

# Technical Requirements for the Cryogenic Valves

## 低温阀门技术要求

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## 1 INTRODUCTION SUMMARY [声明]

The present delivery specification describes the requirements used by CASIPP [Institute of Plasma Physics, Chinese Academy of Sciences] for the cryogenic valves that must comply with the special request of purchase order. This document and the information it contains are confidential and belong to CASIPP. They shall not be reproduced or disclosed to any third party without CASIPP prior written consent.

本规范描述了 CASIPP [中国科学院等离子体物理研究所] 对低温阀门的要求, 必须符合采购订单的特殊要求。本文件及其包含的信息是机密的, 属于 CASIPP。未经 CASIPP 事先书面同意, 不得复制或透露给任何第三方。

## 2 SCOPE of REQUIREMENTS [要求范围]

### 2.1 QUALITY ASSURANCE [质量保证]

- The valve manufacturer is approved according different standards to certify the high level of product and fabrication quality.

-阀门制造商根据不同的标准获得批准, 以证明高水平的产品和制造质量。

- The valve manufacturer is necessary to demonstrate that the valves meet the requirements in this specification such as material certificates and engineering drawings.

-阀门制造商必须证明阀门符合本规范中的要求, 如材料证书和工程图纸。

- All materials used by valve manufacturer for pressure retaining parts are selected according relevant standards or equivalent. All other materials must be listed in the general cryogenic components catalogues and datasheets.

-阀门制造商用于承压部件的所有材料均按相关标准或同等标准选择。所有其他材料必须在通用低温部件目录和数据表中列出。

- The supplier of the valves must provide a documented quality assurance (QA) and quality control program (QC) to ensure that the valves will meet the technical requirements (3.3) specified in this document.

-阀门供应商必须提供文件化的质量保证(QA)和质量控制程序(QC), 以确保阀门符合本文件规定的技术要求。

- Helium tightness tests are performed on all cryogenic components.

-所有低温部件都要进行氦气密封性测试。

### 2.2 DOCUMENTATION [文档]

For each type of valve, CASIPP requires the following documentation:

对于每种类型的阀门，CASIPP 要求提供以下文件:

- Drawing (2D&3D) showing dimensions with parts list.  
-图纸(2d 和 3d), 显示尺寸和零件清单。
- Technical documentation regarding the valve and the positioner.  
-有关阀门和定位器的技术文件。
- A data sheet per valve including: the tag number, the nominal diameter, the actuator characteristic, the plug characteristic, the flow coefficient Kv or Cv, the flow against the valve opening.  
-每个阀门的数据表, 包括:标签编号, 公称直径, 执行机构特性, 阀塞特性, 流量系数 Kv 或 Cv, 阀门开度的流量。
- Providing specific tightness test report of valves.  
-提供阀门的具体密封性测试报告。
- Heat leak by thermal conductivity of solids on cryogenic valves.  
-低温阀门传导热负荷。
- QA & QC documentation reporting the qualification and manufacturing of the valves.  
-证明阀门合格和制造的 QA 和 QC 文件。
- List of used materials for pressure parts and raw material, all material used to manufacture the valves must be traceable.  
-承压部件和原材料的使用材料清单, 所有用于制造阀门的材料必须可追溯。
- Mounting, operating and maintenance instructions.  
-安装、操作和维护说明。

## 2.3 TECHNICAL REQUIREMENTS [技术要求]

### 2.3.1 ENVIRONMENTAL CONDITIONS [使用环境条件]

All the cryogenic control valves (Including warm control valves) will be located on the cold box. The environmental conditions at the cold box in terms of magnetic field and ionizing radiation are reference in APPENDIX 1. Valve components, particularly all elastomer seals, pneumatic diaphragm actuators and positioners, must sustain these environmental conditions:

所有低温控制阀(包括少量常温控制阀)将位于冷箱上。冷箱在磁场和电离辐射方面的环境条件。阀门组件, 特别是所有弹性体密封件, 气动隔膜执行器和定位器, 必须承受这些环境条件:

- Ambient temperature [环境温度]: -15°C~ +45°C .
- Explosion requirement [防爆要求]: NO.
- Moisture[湿度]: Not controlled [不可控]

### 2.3.2 General thermal specification of cryogenic valves [低温阀门通用规范]

- Fluid [流体]: Helium [氦] Nitrogen [氮].
- Service temperature [使用温度]: 4K-470K.
- Seat/Seal [阀座密封材料]: PTFE, PCTFE, PEEK or other.
- Static O-Ring [O 圈]: VITON, NBR. The material shall be compatible with environmental services [材料应适用于环境应用].

