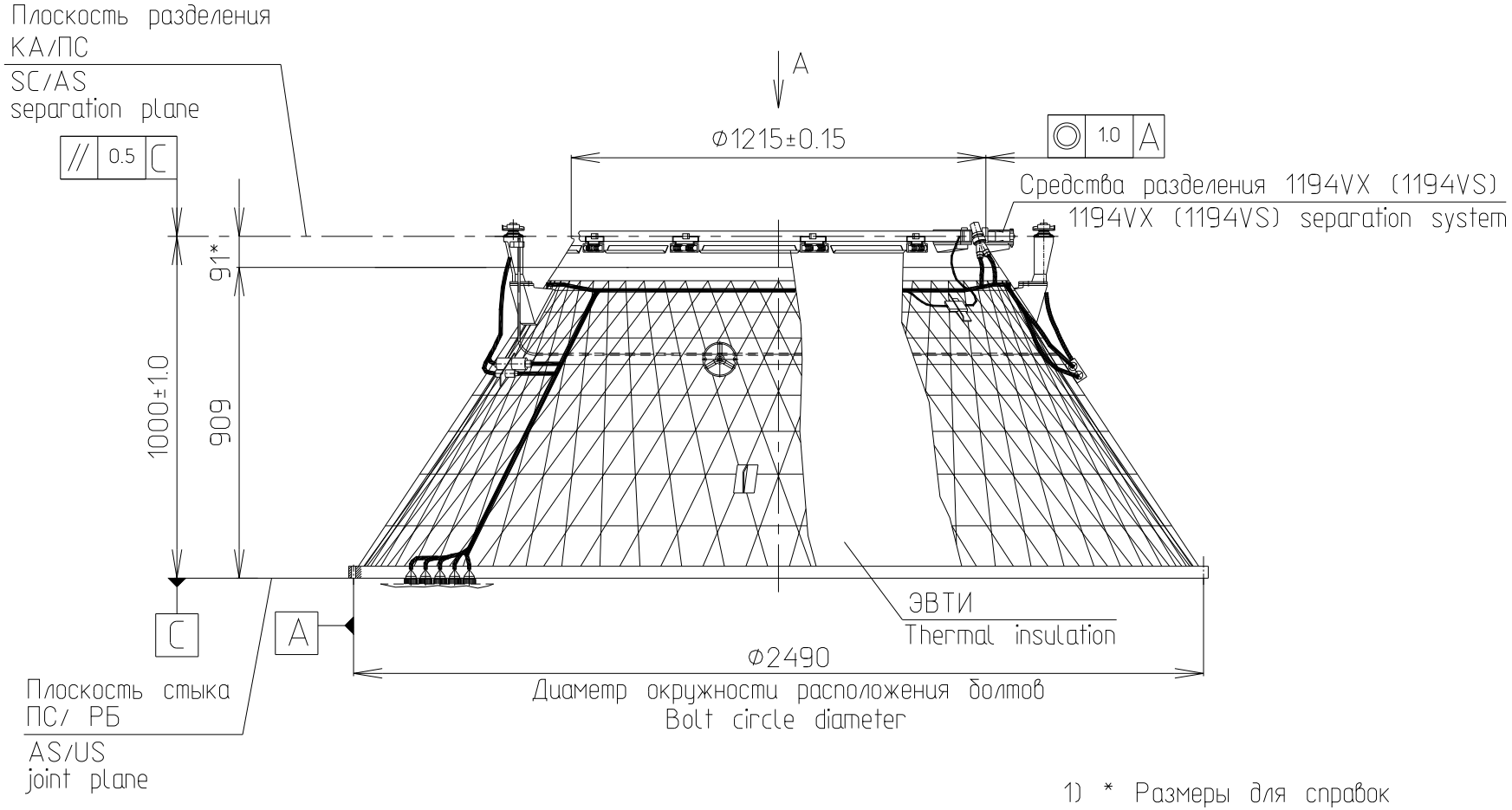
The AS mechanical interface to the SC comprises an AS interface ring, a clampband with 1194VX (1194VS) separation system push springs, separation verification sensors, umbilical electrical connectors (as the mechanical part of the electrical interface), and a SC purge fitting (which is installed depending on the specific SC).

The AS frame is conical and constructed of two parts.

- The top part is a metal ring that includes a SC interface ring. The 1194VX (11994VS) separation system and two separation verification sensors are mounted on it. The 1194LPSU-1000 separation system, which is described in Section 4.1.5, may also be mounted on this ring. One or two scribe marks should be engraved on the side surface of the AS interface ring to control the clocking of the adapter with respect to the SC interface. Angular location of the adapter scribe marks should be the same as for the SC interface ring.
- The bottom part is a carbon composite spacer. It is of typical design and is also used in the 937VB-1168 adapter system. Two brackets with umbilical electrical connectors are mounted on the bottom part of the AS.

Drawings of the 1194VX-1000 AS, which include the mechanical interface, are shown in Figures D.2.1-1a through D.2.1-1e. Figure D.2.1-1b shows a view of the 1194VX-1000 adapter system; Figure D.2.1-1c, of the 1194VS-1000 adapter system. The remaining drawings are identical for both adapter systems.

Figure D.2.1-1a: Adapter System 1194VX-1000 (1194VS-1000)



1) * Размеры для справок
   * Reference dimensions

2) Все размеры в миллиметрах
   All dimensions are in millimeters

Figure D.2.1-1b: Adapter System 1194VX-1000 (1194VS-1000)

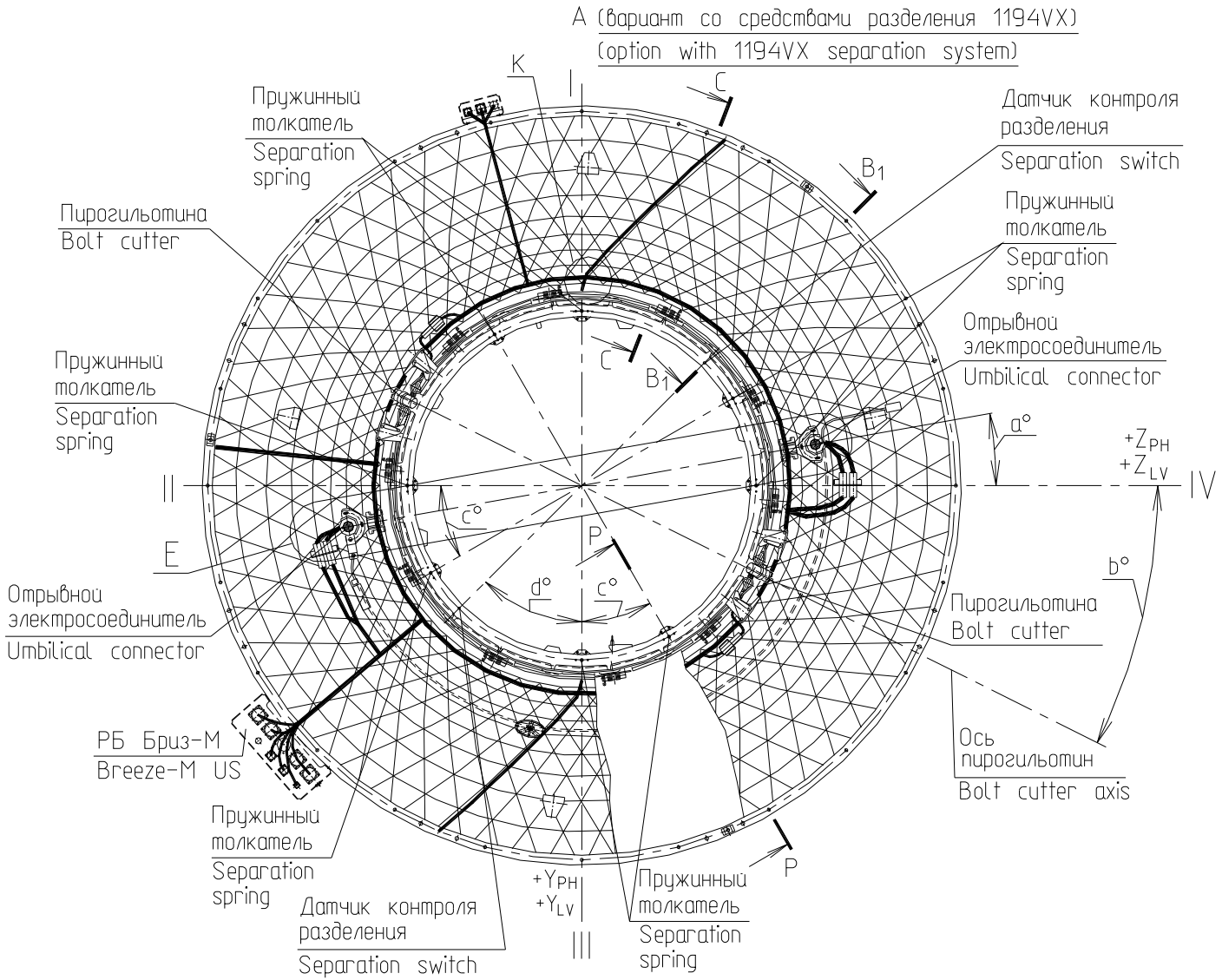


Figure D.2.1-1c: Adapter System 1194VX-1000 (1194VS-1000)

