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Standard Components and Guidelines for Cooling Circuits

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Affected Section(s)	Changes / Reason / Remarks
Chapter 3	NPT threads are not forbidden anymore
	Added new requirement #283
Chapter 4.4	Obsolete 1HE controller removed
Chapter 5.1.2	V-shape compression fittings
Chapter 5.9	Correction cooling fluid: from Antifrogen-N to glycol
Chapter 8	Leak testing

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Contents

1. Introduction

1.1 Scope

5 This document defines standard components and workmanship principles for the construction of chilled medium cooling systems to be installed on ESO telescopes, for example as part of an astronomical instrument.

6 The purpose is to provide sufficient reliability in the operation of those systems by the use of tested components and to improve the maintainability.

7 It is foreseen that this standard is adopted by ESO projects and programs delivering systems such as astronomical instruments to the LPO and ELT observatory.

1.2 Definitions, Acronyms and Abbreviations

9

APV	Air Purge Valve
BSP	British standard pipe thread
CFS	Cuno Filter System
FKM	fluoroelastomer
ID	Inside Diameter
NHS	Nominal Hose Size
NPT	National Pipe Thread
OD	Outside Diameter
OTS	Off The Shelf
P&I	Piping and Instrument diagram
PI	Pressure Indicator
SCP	Service Connection Point
TI	Temperature Indicator

2. Related Documents

2.1 Applicable Documents

284 The following documents, of the exact version shown, form part of this document to the extent specified herein.

12 AD1 ANSI/ASME B1.20.1 Pipe Threads (National Pipe Threads)

13 AD2 EN ISO 1127 Stainless Steel tubes, Dimensions, tolerances and conventional masses per unit length.

14 AD3 EN 10216-5 Seamless steel tubes for pressure purposes – Technical delivery conditions – Stainless steel tubes

15 AD4 ISO 7241 Hydraulic fluid power – Dimensions and requirements of quick-action couplings

16 AD5 ISO 10628 Diagrams for the chemical and petrochemical industry

2.2 Reference Documents

285 The following documents, of the exact version shown herein, are listed as background references only. They are not to be construed as a binding complement to the present document.

18 RD1 Sandvik – Seamless stainless tubes for hydraulic and instrumentation systems

19 RD2 Swagelok – Stainless Steel Seamless Tubing

20 RD3 Swagelok – Gaugeable Tube Fittings and Adapter fittings

21	RD4	Fitok – 6 Series Tube Fittings
22	RD5	Parker – A-Lok Tube Fittings
23	RD6	Swagelok – Hose and Flexible Tubing
24	RD7	Fitok – Hoses and Connectors
25	RD8	Parker – Hose, Fittings and equipment
26	RD9	Swagelok – Tubing Tools and Accessories
27	RD10	Armacell UK Product Catalogue
28	RD11	Parker Distribution Manifolds
29	RD12	Smartflow Stainless Steel Manifolds
30	RD13	Apollo 76-100 Series Stainless Steel Valves
31	RD14	Genebre Industrial Line
32	RD15	Parker – Colorflow ball valves
33	RD16	IMI TA – STADT NPT valves
34	RD17	Swagelok – Needle valves
35	RD18	Fitok – Needle Valves
36	RD19	Parker – Needle Valves
37	RD20	Mecesa – Needle Valves
38	RD21	TA-Scope measuring tool
39	RD22	Bürkert – 2/2 way Solenoid Control Valve
40	RD23	Bürkert – 2/2 way servo-assisted valve
41	RD24	3M – CT Series Filter Housing

42 RD25 3M – Micro-Klean Premium Resin Bonded Filter Cartridges

43 RD26 ROCOL – Leak Detector Spray

44 RD27 Parker – BV & PG Series Bleed/Purge Valves

45 RD28 Swagelok – Bleed Valves and Purge Valves

48 RD31 LOCTITE 577

49 RD32 LOCTITE 5331

50 RD33 SIEMENS Electro-thermal Actuator

51 RD34 SIEMENS valves

52 RD35 SIEMENS Electro-motoric Actuator

3. General clarification

54 This document is written to help during the design process of an instrument, for its testing and for the supply of the cooling fluids.

55 The reason why a standard for instruments is needed:

- To keep the number of spare parts at the observatory small
- To guaranty a high quality standard
- To avoid failures happened in the past
- To keep systems as simple as possible and failsafe as possible
- To avoid different systems for which observatory personnel is not familiar with

56 In South America NPT threads are the most commonly used threads for piping work. That's why this standard lists mostly NPT threads.

NPT and BSP threads are accepted, while the NPT is the preferred one.

All interfaces between sub-units shall be NPT threads or quick couplings as listed in chapter 5.6.

57 If a preferred component is only available with BSP threads it is needed to provide spare parts and to clearly indicate them.

283 A set of various fittings used in the instrument shall be delivered as spare parts to be prepared for necessary interventions during the life time of the instrument.

58 Cooling fluid cooling assemblies which will permanently stay in Europe are free to use BSP threads. As an example: cooling fluid distribution panels for lab use, connection of chillers, test equipment, adapters to the house cooling.

59 **Important:**

All components shall be compliant with all interface specifications given in the defining ICD.

If no component defined in the present standard fulfils the needed specifications other components should be proposed. Those components shall fulfil the design rules given in this document and shall be explicitly approved by ESO.

4. Cooling systems design

4.1 Typical Cooling Circuit Layout

62 Below is the diagram of a typical instrument cooling pipe network attached to a VLT SCP, where a number of cabinets containing heat exchangers, cold plates or cooling pipes, and a cryo-compressor set are attached straight forward to the SCP or to an intermediate distribution manifold connected to the SCP. The piping diagram in Figure 1 shows some of the piping and instrumentation items of cooling circuits covered by this standard.