### 2.3.3 General mechanical specification of cryogenic valves [低温阀门通用机械技术条件]

- All control valves must be axial-stroke valves. All valves bonnet shall be with bellow seal.

所有控制阀必须为轴向行程阀。所有阀门阀盖都应采用波纹管密封。

- The bodies of the cryogenic control valves must use full penetration welds at the weld seams and be 100% inspected using Non-Destructive Evaluation (NDE) method.

低温控制阀的阀体必须在焊缝处采用全透焊, 并采用无损检测(NDE)方法进行 100%检测。

- The materials for pressure retaining parts are 316 L or 304 L.

承压部件材料为 316L 或 304L。

- **The valves will be welded using full penetration butt welds to the process lines (usually made of 316 L).**

阀门将采用全渗透对焊焊接到工艺管线上(管线通常由 316L 制成)。

- **\*The valves will be supplied with vacuum welding flanges suitable to be welded onto the interfaces of the vacuum box. The vacuum welding flange is called ØB [At - 0.1 / - 0.3mm machining tolerance] in the figure 1 below, and it is located on the top of the valve. The Vacuum flange must have a 'groove' or 'lip' for the welding on the cold box, the weld will be of the "top edge melting" type (fusion type). Internal parts of cryogenic valves shall be exchangeable from the top.**

\*阀门将提供真空焊接法兰, 适用于焊接到真空容器的接口上。真空焊接法兰在下图 1 中称为ØB [- 0.1 / - 0.3mm 加工公差], 位于阀门顶部。真空法兰必须有一个“凹槽”或“唇部”, 以便在冷箱上进行焊接, 焊缝应为“顶部边缘熔化”型(熔化型)。低温阀门的内部部件应从顶部可互换。

- Some valves will be supplied with an 80 K copper thermal intercept. See APPENDIX 1. for the requirements for each valve. The copper intercept will be supplied with 4 equally spaced through holes of diameter 4.5 mm, Th=h/3.

有些阀门将提供 80K 铜热截止。参见附录 1, 了解各阀门的要求。铜热截止将提供 4 个直径为 4.5 mm 的等间距通孔, Th=h/3。

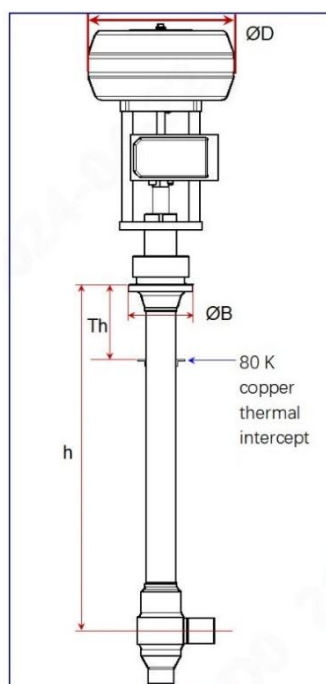


Figure 1: Valve dimension

- **\*Cryogenic valves must be designed in order to reduce heat leaks to process lines. The manufacturer shall notice with the offer any deviation to the following figure 3 and table based on 4 K fluid temperature without 80 K copper thermal intercept:**