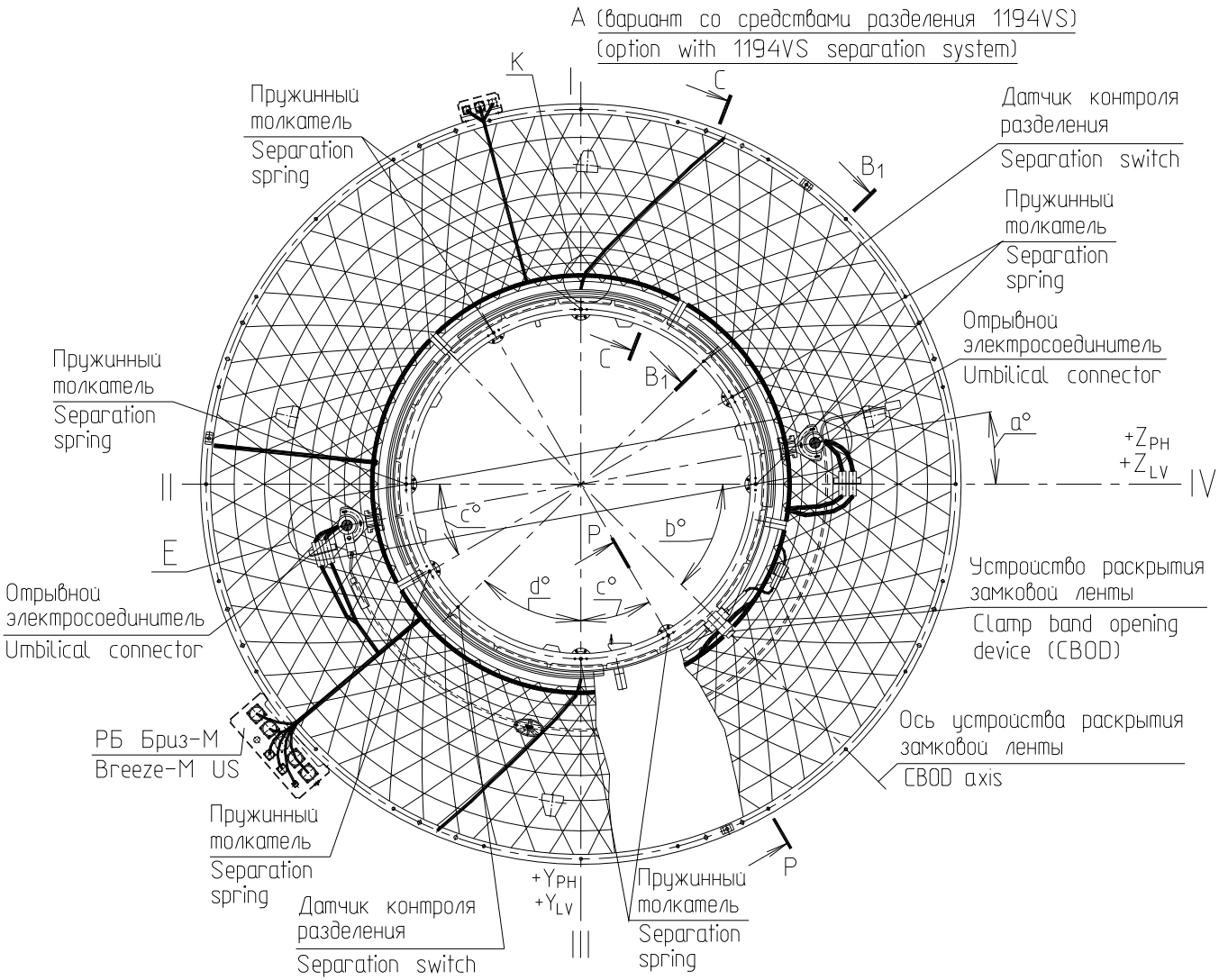


Figure D.2.1-1d: Adapter System 1194VX-1000 (1194VS-1000)

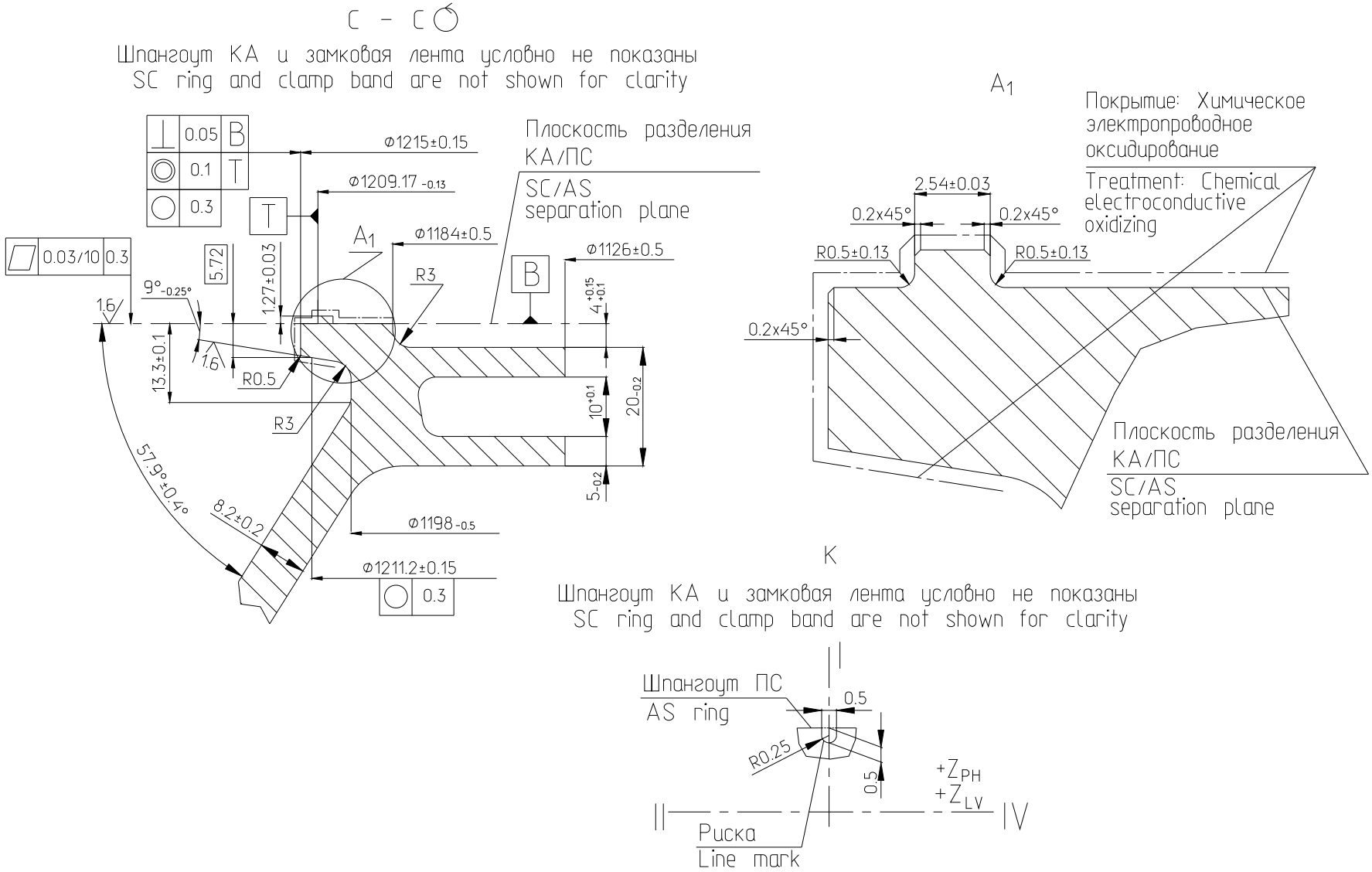


Figure D.2.1-1e: Adapter System 1194VX-1000 (1194VS-1000)