63

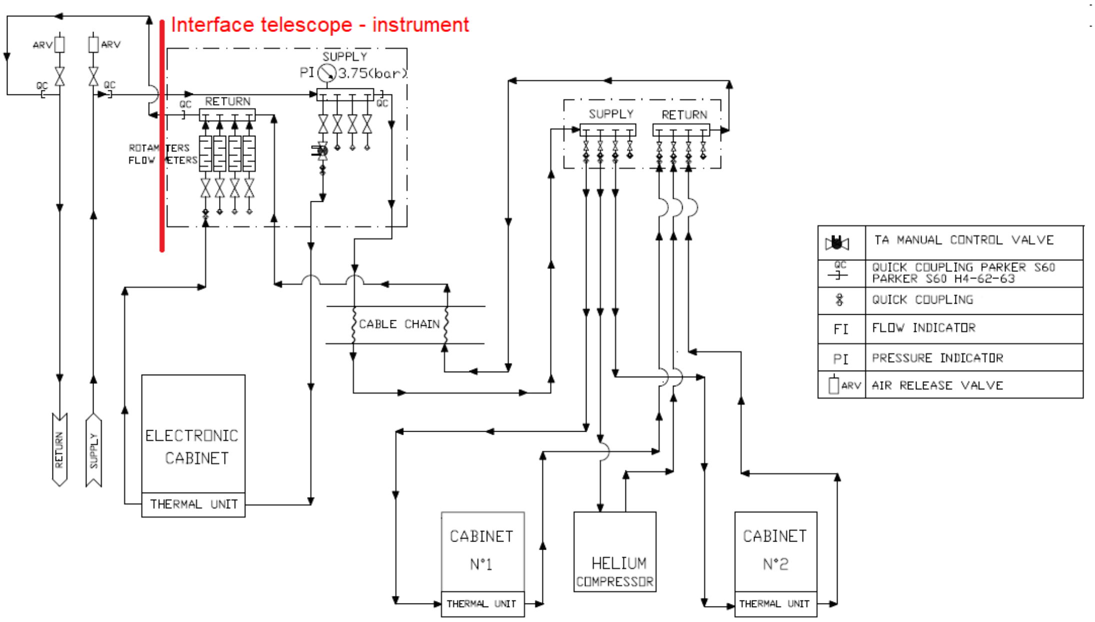


Figure 1: P&I diagram of a typical instrument cooling circuit

64 The specific interface between the cooling circuit of the infrastructure and of the instrument shall be assessed in cooperation with ESO.

65 In some cases where no cooling fluid distribution panel is installed a direct connection to the cooling circuit is needed. In other cases an manifold with installed shut-off valves, filters and quick couplings is in place.

66 The extent of the instrument cooling circuit which will be delivered with the instrument depends on the existing infrastructure and needs to be defined with ESO.

67 If a leak detection is needed two different design proposals are shown in chapter 5.5.4. One is only recommended to detect a burst; with the second one it is possible to detect in addition to a burst very small leaks.

68 **Important:**

The flow regulation balancing of the instrument internal cooling system is under the responsibility of the instrument. The capability to balance shall be foreseen at the instrument, not at the telescope side.

4.2 Cooling Circuit Design

70 The circuits shall be designed for the required working pressure and the components shall be selected accordingly.

71 Metallic components, tubes and fittings shall have a test pressure of a factor of 1.2 higher than working pressure.

72 All metallic parts shall be made of stainless steel except the valves and flowmeters listed in this document and the water-gas heat-exchangers used for electronic cabinet cooling. Parts which have a fluid-contact material of blank steel, zinc-plated steel or blank aluminium are not allowed to avoid contamination of the cooling fluid because of a change of the pH-value which causes a fast corrosion of the aluminium parts. All materials need to withstand a temporary cleaning treatment with citric acid.

73 Elastomeric or plastic components such as hoses shall have a test pressure of a factor of 1.5 higher than working pressure.

74 Each instrument shall be equipped with a filter, see chapter 5.4, in the supply line. A filter shall be used not only in the final configuration but also during the assembly phase to keep the cooling circuit always clean. Who will be responsible for the final filter installed at the SCP or at the instrument shall be assessed in cooperation with ESO.

75 Maintenance instructions shall assure that only trained personal construct and modify cooling circuits according to the manufacturer's recommendations.

76 A cooling circuit layout drawing shall be part of the documentation, see chapter 9.

77 The design parameters for the cooling circuit design shall comply with the corresponding ICD of the telescope.

78 List of design parameters with examples:

- Interface (hose, pipe, quick coupling…)
- Interface diameter (1/2” pipe, 3/8” quick coupling…)
- Working pressure (10 Bar…)
- Medium (water – 30% Glycol…)
- Medium temperature range (-8 …14°C…) (can time vary, depends on interface)
- Medium flow range (8-20 l/h…)
- Maximum delta return temperature of medium (8°C…)
- Maximum coolant flow through system (1.2 m/sec)
- Maximum thermal load (6 kW…)

79 The cooling systems should be robust in handling the coolant temperature variation given in the ICD, design shall consider these variations.

80 These parameters vary from ICD to ICD. It is absolutely necessary to ensure that the right ICD for the design case is chosen.

4.3 Design of cooling fluid distribution panels

82 As shown in Figure 1 there are reasons to have more than one single connection to the cooling fluid cooling system:

- More than one consumer
- Different locations of the consumers
- Thermal and logical groups of consumers

83 To ensure an easy maintainable instrument at minimum one cooling fluid distribution panels shall be implemented. The supply and return line of this panel are the interface to the infrastructure.

84 To distribute the cooling fluid the manifolds shall be installed on panels with the following functions:

- A manifold
- Flow indication of each cooling circuit separately to allow an hydrostatic balancing (to balance the flow of each sub-circuit to ensure sufficient cooling flow in every circuit)
- Flow regulating valves

- Shut-off valves for supply and return lines (not needed in both lines if flow regulation valves are used)
- Purge valve at the highest point of the manifold
- Pressure gauges for supply and return line
- Temperature sensor (optional)
- If needed quick coupling connections

85 The possibility to install a spare circuit is highly recommended.

86 **It is not allowed to connect cooling fluid consumers to the telescope without a possibility to balance the flow.**

87 All lines shall be labelled. The return and supply lines shall be clearly identified.

88 An exemplary purchase list (not complete) is shown in chapter 11.1 and a photo of an installed panel is shown in chapter 11.2.