**\*低温阀门的设计必须能够减少其到工艺管线的热泄漏。投标书应在报价时提供在没有80K 热截止的情况下，阀门在 4k 流体温度基础上的任何热泄露偏差，如下图和表所示：**

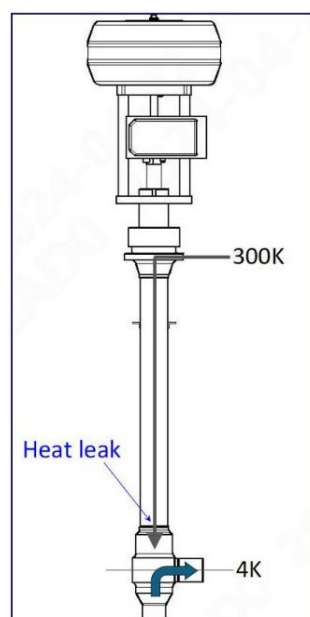


Figure 2

Valve size	DN	300 K max heat leaks [W]
1/8"	6	0.9
1/4"	8	0.9
3/8"	10	0.9
1/2"	15	0.9
3/4"	20	1.2
1"	25	1.3
1"1/4	32	1.3
1"1/2	40	2.5
2"	50	3.4
2"1/2	65	4.5
3"	80	8.0
4"	100	11.4

- Pressure class (PN): 25 bar, other PN available on APPENDIX 1.

压力等级(PN 值):25bar。

- The valves must be tested at a pressure  $1.5 \times \text{PN}$  (Test medium: Helium Gas, at ambient temperature, holding time > 5 min). The valves must also be able to withstand full vacuum.

阀门必须在不小于  $1.2 \times \text{PN}$  的压力下进行测试(测试介质:氦气, 室温下, 保温时间 > 5 分钟)。阀门还必须能够承受全真空状态。

- Leak tightness: [漏率要求]

Helium leak rate <  $10^{-9}$  Pa.m<sup>3</sup>/s (from body to vacuum) [阀体到真空];

Helium leak rate <  $10^{-7}$  Pa.m<sup>3</sup>/s (from body to atmosphere) [阀体到大气];

Helium leak rate <  $10^{-6}$  Pa.m<sup>3</sup>/s across the seat when the valve is closed [阀门关闭时阀座密封];

- **\*Maximum allowable displacement: The valves must be able to function normally even if the bending force results in a valve deflection of up to 3mm (for a cryogenic valve of 875mm stem length). The supplier will provide a table of maximum allowable bending stresses and deflections for each valve type.**

\*最大允许位移:即使弯曲力导致阀门偏转高达 3mm(对于阀杆长度为 875mm 的低温阀门), 阀门也必须能够正常工作。供应商将提供每种阀门类型的最大允许弯曲应力和挠度表。

- Valves are supplied with air regulator with associated filter for pneumatic actuator.

阀门配有用于气动执行机构的带相应过滤器气源调节器。

➤ Valves and components free of oil and grease or any other dirt for cryogenic fluids.  
阀门和部件无油脂或任何其他污垢用于低温流体。

➤ Stroke time: To be proposed by the manufacturer for each nominal valve size.  
行程时间:由制造商针对每个标称阀门通径提出。

#### 2.3.4 Actuator and Positioner [执行器和定位器]

➤ Actuator: Pneumatic (with 8 barg max supplied air, oil and water free), some valves will be fitted with a 24 V solenoid valve which is used to fast closing located in between the positioner and the valve actuator. See APPENDIX 1. for the requirements for each valve.

The actuators must be able to be changed without opening the circuits.

执行器:气动(最大 8 barg 供气, 无油和水), 一些阀门将配备一个 24 V 电磁阀, 用于快速关闭位于定位器和阀门执行器之间。参见附录 1, 了解各阀门的要求。执行器必须能够在不打开管线的情况下进行更换。

➤ Positioner: Position duplication (4-20mA), End switches (positive and negative open/close indication, if required) for the control valves. Some positioner includes analogues travel feedback as 4-20mA signal.

定位器:控制信号(4-20mA), 控制阀的限位开关(如需要)。一些定位器包括模拟行程反馈作为 4-20mA 信号。

➤ In case of air or electricity fault, automatic valves (control valves and shut-off automatic valves) must return to their failure position: either close (FC) or open (FO).

在发生空气或电力故障时, 自动阀门(控制阀和开关阀)必须返回其故障位置:关闭(FC)或打开(FO)。

➤ If indicated in APPENDIX 1, a valve must be equipped with end-switches (type: Inductive 2-wire).