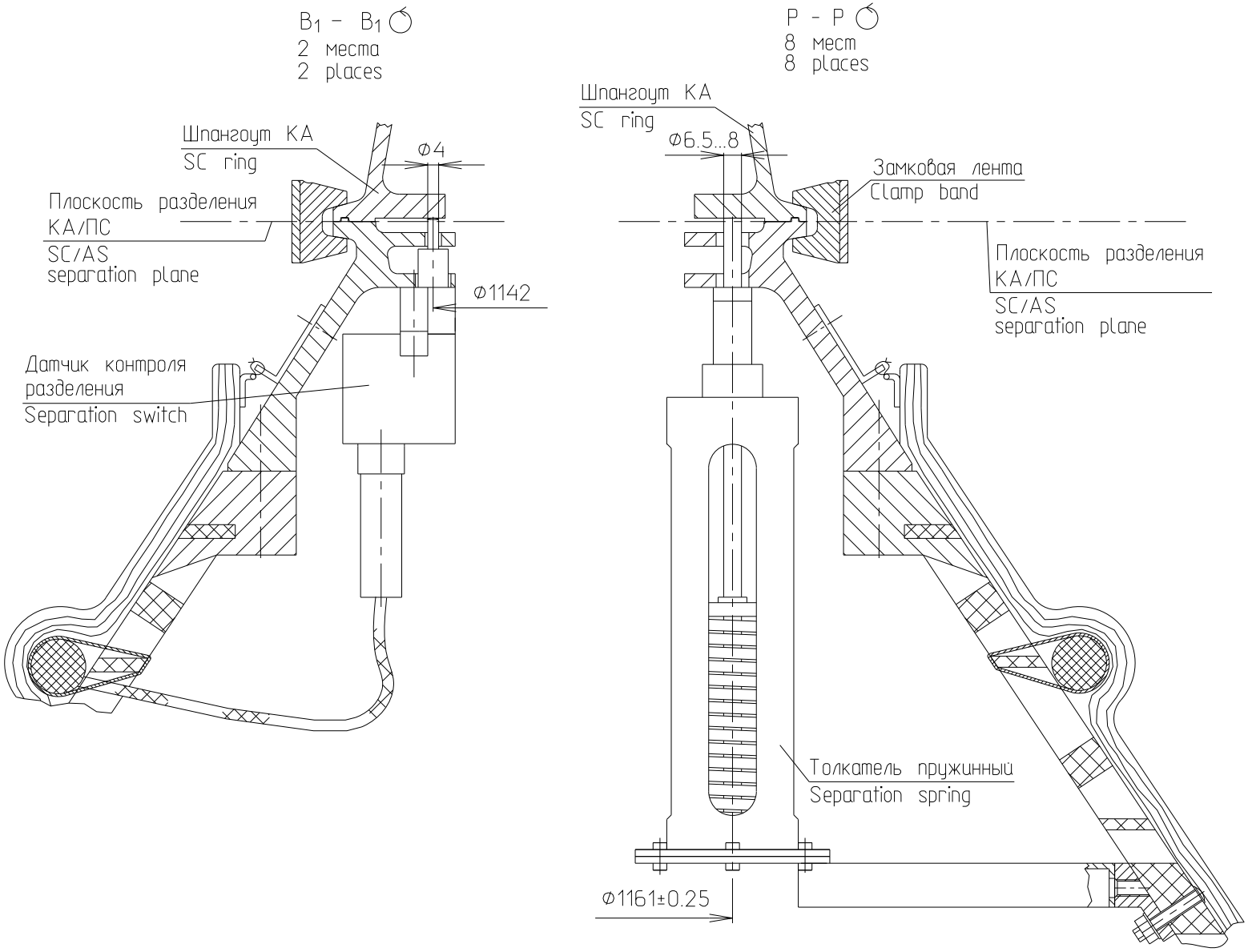
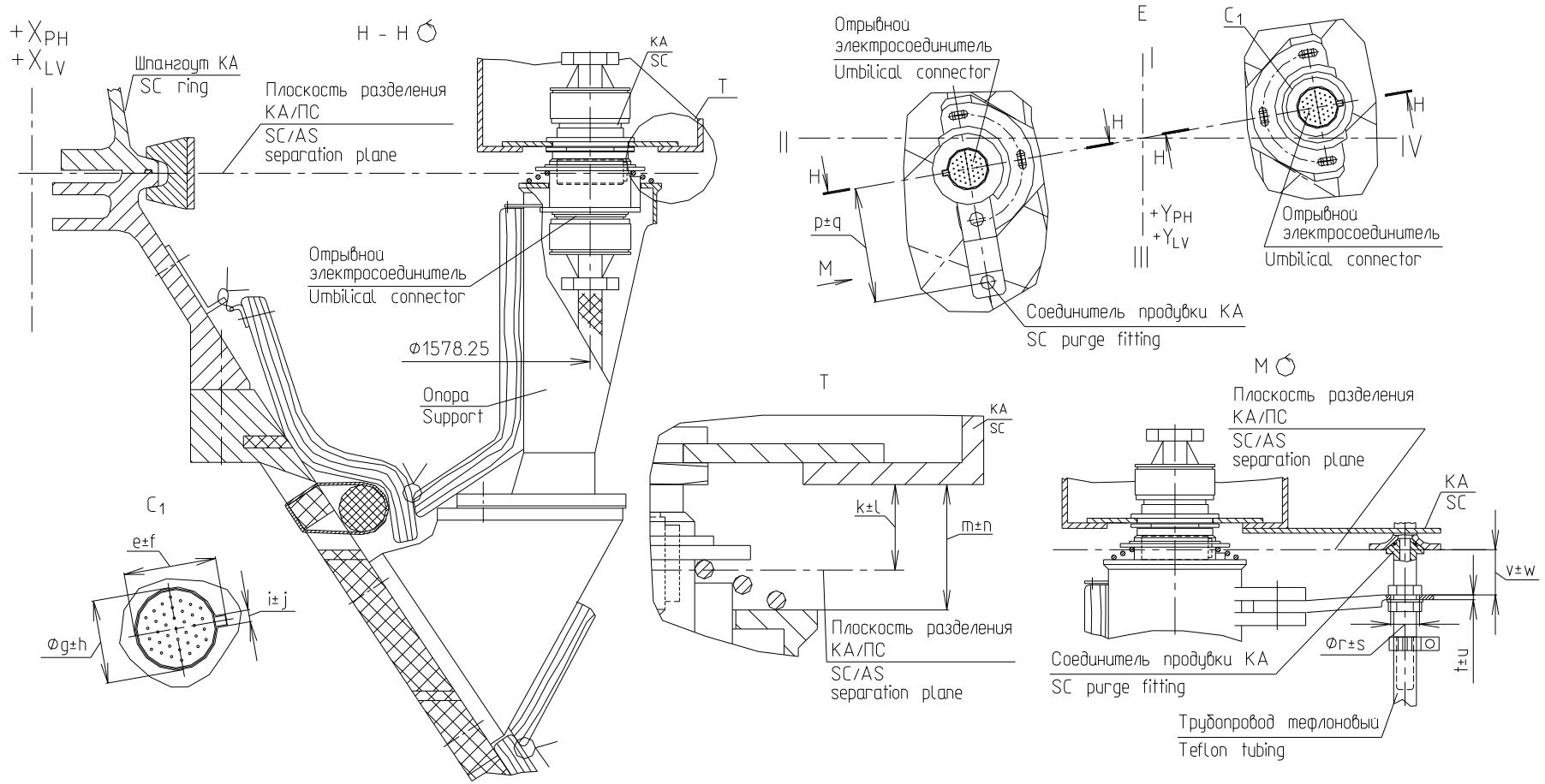


Figure D.2.1-1f: Adapter System 1194VX-1000 (1194VS-1000)



e,f,g,h,i,j,k,l,m,n предоставляются подрядчиком по КА в зависимости от конкретного отрывного электросоединителя
e,f,g,h,i,j,k,l,m,n are provided by SC cotractor depending on specific umbilical connector

Положение электросоединителя может регулироваться в плоскости Z_{PH} – Y_{PH} и вдоль оси X_{PH}
Umbilical connector location can be ajusted in Z_{LV} – Y_{LV} plane and along X_{LV} axis

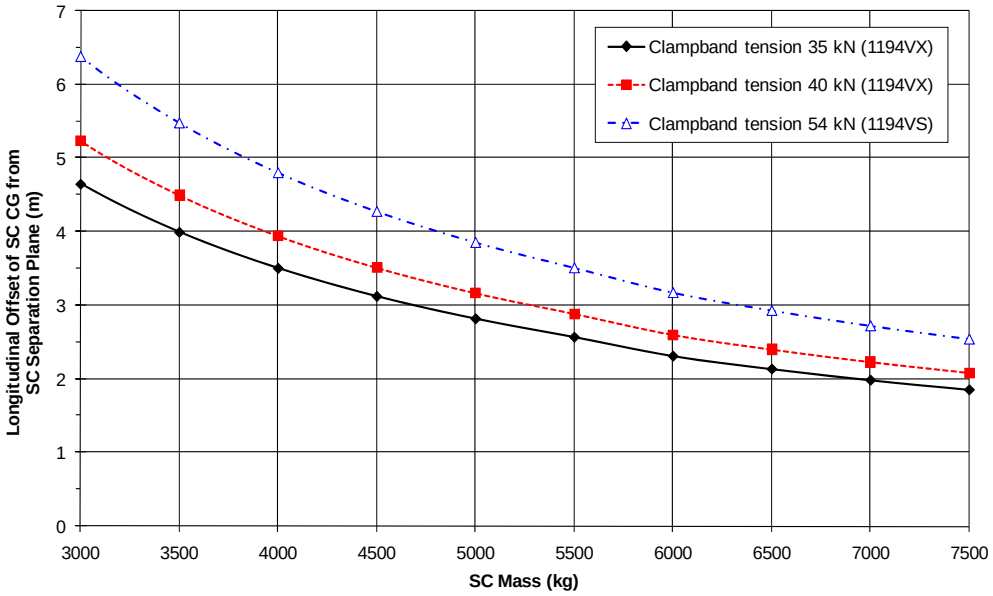
Соединитель продувки КА может быть установлен в зависимости от требований конкретного КА.
p,q,r,s,t,u,v,w предоставляются подрядчиком по КА
SC purge fitting can be mounted depending on specific SC requirements.
p,q,r,s,t,u,v,w are provided by SC cotractor

D.2.2 Load-Bearing Capability

The load-bearing capability of the AS structure is based on the allowable load determined after testing. The maximum allowable longitudinal position of the SC CG relative to the separation plane is shown in Fig. D.2.2-1 as a function of SC mass for various nominal values of clampband tension when using the 1194VX-1000 and 1194VS-1000 adapter systems. This position of the SC CG is determined for standard interface ring characteristics, specified in Table D.2.3-1, and geometrical parameters, specified in Figure D.2.1-1d. Quasi-static accelerations used in the calculation are shown in Section 3.4.1. It is assumed that the circumferential linear load is uniformly distributed in the separation plane. A potentially non-uniform linear load will reduce the allowable distance to the CG for a SC of the given mass.