89

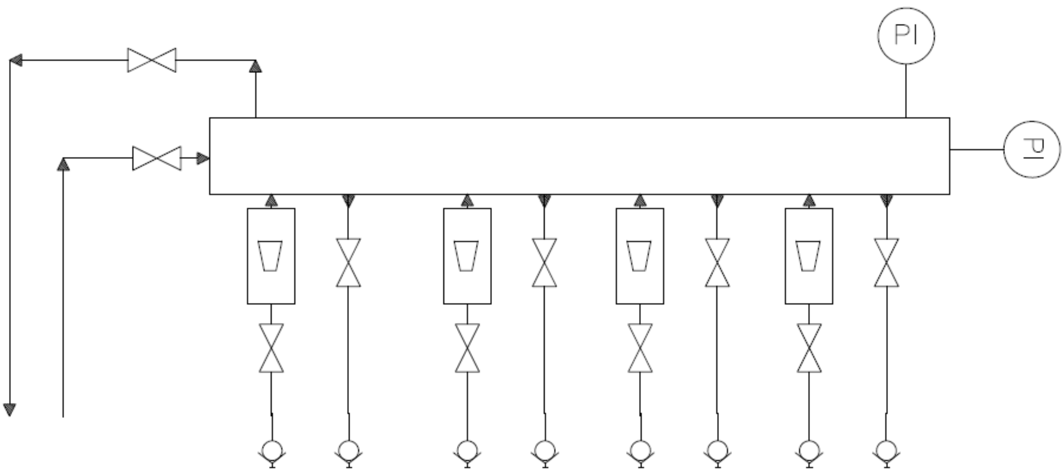


Figure 2: example of a cooling fluid circuit schematic using a MAGRA manifold, see chapter 5.2

4.4 Design of temperature controlled circuits

91 The temperature controlling of devices like electronic cabinets or enclosures shall be done via the instrument PLC.. An example for a SIEMENS Simatic controlling can be found in chapter 11.3.

93 To avoid unnecessary high pressure drops in the cooling system, unused pumped cooling fluid and an decrease of the return temperature of the cooling fluid only 2-way-valves shall be used.

94 If there is an technical need to make use of a 3-way-valve the decision shall be assessed in cooperation with ESO.

95

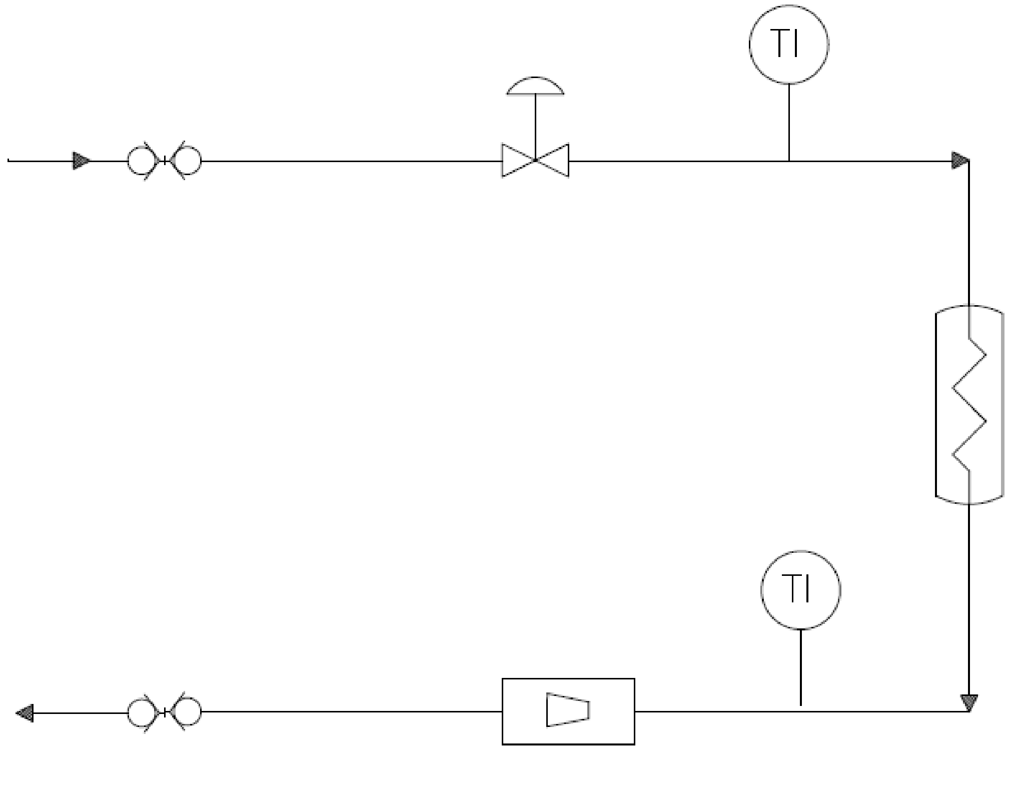


Figure 4: example of a temperature control via controlled cooling fluid flow

5. Main Components

97 As a general rule, the pressure resistance of all components shall be a minimum factor of 1.2 higher than the working pressure, defined in relevant ICD.

98 Those components which are NOT compatible with the working pressure should be part of a secondary isolated circuit. This should be avoided and shall be communicated with a waiver.

99 Specific requirements for each components are in the following chapters.

100 **Clarification:**

All chosen components shall fulfil the specifications given in the relevant ICD.

Special precaution shall be taken in respect to the maximum working pressure.

Not all components proposed in this document fulfil a higher working pressure than 10 Bar.

Components which are not listed shall be approved by ESO.

5.1 Piping work

102 This standard covers rigid tubes and flexible hoses.

5.1.1 Rigid Tube

5.1.1.1 Dimensional requirements

105 Tube dimensions and tolerances shall be according to AD2 (D4, T3 tolerance for all diameters specified in this document). Only the following metric diameters shall be used: OD (mm) 10 / 12 / 16 / 25

106 The pressure resistance shall be a minimum factor of 1.2 higher than the working pressure, defined in the relevant ICD.

5.1.1.2 Materials

108

EN	ASTM
1.4306	304L
1.4401	316
1.4404	316L

109 At the time of writing RD1 and RD2 brands meet the above requirements.

5.1.2 Tube fittings

111 Compression fittings, threaded fittings or flange fittings shall be used for rigid pipe work. No welding fitting is allowed in circuits attached to an SCP. Only compression fittings with V-system and standard sealing are allowed.