如果附录1中有说明, 阀门必须配备端部限位开关 (类型: 接近式2线)。

A positive logic shall be used [采用正逻辑规则]:

- ZSH: will be set to 1 if the valve is 100% open.

如果阀门 100%打开, ZSH 将设置为 1。

- ZSL: will be set to 1 if the valve is closed.

如果阀门关闭, ZSL 将设置为 1。

➤ Refer to APPENDIX 1 to check if fast closing, slow closing, or slow opening is required for each valve.

- Time of opening/closing

Fast closing valve shall be able to be closed **in less than 2 seconds**.

In case of a control valve, if the actuator is not capable of closing the valve in less than 2

seconds, a 3-way valve [solenoid valve] will be installed on the bleeding line in between the positioner and the valve actuator. It will allow discharging the actuator without going through the positioner. The failure position of these 3-way valves will connect the actuator to the atmosphere. The manufacturer will indicate the guaranteed closing time.

快速关闭应能在 2 秒内完成。

对于控制阀，如果执行机构不能在 2 秒内关闭阀门，则将在定位器和阀门执行机构之间的放气线上安装一个三通阀 [电磁阀]。它将允许在不经定位器的情况下排放执行机构。这些三通阀的故障位置将把执行机构连接到大气中。制造商将说明保证的关闭时间。

- Slow opening

Slow opening valve will be able to open slowly (around 2 minutes). The manufacturer will include a needle valve or check valve on instrument air inlet (or equivalent technical solution) to comply with the request.

缓慢开启的阀门将能够缓慢开启（大约 2 分钟）。制造商将在仪表进气口上安装一个针阀或止回阀（或同等技术方案），以符合要求。

- Slow closing

This type of valve will be able to close slowly (around 2 minutes). The manufacturer will include a needle valve or check valve on instrument air outlet (or equivalent technical solution) to comply with the request.

这种类型的阀门将能够缓慢关闭（大约 2 分钟）。制造商将在仪表空气出口上安装一个针阀或止回阀（或同等技术方案），以符合要求。

### 2.3.5 Special requirements [特殊要求]

- Reliability: The valve quality assurance period is 2 years, and the quality assurance period starts from the valve being put into operation. The quality assurance also includes that the control valves shall be operated for at least 10000 stroke cycles and 50 thermal cycles without replacing any of their components. After the 10000 stroke cycles, maintenance shall be accomplished by only exchanging easily dismountable parts of the valves whilst maintaining the valves in its original installation position.

可靠性: 阀门质量保证时间为 2 年，质量保证时间从阀门投入运行操作开始计时，并且质量保证也包括控制阀应在不更换任何元件的情况下至少运行 10000 次冲程循环和 50 次热循环。在 10000 次冲程循环后，维护应只通过更换易于拆卸的阀门部件来完成，同时保持阀门在其原始安装位置。

- Installation and check tools and auxiliary agents, and is listed separately.  
安装工具和辅助剂，并单独列出。

- Maintainability: It is imperative that the manufacturer be able to provide spare parts for at least 5 years.

可维护性: 至关重要的是，制造商能够提供至少 5 年的备件。

- The valve supplier must reply within 48 hours in case of technical or product quality problems.



如出现技术或产品质量问题，阀门供应商须在 48 小时内给予答复。

- The following indications have to be indelibly marked on the valves and visible after installation:

阀门上必须永久标记以下标识，安装后可见：

- Name of the supplier. [供应商名称]
- Serial number. [序列号]
- Nominal diameter. [公称直径]
- Pressure rating. [压力等级]
- Fluid direction. [流体方向]
- Valve TAG number. [阀门编号]

## 2.4 WEADING AND LEAK TEST [焊接和检漏]

According to regulation and construction code, any welding and non-destructive examination will be carried-out by authorized and certified staff. The welds declared unacceptable by the non-destructive examination must be repaired by a qualified operator. After repair, the welds must be inspected by the same criteria and method. A leak test must be performed with 100% of helium, all the welds, gaskets and the bellow must be tested for tightness.