The shown values of load-bearing capacity should be used only for preliminary evaluation of AS strength. During the early phase of SC integration with the LV, it will be necessary to perform a CLA to verify strength when loading the AS structure and the separation system.

Figure D.2.2-1: Load-bearing Capability of 1194VX-1000 and 1194VS-1000 Adapter System



SC Mass (kg)	Allowable CG Offset Relative to SC Separation Plane (m)		
	35 kN Tension (1194VX)	40 kN Tension (1194VX)	54 kN Tension (1194VS)
3000	4.65	5.24	6.38
3500	4.00	4.50	5.48
4000	3.51	3.95	4.80
4500	3.12	3.51	4.28
5000	2.82	3.17	3.86
5500	2.57	2.89	3.51
6000	2.31	2.60	3.18
6500	2.13	2.40	2.93
7000	1.98	2.23	2.72
7500	1.85	2.09	2.54

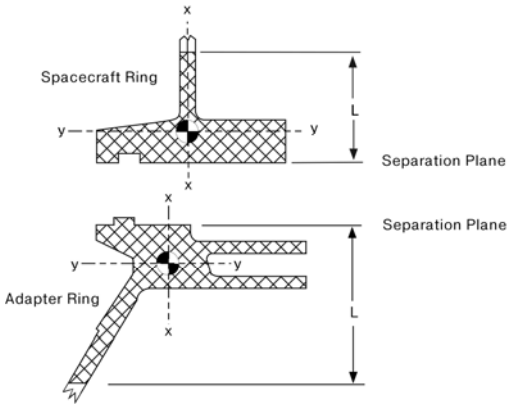
D.2.3. Interface Ring Characteristics

The SC and AS interface rings and the separation system are designed to transfer loads from the SC to the AS during ground operations and in flight. The outer contours of the rings are designed to mate with the separation system clampband. A description of the SC and AS interface ring cross sections and materials are shown in Table D.2.3-1. Figure D.2.3-1 shows the reference frame axes used to analyze the characteristics of the interface ring geometrical cross sections.

Table D.2.3-1: Characteristics of SC and AS Interface Rings

Ring Characteristic	SC Ring	AS Ring
Height of effective cross section (L)	25 mm	25 mm
Cross-section area (A)	481 mm^2	600 mm^2
Moment of inertia (I_{XX})	56900 mm^4 ± 15%	80000 mm^4
Moment of inertia (I_{YY})	13400 mm^4 ± 15%	40000 mm^4
Modulus of elasticity (E)	69 x 10^3 MPa	70 x 10^3 MPa

Figure D.2.3-1: SC and AS Interface Ring Cross Sections



D.3 ADAPTER SYSTEM 1666V-1000

D.3.1 Adapter System Description

Adapter system 1666V-1000 comprises a frame, the 1666V separation system (developed by RUAG Aerospace Sweden AB), telemetry and ground measurement system sensors, thermal insulation, and electrical cables.

The AS mechanical interface to the SC comprises the AS interface ring, a clampband with 1666V separation system push springs, separation verification sensors, umbilical electrical connectors (as the mechanical part of the electrical interface), and a SC purge fitting (which is installed depending on the specific SC).

The AS framework is conical and constructed of two parts.

- The upper part is a metal spacer developed by RUAG, which includes an interface SC interface ring. The 1666V separation system, two separation verification sensors, and umbilical electrical connectors are mounted on the spacer.

- The lower part is a metal spacer designed by KhSC.

Drawings of the 1666V AS, which include the mechanical interface, are shown in Figures D.3.1-1a through D.3.1-1e.