112 The stainless steel series of SWAGELOK, FITOK, Hy-LOK or PARKER shall be used for threaded unions and fittings.

113 • Dimensions of unions shall be in millimetres.

114 • Threads for fittings shall meet AD1

115 • Tools for installation of compression fittings are not available at Paranal

5.1.3 Hoses

5.1.3.1 General Purpose Hoses

118 The following multi-purpose hose series for push-on end fittings shall be used:

Swagelok PB series (working pressure up to 24 Bar; see RD6 for hoses and end fittings)

Fitok MP Series (working pressure up to 20 Bar; see RD7 for hoses and end fittings)

Parker Push-Lok Plus (working pressure up to 27 Bar; see RD8 for hoses and end fittings)

119 The three series of hoses and end fittings are interchangeable.

120 Only push-on hose connection shall be used.

121 By using push-on fittings and hoses no additional hose clamps are needed.

122 **Comment:**

According to Swagelok it is recommended to replace the hoses because of aging after 5 years in operation.

123 A regular inspection of the hoses shall be added to the maintenance manual.

124 To minimise maintenance the use of hoses shall be minimised where ever it is possible.

5.1.3.2 Special Tools

126 Proper tools as per required following shall be used when manufacturing and assembling hoses or rigid pipe lines.

5.1.3.2.1 Tools for Hoses

128 • A hose dedicated cutting tool shall be used, not being allowed the use of scissors, pliers or saws.
RD6 (MS-HC-SC-1A) contains an example of this type of tool

129 • A push on tool like the one proposed in RD6 (MS SPOT) or equivalent may be used.
This push-on-tool is available at ESO HQ.

130

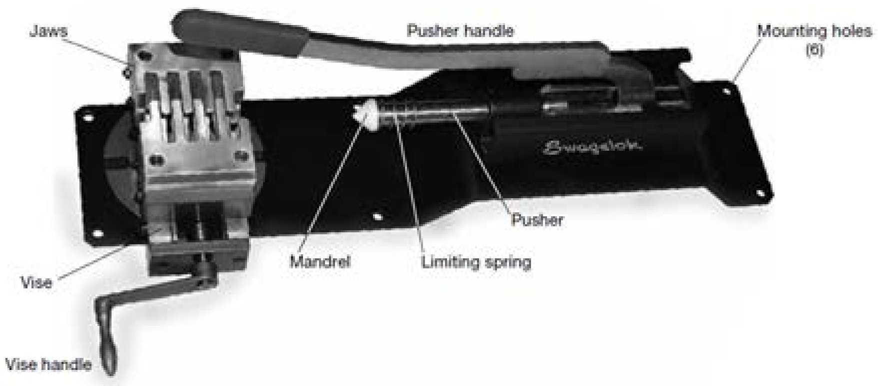


Figure 5: Swagelok push-on tool

5.1.3.2.2 Tools for rigid pipes

132

Tool	**Reference in RD9**
Tube cutter	MS-TC-308
Tube sawing guide	MS-TSG-16
Tube bending manual tool (up to 25 mm OD)	MS-BTB-M-
Tube bending electrical tool (up to 50 mm OD)	MS-TBE-2-
Tube deburring tool	MS-TDT-24

5.1.3.3 Insulation

134 To avoid condensing water, avoidable cooling power losses and cold spots all cooling fluid lines shall be thermal insulated.

135 Armacell elastomeric insulation for pipes (RD10) shall be used for hoses and tubes insulation.

136 Rigid tube shall be additionally jacketed with Armacheck (RD10) or equivalent. An aluminium custom jacket is also accepted.

5.2 Distribution Manifolds

138 They shall be of Stainless Steel with NPT connection ports. Cooling fluid supply and return ports shall be of a minimum size of 1/2” NPT.

139 Parker manifolds (RD11) and Smartflow manifolds (RD12) meet the above requirements.

140 It is recommended to use the water manifolds from MAGRA, type 60/60 stainless steel.

Unfortunately there is no type with NPT threads and an maximum pressure of 10 bar off-the - shelf on the market.

ESO has some custom-made versions of this manifolds with NPT thread with 4 or 6 cooling circuits on stock. On request it can be provided to the consortium.

141 Material: stainless steel

142 Thread connection: infrastructure side: IN / OUT: 1” NPT; consumer side: in / out ½” NPT

143 Quantity of connections: 2 IN / 2 OUT; 4 (or 6) in / 4 (or 6) out

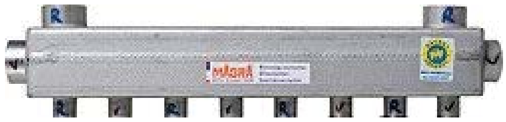
144


Figure 6: MAGRA 60/60 manifold with 4 cooling circuits (custom-made for ESO)

145 **Comment:**

The MAGRA manifold combines supply and return line in one manifold. Only one manifold is needed per circuit.

5.3 Valves

5.3.1 Shut off Valves

148 They shall be of the ball type, with threaded NPT (AD1) connections. The body and the ball shall be of stainless steel. Ball seat shall be of a thermoplastic material. The pressure resistance shall be higher than the working pressure, see relevant ICD.

149 Apollo (RD13), Fitok or Genebre (RD14) meet the above requirements.

5.3.2 Flow regulation and measuring valves

151 The balancing valves shall have available the double capability of shutting off and flow adjustment. They shall be of stainless steel or AMETAL® (see RD16). Connections shall be NPT or tube compression fitting. Any of the valves in Table 1 shall be used.

152

Vendor	**Reference**	**Use**	**connection**
Parker	Colorflow Series F Flow Control Valves	Flow regulation, shut off	NPT threads See RD15
Parker	V series stainless steel needle valve	Flow regulation, shut off	NPT or compression fitting (A-LOK) See RD19
IMI TA	STAD series	Flow regulation and measurement, shut off	NPT See RD16

Swagelok	18 series SS316 needle valve with regulating stem	Flow regulation, shut off	NPT or compression fitting (Swagelok fitting) See RD17
FITOK	ND Series	Flow regulation, shut off	NPT threads See RD18
MECESA	06XHG1 Series	Flow regulation, shut off	NPT threads See RD20

Table 1 – Flow regulation and measuring valves

5.3.3 Bleed/Purge valves

154 Stainless Steel 1.4301(304), 1.4306(304L), 1.4401(316), 1.4404(316L) purge valves shall be installed in high, easily accessible points of the cooling circuit in order to vent or bleed the system properly.