根据法规和制造规范，任何焊接和无损检测都将由授权和认证的人员进行。无损检验认定为不可接受的焊缝，必须由合格的操作人员进行修复。修复后，焊缝必须用相同的标准和方法进行检查。必须用 100% 的氦气进行泄漏测试，所有的焊缝、垫片和波纹管必须进行密封性测试。

## 2.5 PACKING

**Valves must be packed and transported separately according to the document names listed in APPENDIX 1. Valves with different document names cannot be mixed and placed in the same packaging box. Installation tools, testing tools, and accessories should be packed and transported separately.**

阀门必须按照附件 1 所列的文档名称分别进行装箱运输，不可将不同文档名称阀门混合放置于同一包装箱内，其中安装工具和检测工具及附属配件单独包装运输。

Particular attention will be paid to the cleanliness of the supply at delivery time. After testing and cleaning, each valve must be individually packed in a sealed plastic bag with end caps covering the inlet and the outlet.

交付时特别注意供应的清洁度。测试和清洁后，每个阀门必须单独包装在密封的塑料袋中，塑料袋的端盖覆盖阀门的入口和出口。

## 2.6 REQUIRED DOCUMENTS WITH THE OFFER [报价文件要求]

All documentation must be prepared in accordance with the relevant standards, codes and specifications. The potential tender should provide:

所有文件必须按照相关的标准、规范和规范准备。供应商标书应提供:

### 2.6.1 Documents to be provided before purchase order or at tender process [采购订单前或投标阶段需要提供的文件]

- The preliminary overall 2D drawings with dimensional constraints and nomenclature (.dwg or .pdf).

带有尺寸限制和命名的初步总体 2D 草图(DWG 格式 或 pdf 格式)

- For each valve: DN, Kv with associated calculations according APPENDIX 1, provide selected valve plug characteristic table (**The relationship between Flow Coefficient Kv value and Open Percent table [not curve figure]**), heat leaks, actuator characteristics.

对于每个阀门:DN, Kv 值, 根据附录 1 进行设计点相关计算, **提供选定阀门的特性曲线表格 (流量系数 Kv 值与阀门行程开度的关系表格 [不是曲线图])**, 热泄漏, 执行器特性。

- Lists the component parts which contain polymer materials. Only materials are used which satisfy the specified requirements for radiation dose (if necessary).

列出包含聚合物材料的零部件。仅使用满足辐射剂量规定要求的材料 (如果需要)。

3 APPENDIX 1 [ 附录 1]

Item	Tag-no	qty	Datas for CV calculation								FO or FC	Position	Alarm	Pressure
			Fluid	P <sub>in</sub>	P <sub>out</sub>	T <sub>op</sub>	Flow		R	R		feedback	module	gas filter & regulator
				bar(a)	bar(a)	K	rate					Y/N	Y/N	Y/N
1	CV3301	1	SHe	6	5.97	4	100		EQ%	1:100	FC	Y	Y	Y
2	CV3302	1	SHe	6	5.97	4	75		EQ%	1:100	FC	Y	Y	Y
3	CV3303	1	SHe	6	5.97	4	20		EQ%	1:100	FC	Y	Y	Y
4	CV3304	1	SHe	6	5.97	4	100		EQ%	1:100	FC	Y	Y	Y
5	CV3305	1	GHe	5.9	5.87	50	20		EQ%	1:100	FC	Y	Y	Y
6	CV3306	1	GHe	5.9	5.87	50	20		EQ%	1:100	FC	Y	Y	Y
7	CV3307	1	GHe	5.9	5.87	50	20		EQ%	1:100	FC	Y	Y	Y
8	CV3308	1	SHe	6	5.97	4	250		EQ%	1:100	FC	Y	Y	Y
9	CV3309	1	GHe	5.9	5.87	77	60		EQ%	1:100	FC	Y	Y	Y
10	CV3310	1	GHe	6	5.97	80	100		EQ%	1:100	FC	Y	Y	Y
SHe	Supercritical Helium													
GHe		Gas Helium												