Figure D.3.3-1a: Adapter System 1666V-1000

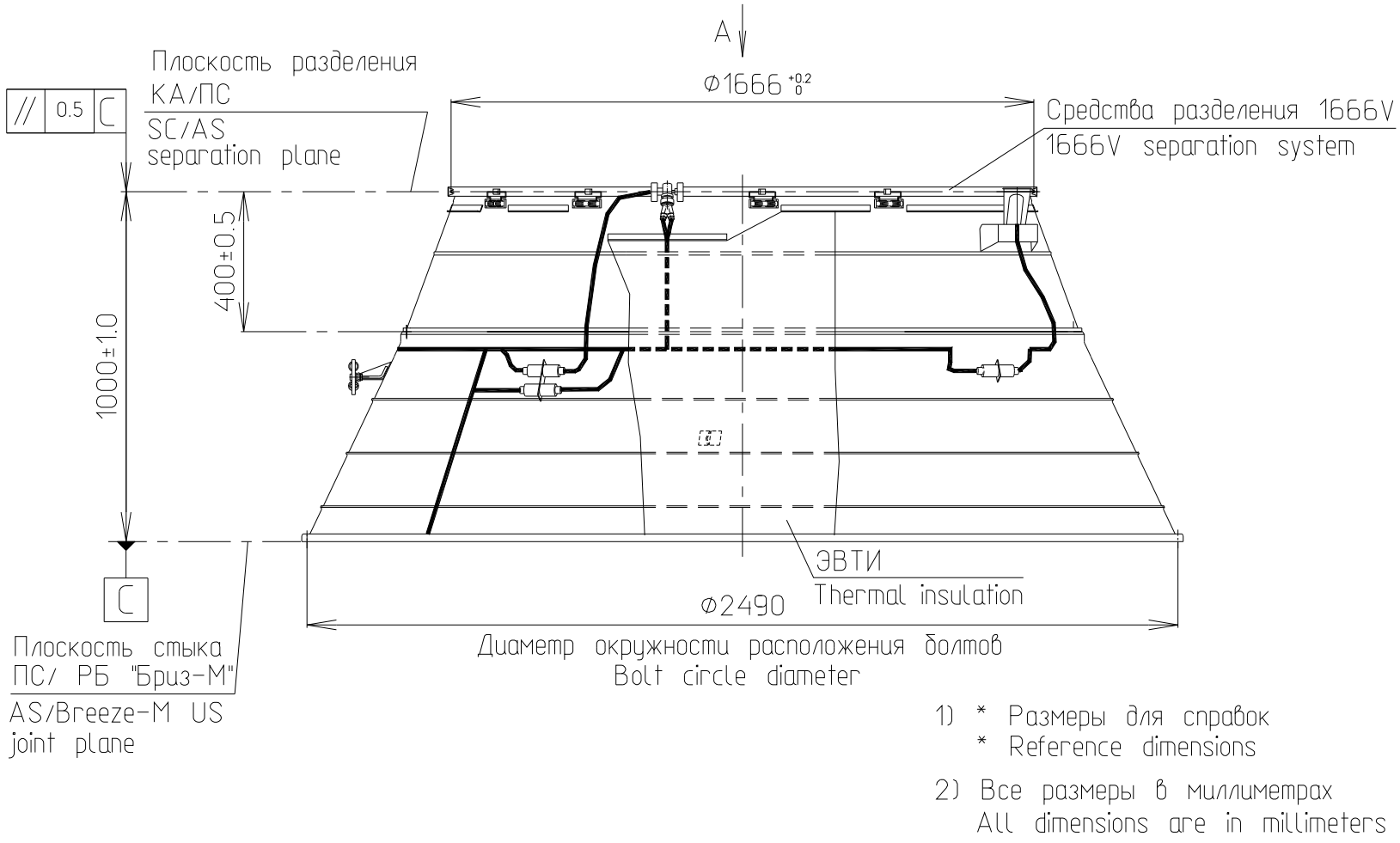


Figure D.3.1-1b: Adapter System 1666V-1000

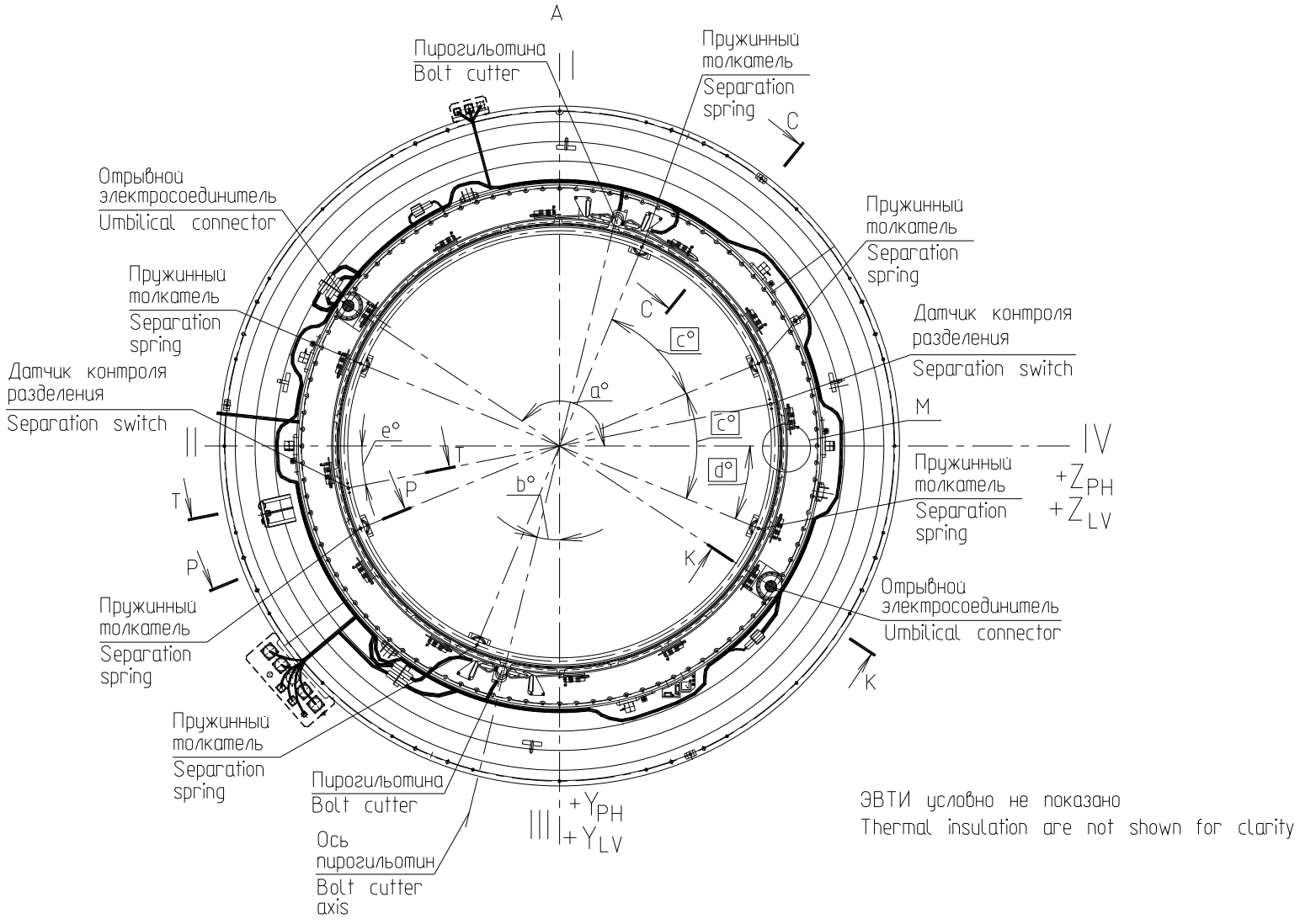


Figure D.3.1-1c: Adapter System 1666V-1000

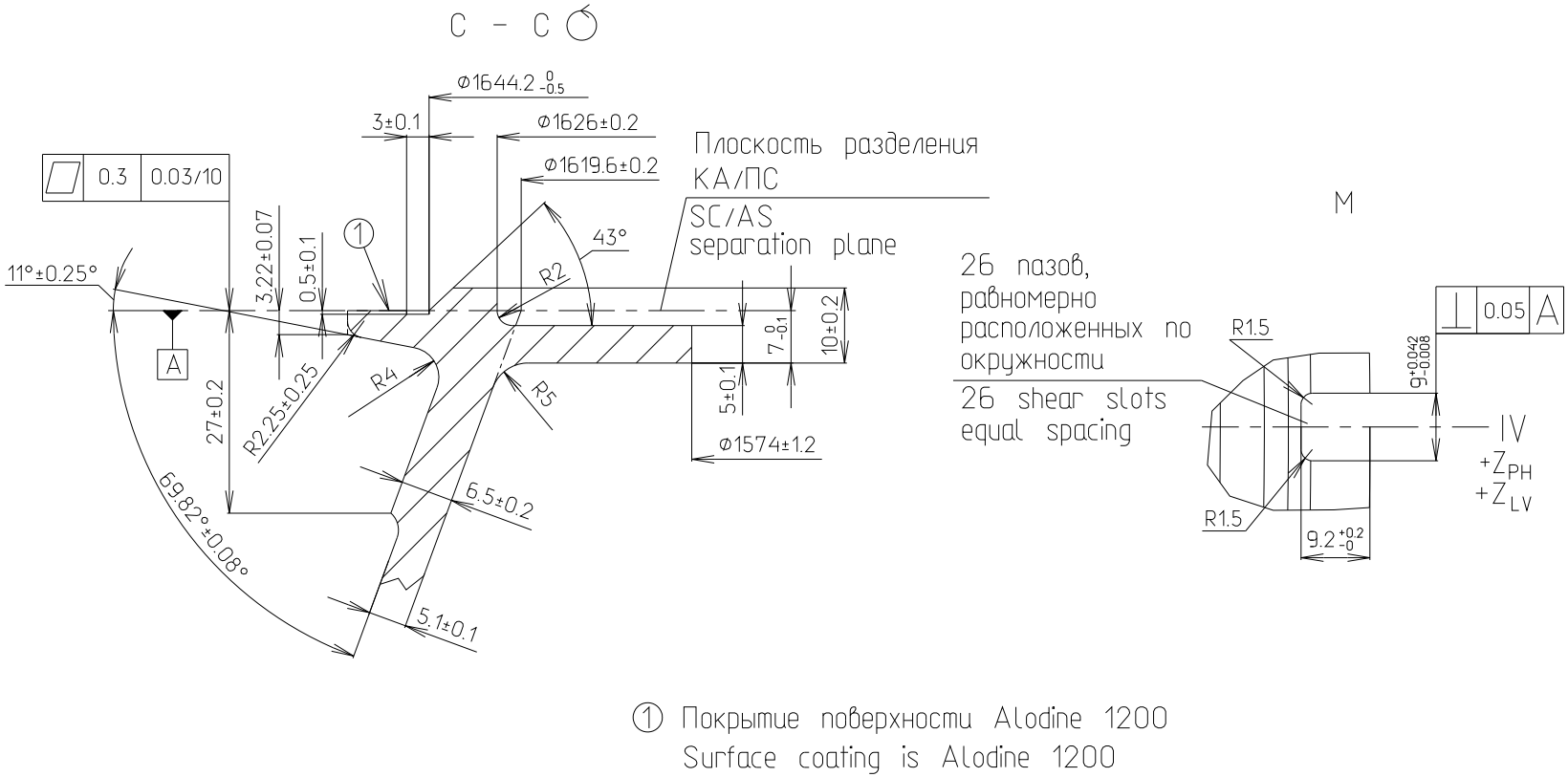


Figure D.3.1-1d: Adapter System 1666V-1000

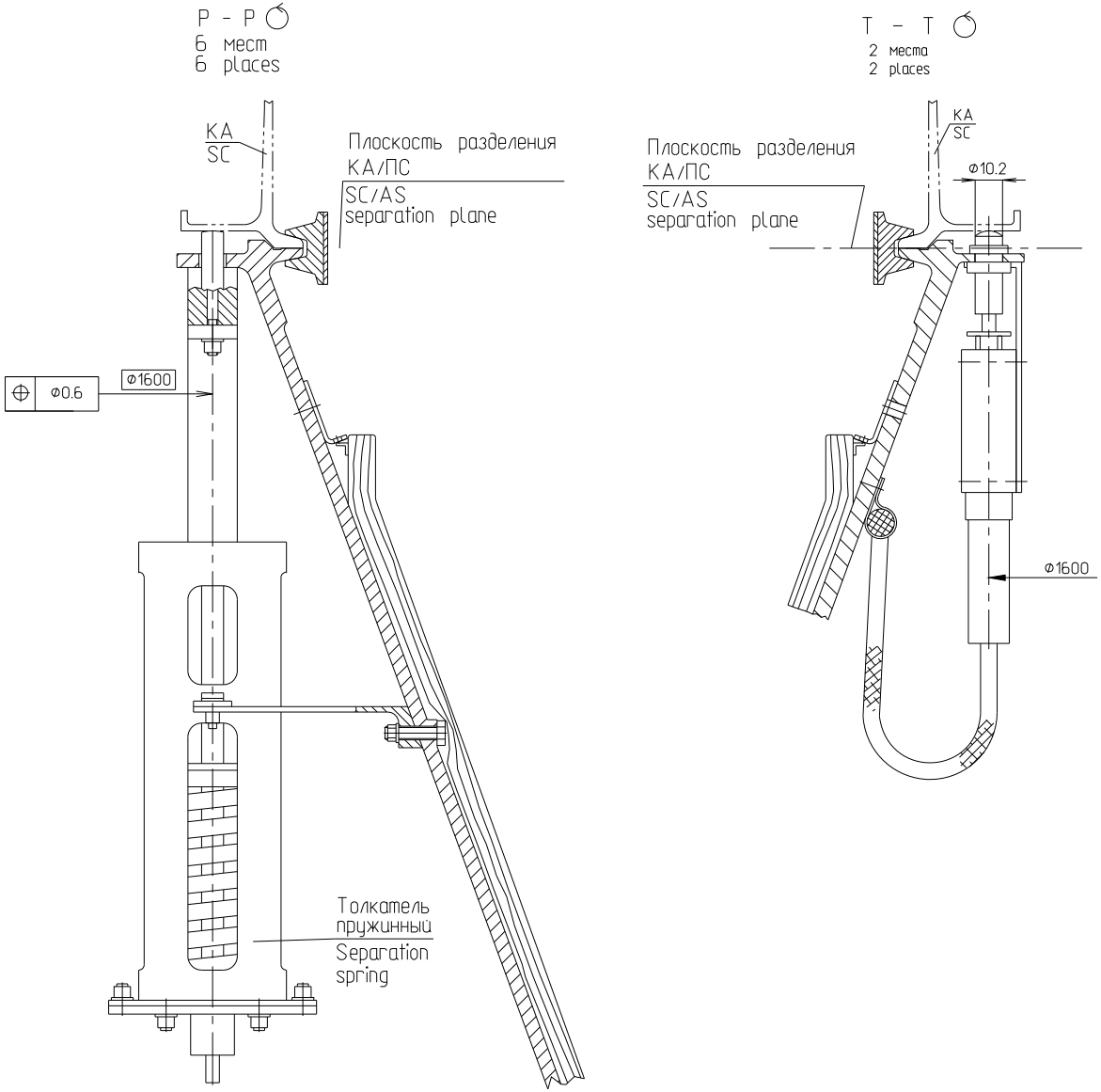
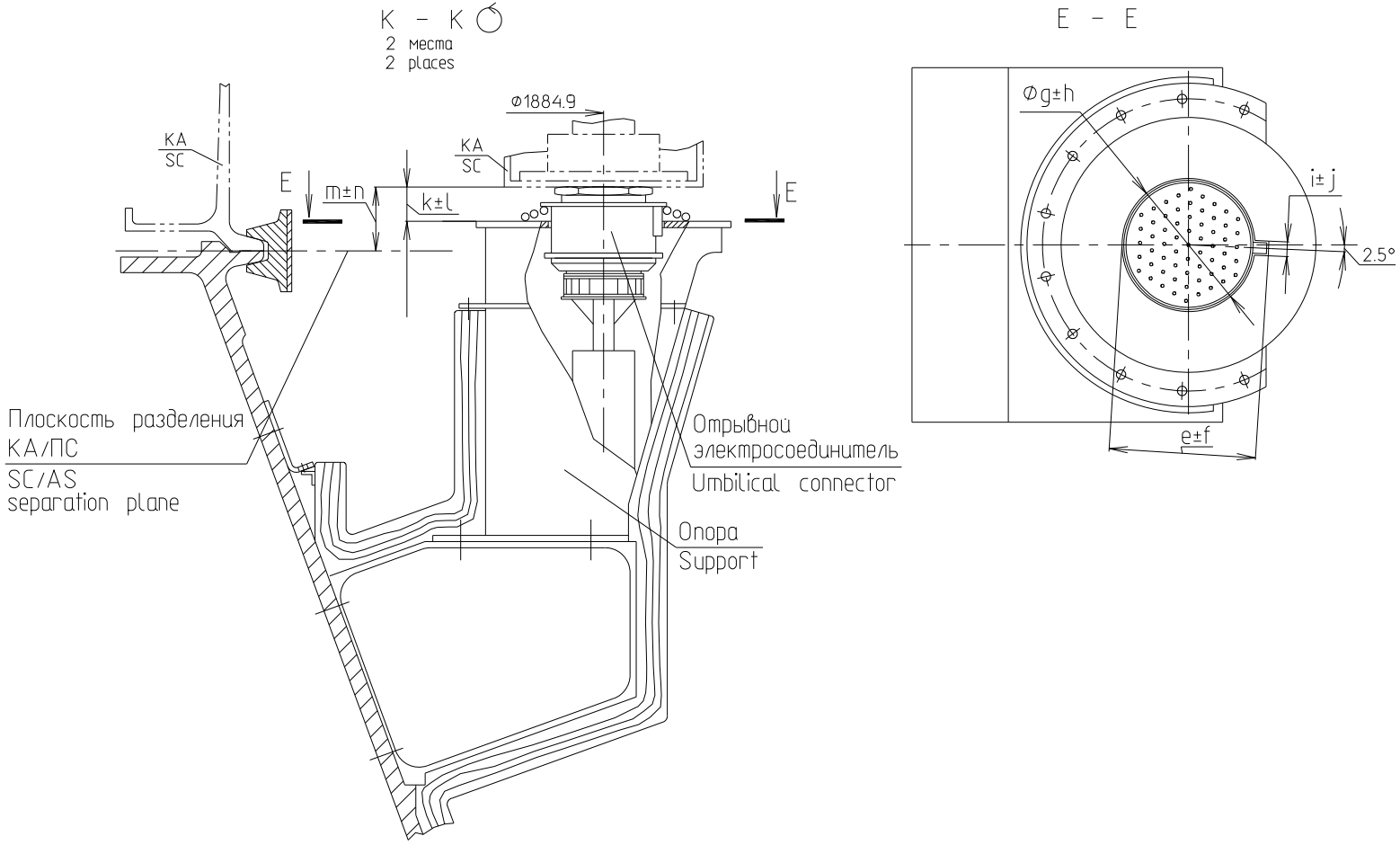


Figure D.3.1-1e: Adapter System 1666V-1000



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e,f,g,h,i,j,k,l,m,n are provided by SC cotractor depending on specific umbilical connector

Положение электросоединителя может регулироваться в плоскости Z_{PH} - Y_{PH}
Umbilical connector location can be ajusted in Z_{LV} - Y_{LV} plane

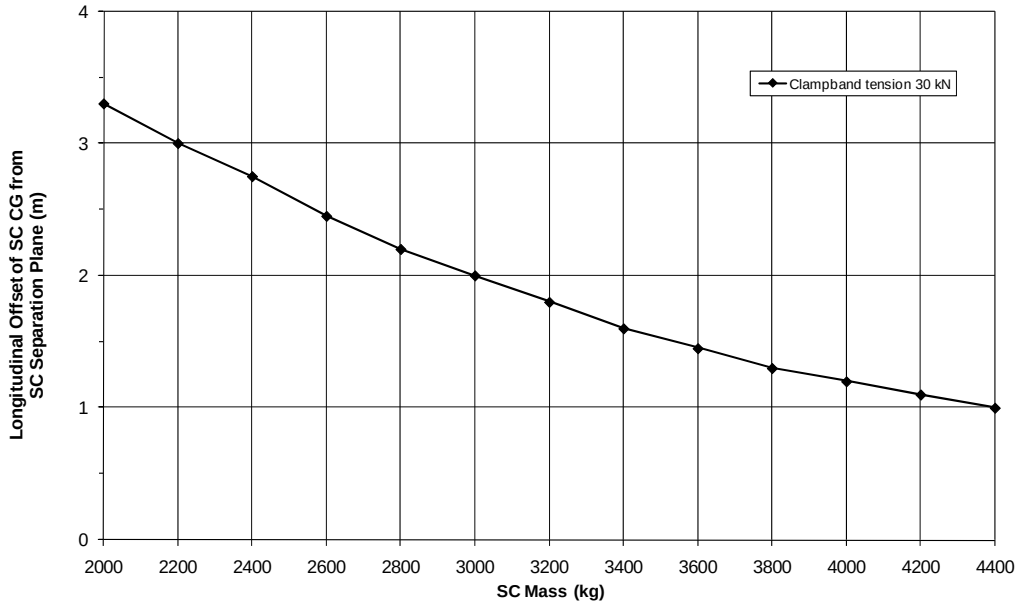
Соединитель продувки КА может быть установлен на опоре в зависимости от конкретного КА
SC purge fitting can be mounted on support depending on specific SC

D.3.2 Load-Bearing Capability of the Structure

The load-bearing capability of the AS structure is based on the allowable load determined after testing. The maximum allowable longitudinal position of the SC CG relative to the separation plane is shown in Figure D.3.2-1 as a function of SC mass for a nominal clampband tension of 30 kN when using the 1666V-1000 adapter system. This position of the SC CG is determined for standard interface ring characteristics, specified in Table D.3.3-1, and geometrical