155 The valve end connection shall be NPT (AD1) or a compression fitting.

156 RD27 and RD28 shows to types of valves which meet the above requirements. Equivalent products are accepted.

5.3.3.1 Special tools for valves

158 A TA Heimeier measuring device is needed for flow measurement on a TA valve (RD21), in case this kind of valve is used for flow adjustment purposes. This device is available at Paranal.

5.3.4 Electrical valves

160 Bürkert valves shall be used either for shut-off or for flow control purposes.

5.3.4.1 Flow Control

162 • Bürkert 2836 2/2 way solenoid control valve shall be used. They shall be of stainless steel with NPT connection threads with FKM seal material (see RD22)

5.3.4.2 Open-Close valve

164 • Bürkert 6213 2/2 way shall be used. They shall be of stainless steel with NPT connection threads for a 10 bar maximum pressure with FKM seal material (see RD23)

5.3.4.3 For temperature controlling

166 SIEMENS 2-way valve VVP47.10 (see RD34)

or

SIEMENS 3-way valve VXP47.10 (see RD34)

combined with the electrothermal actuator SIEMENS STA73/00 (Siemens nr. S55174-A109) (see RD34RD33) and the cable ASY23L100HF (Siemens nr. S55174-A136) or to purchase the version including cable if it is long enough for the application.

167 As an alternative electrothermal actuator the IMI EMO-T 24V (IMI nr. 4024052835812) shall be used.

168 This type of actuator is very reliable and allows operation in all orientations. The cable is halogen free.

170

Figure 7: SIEMENS 3-way-valve / 2-way- valve, electrothermal actuator

171 See chapter 4.4 (electronic cabinet temperature controlling)

172 **Comment:**

Valves from Heimeier are not suitable because of a too low maximum differential pressure of these units. If the differential pressure is higher than 3.5 bar the Heimeier valve will open, independently from how it is controlled.

173 This valves are equipped with BSP threads which is acceptable because the heat exchangers of the electronic cabinets have also BSP threads.

5.4 Filters

175 CUNO/3M Housing size CT102 for cartridge filters with draining feature (see RD24) shall be used. Connection shall be NPT 3/4" or 1" according to design needs.

176 The filter cartridge shall be Micro-Klean III 20" long for a nominal 10 µm particle (see RD25).

177

Figure 8: filter pair installed at Paranal

5.5 Sensors

179 This chapters refers to temperature, pressure and flow sensors and flow meters.

180 The device family reference shown below shall be used. Design parameters like flow range or connection sizes shall be selected according to the design requirements.

5.5.1 Pressure sensors

5.5.1.1 For digital signal:

183 KOBOLD SEN- series with the following details:

Body material: Stainless Steel

Thread connection: NPT

5.5.1.2 For visualisation:

185 Pressure gauge with pressure range 0- 16 Bar (app.)

186 Connection thread ¼” NPT or ½” NPT

187 Material: Stainless Steel

188

Figure 9: Example WIKA 68124315

5.5.2 Temperature sensors

5.5.2.1 For digital signal:

191 KOBOLD TDA series with the following details:

192 Body material: Stainless Steel

193 Thread connection: NPT male

194 Temperature display (if any): °C

5.5.2.2 For analog signal:

196 PT100 pipe sensor

197

Figure 10: Example Sensorshop24 and POLLIN 180029

198 This type of sensor shall be clamped to the outer shell of the pipe / hose. Inline sensors are possible.

199 No exact type of sensor is prescribed.

5.5.2.3 For visualisation:

201 Bimetal temperature sensor

202 Connection thread ¼” or ½” NPT

203 Material: Stainless Steel

204

Figure 11: Example WIKA R52.063-S-CCD-ND-B063GZ-Z-ZZZ

5.5.3 Flow meters

5.5.3.1 Flow meters with graduated scale

207 KOBOLD VKG series with the following details:

208 Body material: Stainless Steel

209 Thread connection: NPT

210 Installation orientation: any

211 Note: this type is viscosity compensated. Non-compensated flowmeters measure with an error of app. 50 % because of 30 % glycol-water mixture in Chile.

212

Figure 12: KOBOLD VKG flow meter (viscosity compensated)

213 **Comment:**

The former standard part DSV is not compensated and is not recommended anymore!

214 Only for the use in European laboratories, not in Chile, the flowmeters from TACONOVA Tacosetter are recommended.

215 Body material: brass

216 Thread connection: BSP

217

Figure 13: flow meter only for lab use: TACONOVA Tacosetter

5.5.3.2 Flow meters with a digital display and signal output

219 **For high precision flow measurement:**

IFM SM6000 Magnetic-inductive flow meter / 0,1...25 l/min / resolution 0,05 l/min / ½" BSP thread / including temperature sensor -20 to 80 °C, Pmax 16 bar

220 **For low resolution measurement:**

IFM SBG232 Flow transmitter / 0,5...25 l/min / resolution 0,1 l/min / ½" BSP thread, including temperature sensor -10 to 100 °C, Pmax 40 bar

221

Figure 14: IFM SM6000 (left) and SBG232 (right)

222 **Comment:**

Unfortunately it is not possible to purchase this flowmeters with a metric scale and NPT threads. BSP to NPT adapter needs to be used.

227 Other parameters like connection size, electronics connection and power input shall be selected according to the project requirements.

5.5.4 Leakage sensor

229 In some applications a leak detection is needed to avoid contamination inside the instrument. In most cases a comparison of the supply and the return flow measured with very accurate flow meters is not sufficient. It is recommended to make use of dedicated leak sensors which are available to detect a leak on larger surfaces or on dedicated points.

230 It is recommended to make use of the following leakage sensors:

- OMRON K7L Series

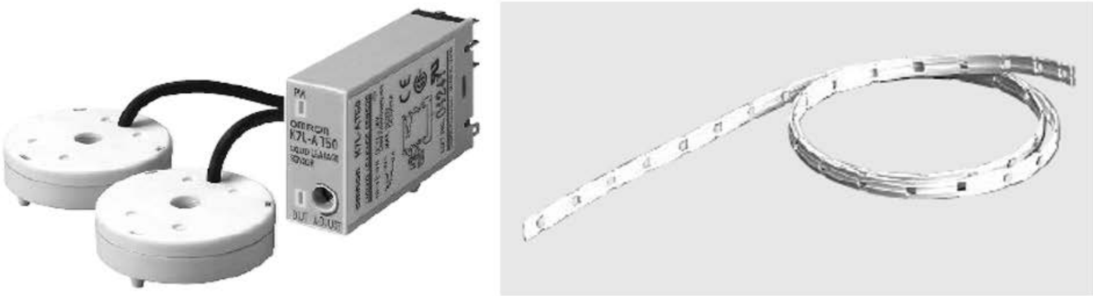
231 

Figure 16: OMRON point and surface leakage sensor

232 If just a detection of a burst of a pipe, hose or manifold is needed a differential pressure switch between supply and return line can be installed.

5.6 Quick couplings

234 Couplings according to ISO 7241-1 series B, (output male, return female) (AD4) shall be used. The material shall be of stainless steel 1.4301(304), 1.4306(304L), 1.4401(316), 1.4404(316L) or higher grade. The connections shall be female NPT threads. Minimum size shall be 3/8".

235 Sealing must be suitable for cooling water with 35% glycol like for example EPDM or VITON.

236 Following references are suggested, others covered by AD4 are acceptable:

- PARKER hydraulic quick coupling 60 series for general purpose - stainless with NPT female threaded connections, size is available from 3/8" to 1".

Sample of reference for a 1/2" coupling:

Coupler: SH4-62 NPT

Nipple: SH4-63 NPT

- RECTUS KB Series (71KB, 72KB, 73KB, 74KB, 75KB, 76KB)
- TEMA IB series (IB2500, IB3800, IB5000, IB7500, IB10000)
- FITOK 316 SS QV Series

237 

Figure 17: Example RECTUS 73 KB stainless steel ¾” NPT

238 Only the quick coupling according to ISO 7241-1 series B are allowed as plug-able interface to the infrastructure.

239 If an alternative quick coupling for instrument internal use is needed the Stäubli RME coupling is recommended. It provides a lower pressure drop, an allways tight connection operation, low spill during connection and a slim form factor. The thread gender needs to be chosen according to the use case.

240 

Figure 18: alternative quick coupling STÄUBLI RME 09

282

Type	Gender	Thread	Thread Type	Order Number	Comment
RME 09	socket	G 3/8	female thread	RME 09.1102/JE	EPDM sealing
RME 09	plug	G 3/8	female thread	RME 09.7102/JE	EPDM sealing
RME 16	socket	G 3/4	female thread	RME 16.1104/VP/JE	EPDM sealing + Enhanced locking ring
RME 16	plug	G 3/4	female thread	RME 16.7104/VP/JE	EPDM sealing + Enhanced locking ring

Table 2: STÄUBLI quick coupling order numbers for female threads

241 The use of CPC quick couplings shall be avoided because of a lack of quality and reliability.

242 **Clarification:**

In the past the detector NGC's were equipped with CPC couplings. To keep the NGC's interchangeable all NGC's planned to use at the VLT will keep CPC couplings. All controllers planned to be used for an ELT project will be equipped with the quick coupling RME type from the company Stäubli.

243 **Clarification:**

The flow direction is always from the male connector to the female connector.

5.7 Fittings

245 All fittings shall be of stainless steel, threads shall be NPT or BSP and the pressure resistance shall be higher than the working pressure, see relevant ICD.

246 **Comment:**

In Europe it is not so easy to get all needed fittings with an NPT thread. The following suppliers have a wide range of fittings fulfilling the requirements and are easily procurable in Europe: SWAGELOK / FITOK / Hy-LOK / PARKER / DK-LOK

5.8 Unions with O-rings

248 This shall be used only when no other option is available or suitable. In this case they shall be of Stainless Steel 1.4306(304L), 1.4401(316), 1.4404(316L) and exclusively with internal flat face O-ring (high pressure type, see picture below).

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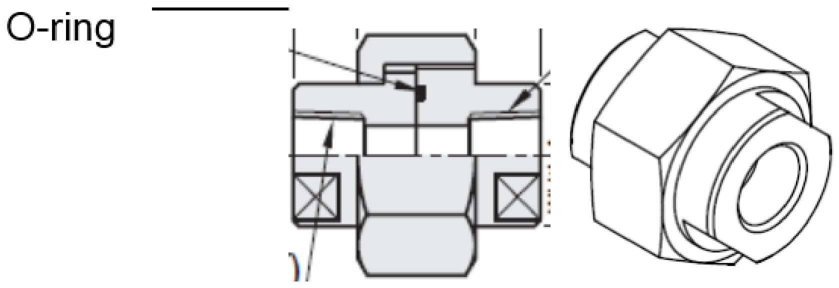


Figure 19: union with O-ring

5.9 Coolant

251 A coolant mixture of water and 30% glycol shall be used to ensure a sufficient low freezing point.

252 Additional anticorrosion and biocide additives are needed.

253 The correct concentration shall be monitored annual.

The cooling fluid needs to be clean and transparent.

254 The pH value shall be monitored and must be between 7 – 9.

255 Parameters like pressure and temperature ranges are given in the related ICD.

6. Other components

6.1 Thread sealants

258 For chemical bonding of fittings made of metal LOCTITE 577 (hardness is medium) or LOCTITE 5331 (hardness is low) are recommended. See RD31 and RD32.

259 To bond plastic-plastic or plastic-metal fitting connection LOCTITE 5331 shall be used.

7. Circuit Cleanliness

262 The coolant within instrument circuits shall be of the highest quality fluid to ensure maximum availability. For this purpose:

- A filtration media as per chapter 5.4 shall be used during integration, testing and operation phases.