parameters, specified in Figure D.3.1-1c. Quasi-static accelerations used in the calculation are shown in Section 3.4.1. It is assumed that the circumferential linear load is uniformly distributed in the separation plane. A potentially non-uniform linear load will reduce the allowable distance to the CG for a SC of the given mass.

The shown values of load-bearing capacity should be used only for preliminary evaluation of AS strength. During the early phase of SC integration with the LV, it will be necessary to perform a CLA to verify strength when loading the AS structure and the separation system.

Figure D.3.2-1: Load-bearing Capability of 1666V-1000 Adapter System



SC Mass (kg)	Allowable CG Offset Relative to SC Separation Plane (m)
	30 kN Tension
2000	3.30
2200	3.00
2400	2.75
2600	2.45
2800	2.20
3000	2.00
3200	1.80
3400	1.60
3600	1.45
3800	1.30
4000	1.20
4200	1.10
4400	1.00

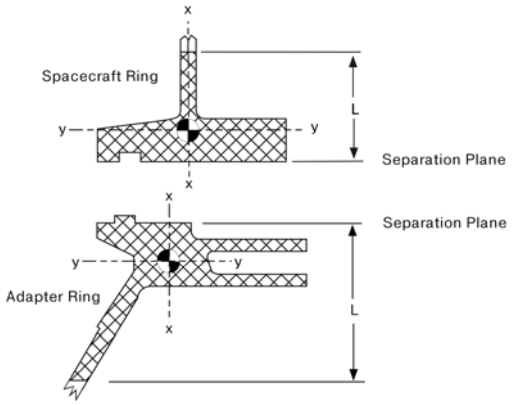
D.3.3 Interface Ring Characteristics

The SC and AS interface rings and the separation system are designed to transfer loads from the SC to the AS during ground operations and in flight. The outer contours of the rings are designed to mate with the separation system clampband. A description of the SC and AS interface ring cross sections and materials are shown in Table D.3.3-1. Figure D.3.3-1 shows the reference frame axes used to analyze the characteristics of the interface ring geometrical cross sections.