- Cooling circuits supplied by second parties shall be integrated, tested and operated with a mixture of 70 % water and 30 % glycol.
- During the installation of the cooling circuit at the integration and testing premises the cooling circuits shall be flushed at the nominal flow speed when plugging it to the integration or test facility and before operation. The filter cartridge shall be replaced with a fresh one after the flushing feature.

263 If there are specifications on the cleanliness given in the relevant ICD the ICD overrules this chapter.

8. Circuit Leak Testing

265 The instrument cooling circuit shall be leak proof. For that purpose the circuit shall be tested for leaks according to the following procedure:

266 i. A first air pressure test shall be carried out to detect leaks safely under a pressure of 3 bar for at least three hours. Acceptance criteria: pressure variation within ±3% of the input value and the absence of leaks detected with leak detection spray. Leak detection sprays (e.g. RD26) suitable for compressed air shall be used according to the manufacturer's instructions to find leaks on joints while the system is pressurized.

267 ii. A hydraulic leak test according to DIN EN 806-4 shall verifies the tightness of the system. The standard cooling fluid shall be used to avoid circuit contamination. The system shall be able to maintain the working pressure * 1.2 during 30 minutes. Acceptance criteria: no pressure variation after a settling time of 10 minutes and the absence of visible leaks. Desiccant paper may be used to find leaks on joints. The working pressure is given in the relevant ICD.

268 iii. The leak test procedure and parameters used and the test results shall be documented in a test report.

9. Documentation

270 Every cooling circuit attached to an SCP shall have an associated P&I diagram, see Figure 1. The documentation shall comprise comprehensively all cooling items according to AD5, including at least the components referred in this standard and their size, the full reference of each item, the type and size of pipework, details of insulation, fluid flow direction, the pressure drop of the system at given flow (or the flow factor Kv of the system) and nominal temperature

values and any other detail which is necessary for the correct operation and maintenance of the circuit. The flow factor would help the observatory to adjust the cooling supply such a way that it will be sufficient for the instrument cooling system.

271 To ensure an efficient troubleshooting one P&I diagram shall be placed at the SCP.

10. Waiver to the standard

273 Exceptions under justified circumstances to this standard may be asked to the relevant ESO authorities following by a request for waiver. As part of this waiver the technical reasons for the exception needs to be explained and related test reports which show the technical quality of the new technical solution need to be attached.

aa

11. Examples

11.1 Purchase list cooling fluid distribution panel

276

description	thread	producer	part number producer	vendor	part number vendor	quan tity	cost /pc. €
hose for panel connection:							
Swagelok Push-On Hose, 1/2 in. Hose Size, Blue		Swagelok	PB-8-250	Swagelok	PB-8-250	250	4.11
Swagelok Push-On Hose End Connection, 1/2" Stainless Steel Male NPT, 1/2" Hose Size		Swagelok	SS-PB8-PM8	Swagelok	SS-PB8-PM8	4	25.51
QV Series Quick-Connects Stems,1/2 Female NPT EPDM	NPT	FITOK	SS-QV8-FNS8-D-E	HPS	SS-QV8-FNS8-D-E	2	35.88
QV Series Quick-Connects Bodies,1/2 Female NPT EPDM	NPT	FITOK	SS-QV8-FNS8-B-E	HPS	SS-QV8-FNS8-B-E	2	70.24
hose instrument side							
Swagelok PB-06 Push-On hose blue 3/8“ d=9.7mm		Swagelok	PB-06	Swagelok	PB-06	250	3.01
End Connection stainless steel 3/8" Push-On 3/8" NPT male SS-PB6-PM6	NPT	Swagelok	SS-PB6-PM6	Swagelok	SS-PB6-PM6	24	19.44
sensors							
Kobold flow meter VKG-120500N15 stainless steel / 1-10l/min / 10 bar / 1/2" NPT tread female	NPT	Kobold	VKG-120500N15	Kobold	VKG-120500N15	6	650
Pressure gauge VG20S-16B 0-16 bar / stainless steel / 1/4" NPT male	NPT	Vigourco	VG20S-16B	HPS	VG20S-16B	2	26.79
manifold							
Magra 6x stainless steel 60/60 4x 1"female 12x 1/2" male NPT	NPT	Magra		Magra		1	408.00
Magra mounting kit 60/60		Magra	73200603	Weinmann & Schanz	90 102 41	1	22.05
Pipe plug stainless steel 1" NPT male	NPT	FITOK	SS-PP-NS16	HPS	SS-PP-NS16	2	14.16
Reducing Bushing 1" male NPT / 1/4" female NPT stainless steel	NPT	FITOK	SS-PRB-NS16-NS4	HPS	SS-PRB-NS16-NS4	2	13.33
Street Elbow, 1/2 Female NPT × 1 Male NPT SS	NPT	FITOK	SS-PSE-NS8-NS16	HPS	SS-PSE-NS8-NS16	2	67.26
instrument side							

Pipe cap 1/2" NPT female stainless steel	NPT	FITOK	SS-PC-NS8	HPS	SS-PC-NS8	4	8.39
Ball valve SS 3/8 Female NPT,0.28" Orifice	NPT	FITOK	BRSS-FNS6-07	HPS	BRSS-FNS6-07	10	53.32
Adapter , 1/2 Female NPT × 3/8 Male NPT SS	NPT	FITOK	SS-PA-NS8-NS6	HPS	SS-PA-NS8-NS6	6	11.37
Hex Nipple, 1/2 Male NPT × 3/8 Male NPT SS	NPT	FITOK	SS-PHN-NS8-NS6	HPS	SS-PHN-NS8-NS6	6	8.07
NGC & TMP & small electronic & APD rack							
Female Elbow, 3/8 Female NPT × 3/8 Female NPT SS	NPT	FITOK	SS-PE-NS6	HPS	SS-PE-NS6	4	16.60
Hex Coupling 3/8 Female NPT × 3/8 Female NPT	NPT	FITOK	SS-PCG-NS6	HPS	SS-PCG-NS6	4	8.77

This purchase list is only an example. The diameters needs to be adapt to the respective needs.