Table D.3.3-1: Characteristics of SC and AS Interface Rings

Ring Characteristic	SC Ring	AS Ring
Height of effective cross section (L)	25 mm	25 mm
Cross-section area (A)	460 ± 15% mm^2	344 mm^2
Moment of inertia (I_{XX})	52000 mm^4 ± 15%	33800 mm^4
Moment of inertia (I_{YY})	13400 mm^4 ± 15%	18700 mm^4
Modulus of elasticity (E)	69 x 10^3 MPa	70 x 10^3 MPa

Figure D.3.3-1: SC and AS Interface Ring Cross Sections



D.4 ADAPTER SYSTEM 1664HP-1000

D.4.1 Adapter System Description

Adapter system 1664HP-1000 comprises a frame, the 1664HP separation system (developed by KhSC), telemetry and ground measurement system sensors, thermal insulation, and electrical cables.

The AS mechanical interface to the SC comprises an AS interface ring, four latches and push springs for the 1664HP separation system, separation verification sensors, umbilical electrical connectors (as the mechanical part of the electrical interface), and a SC purge fitting (which is installed depending on the specific SC).

The AS framework is conical and constructed of two parts.

- The upper part is a metal ring, which is intended for mating to the SC. The 1664HP separation system, with its four hard-points for securing the SC to the AS, is mounted on this ring.

- The lower part is a carbon composite spacer. Two brackets with umbilical electrical connectors are mounted on the bottom part of the AS.

Drawings of the 1664HP-1000 AS, which include the mechanical interface, are shown in Figures D.4.1-1a through D.4.1-1d.

Figure D.4.1-1a: Adapter System 1664HP-1000

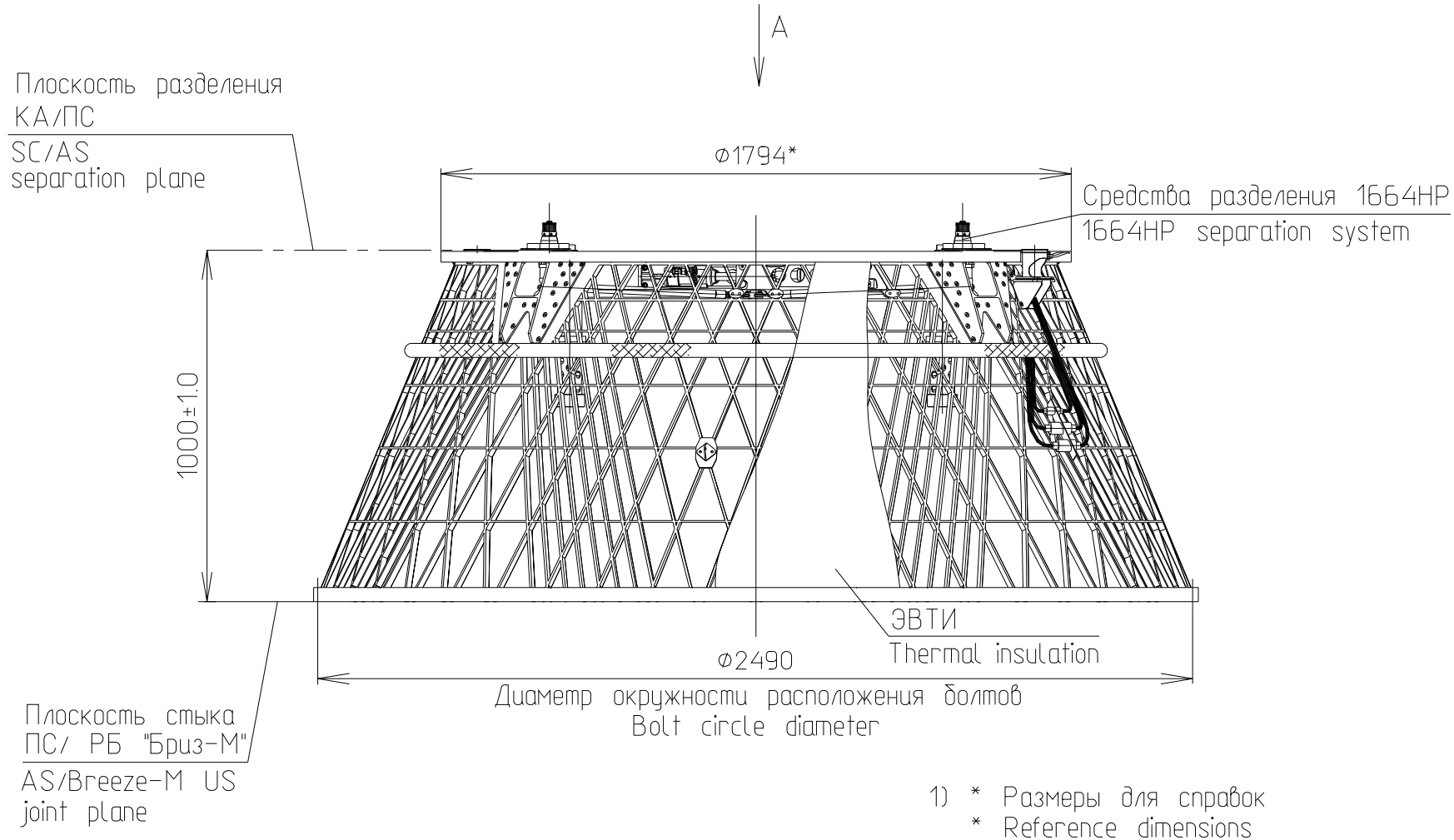


Figure D.4.1-1b: Adapter System 1664HP-1000

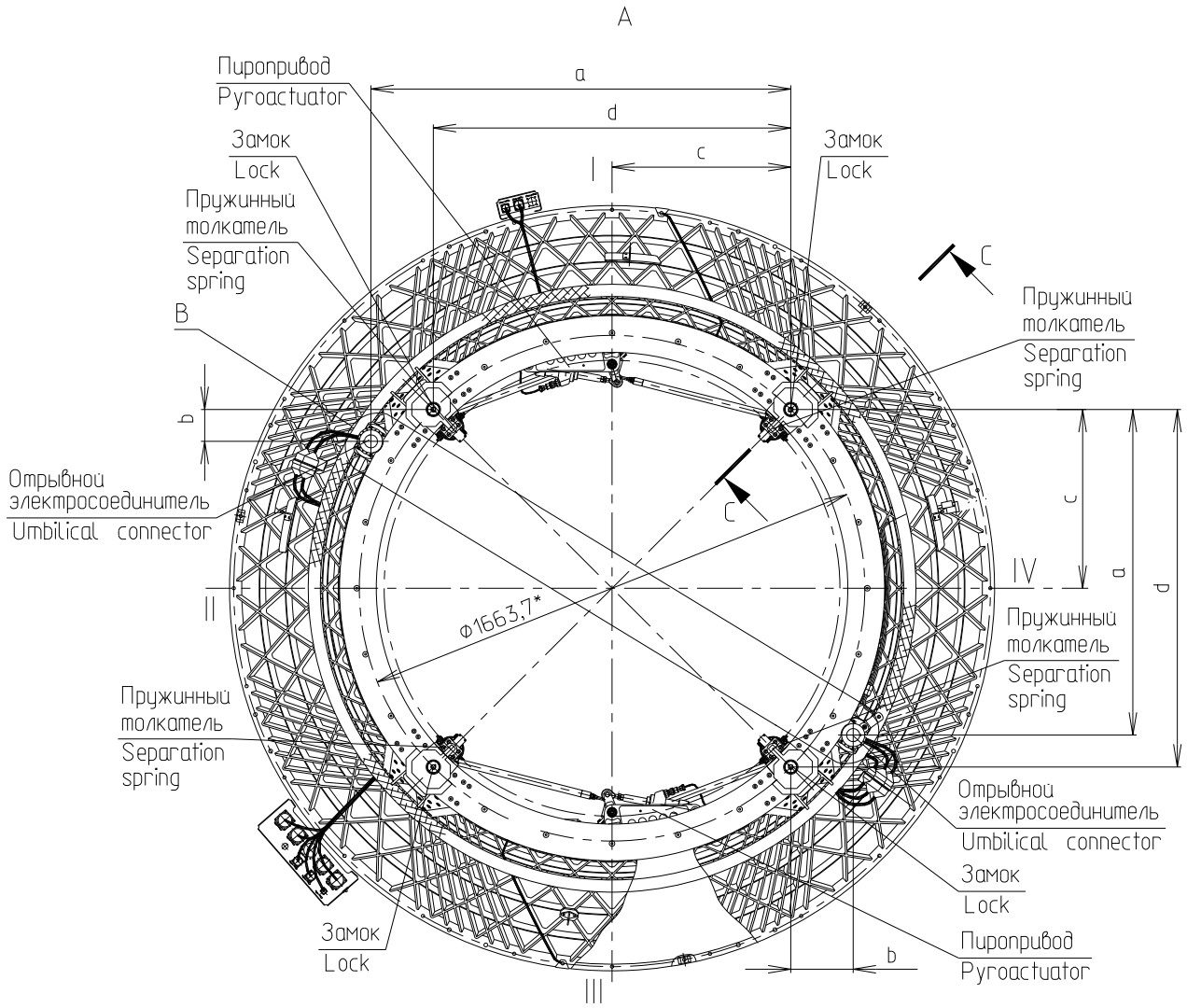


Figure D.4.1-1c: Adapter System 1664HP-1000

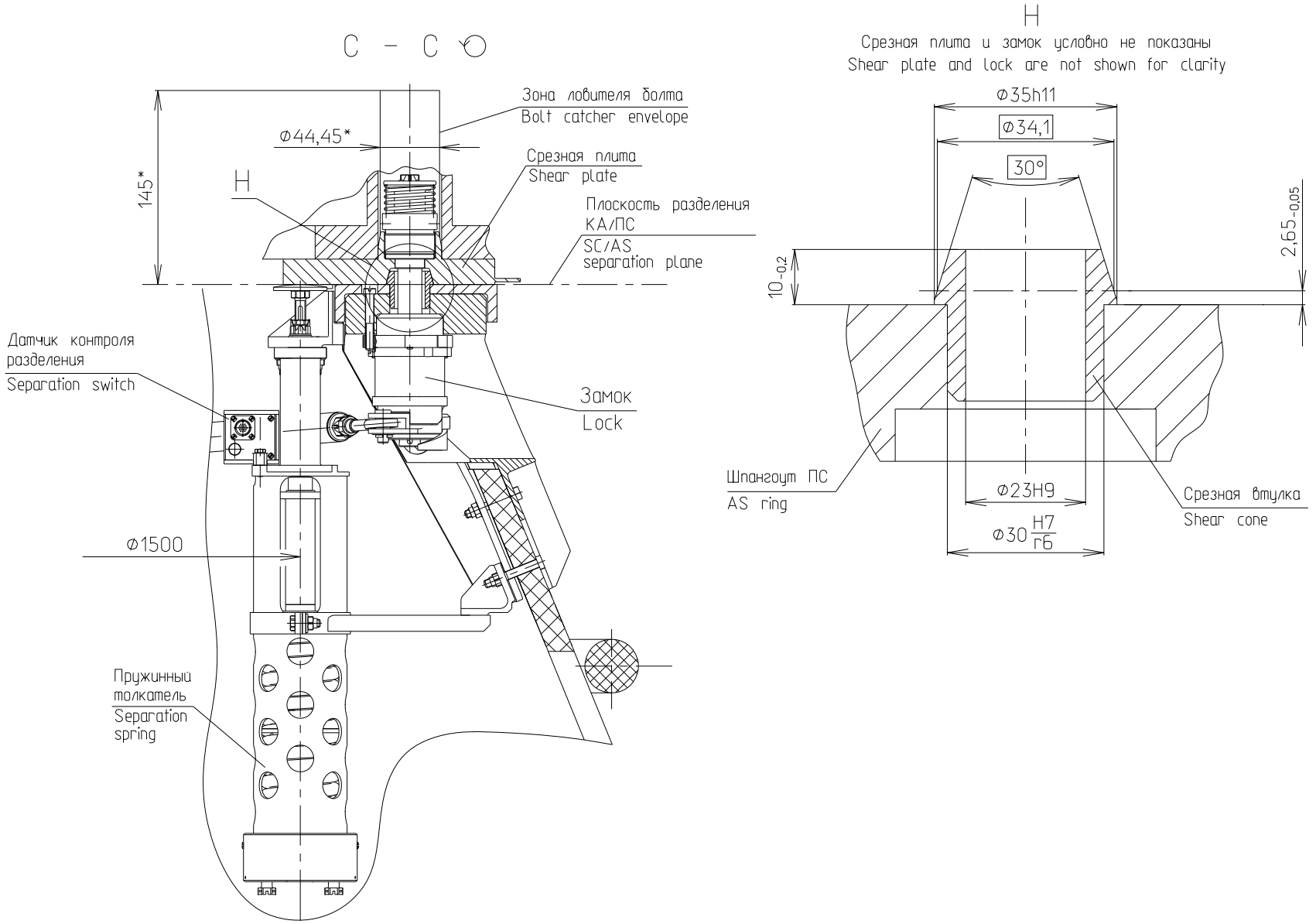
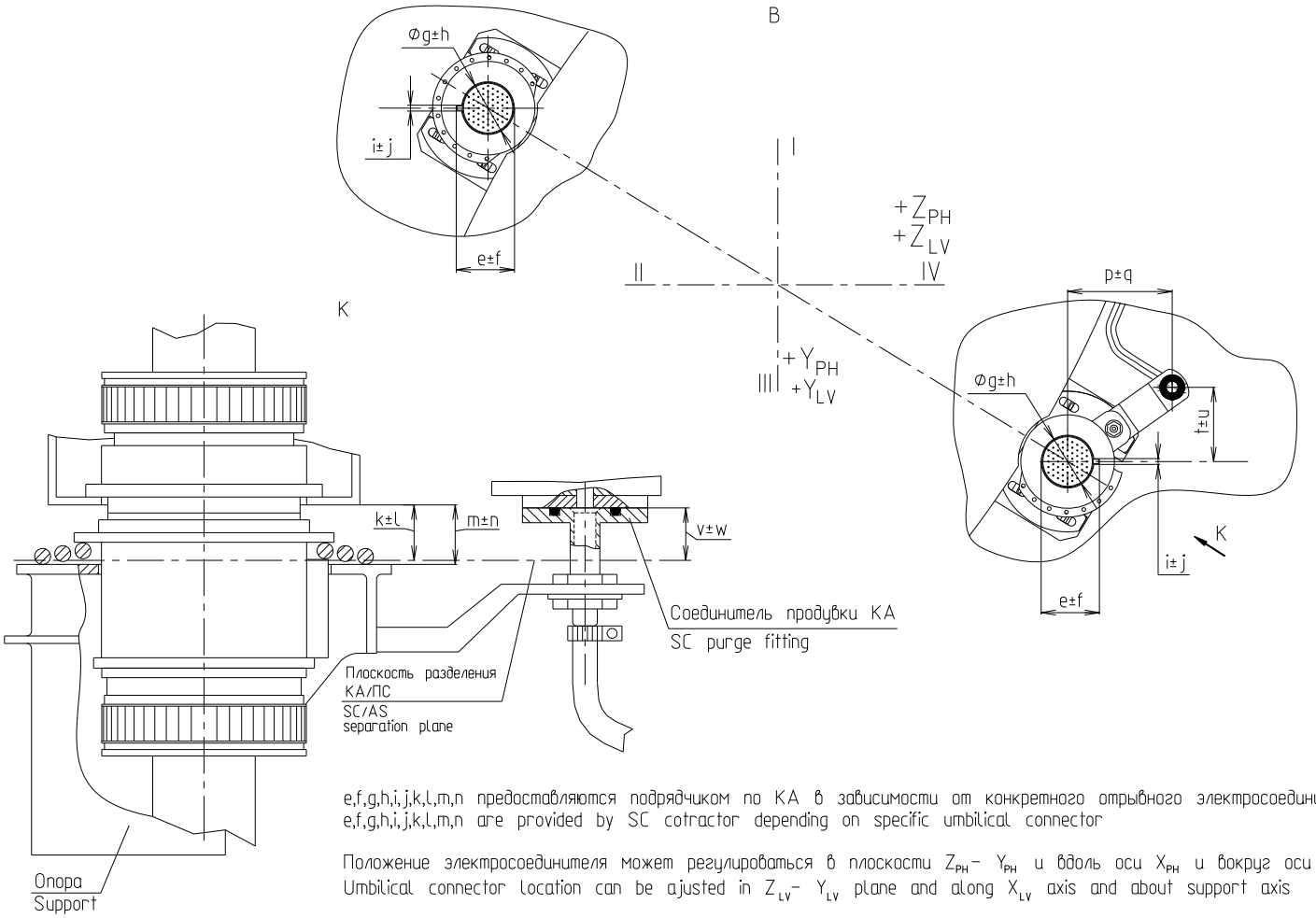


Figure D.4.1-1d: Adapter System 1664HP-1000



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e,f,g,h,i,j,k,l,m,n are provided by SC cotractor depending on specific umbilical connector

Положение электросоединителя может регулироваться в плоскости Z_{PH}- Y_{PH} и вдоль оси X_{PH} и вокруг оси опоры
Umbilical connector location can be ajusted in Z_{LV}- Y_{LV} plane and along X_{LV} axis and about support axis

Соединитель продувки КА может быть установлен в зависимости от конкретного КА.
p,q,t,u,v,w предоставляются подрядчиком по КА.
SC purge fitting can be mounted depending on specific SC.
p,q,t,u,v,w are provided by SC cotractor.

Положение соединителя продувки КА может регулироваться в плоскости Z_{PH}- Y_{PH} и вдоль оси X_{PH}
SC purge fitting location can be ajusted in Z_{LV}- Y_{LV} plane and along X_{LV} axis

D.4.2 Load-Bearing Capability

The load-bearing capability of the AS structure is based on the allowable load determined after testing. The AS will hold down a SC having a maximum mass of 6000 kg, whose CG is located 1.7 m above the separation plane. This structural load-bearing capability is determined for standard interface ring geometrical parameters, specified in Fig. D.4.1-1c. Quasi-static accelerations used in the calculation are shown in Section 3.4.1.

The shown values of load-bearing capacity should be used only for preliminary evaluation of AS strength. During the early phase of SC integration with the LV, it will be necessary to perform a CLA to verify strength when loading the AS structure and the separation system.

D.4.3 Interface Ring Characteristics

The characteristics of the payload AS interface ring in the vicinity of the separation push springs are shown in Fig. D.4.1-1c.

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