11.2 Installed cooling fluid distribution panel

278

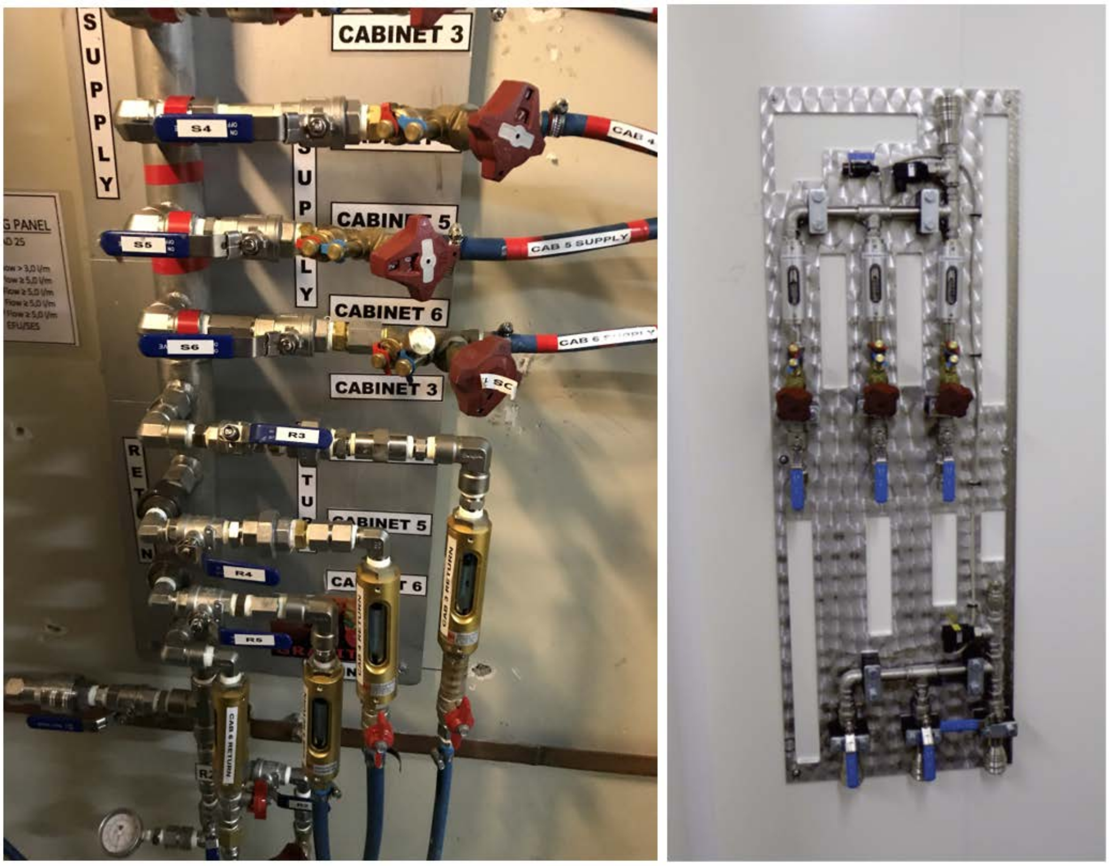


Figure 20: examples cooling fluid distribution panel in Combined Coudé Lab

11.3 Example PLC control

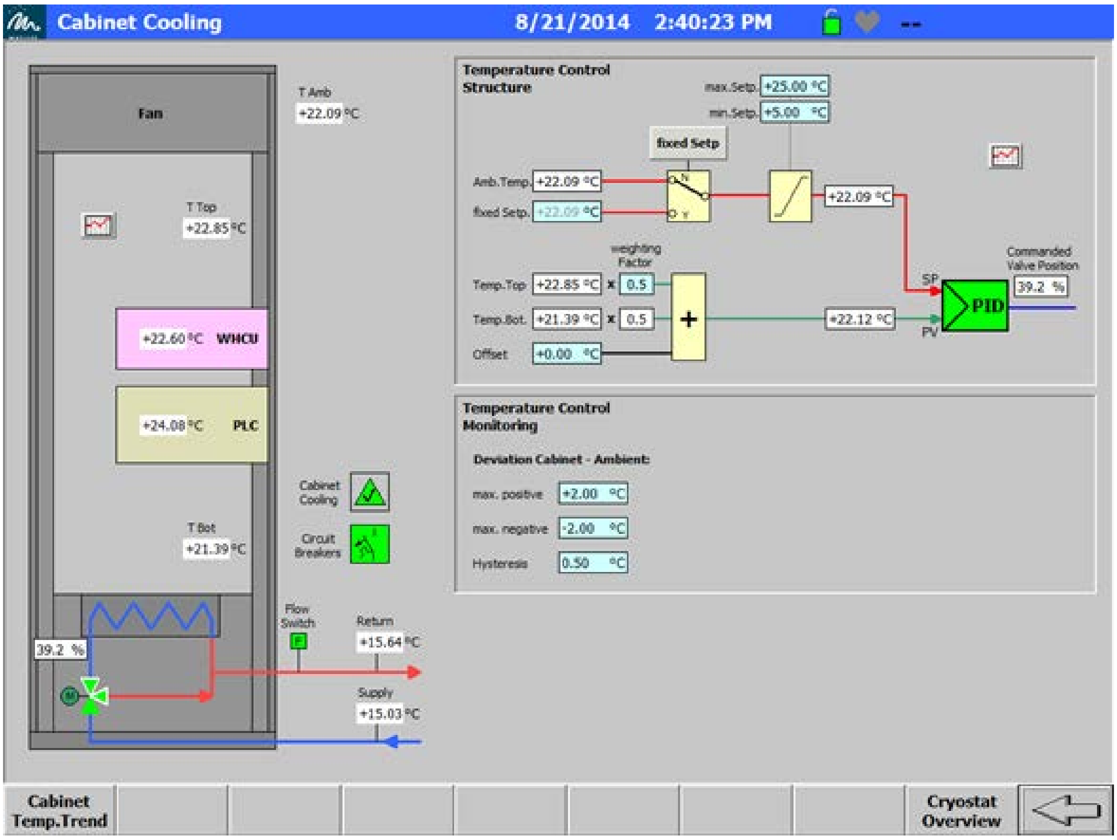
280 

Figure 21: elect. cabinet temperature control via SIEMENS PLC

281 **--- End of document ---**