



Programme: GEN

Project/WP: ESO Standards management

Standard Components and Guidelines for Cooling Circuits

Document Number: ESO-254314

Document Version: 6

Document Type: Standard (STD)

Released On: 2021-11-09

Document Classification: ESO Internal Use [Confidential for Non-ESO Staff]

Prepared by: Haug, Marcus

Validated by: Jakob, Gerd

Approved by: Egner, Sebastian Elias

Name



Authors

Name	Affiliation
E. Fuenteseca	ESO - MSE
J. Abad	ESO - DoE
M. Haug	ESO - DoE
M. Kraus	ESO - DoE
S. Eschbaumer	ESO - DoE
A. Jost	ESO - DoE

Change Record from previous Version

Affected Section(s)	Changes / Reason / Remarks
all	Corrected wording: "working pressure" to "maximum working pressure"
All / Chapter 1.3	Introduced object identifier [R-COL-xxx]
Chapter 2.2	Removed RD35
Chapter 4.2	Added definition of maximum working pressure
Chapter 5.3.4.3	Removed Req #167
Chapter 5.5.1.1	Exact definition of pressure sensor
Chapter 5.5.3.2	Adding flowmeter with two analogue outputs instead of IO-link and with flow up to 50 l/min
Chapter 8	Test pressure lowered to factor of 1.1



Contents

1. Introduction	5
1.1 Scope	5
1.2 Definitions, Acronyms and Abbreviations.....	5
1.3 Object Identifiers	6
2. Related Documents.....	7
2.1 Applicable Documents.....	7
2.2 Reference Documents.....	7
3. General clarification.....	9
4. Cooling systems design	10
4.1 Typical Cooling Circuit Layout	10
4.2 Cooling Circuit Design	11
4.3 Design of cooling fluid distribution panels.....	13
4.4 Design of temperature controlled circuits.....	15
5. Main Components	16
5.1 Piping work.....	16
5.1.1 Rigid Tube.....	16
5.1.1.1 Dimensional requirements.....	16
5.1.1.2 Materials	17
5.1.2 Tube fittings.....	17
5.1.3 Hoses.....	17
5.1.3.1 General Purpose Hoses.....	17
5.1.3.2 Special Tools	18
5.1.3.2.1 Tools for Hoses	18
5.1.3.2.2 Tools for rigid pipes	19
5.1.3.3 Insulation	19
5.2 Distribution Manifolds	19
5.3 Valves	20
5.3.1 Shut off Valves	20
5.3.2 Flow regulation and measuring valves.....	21
5.3.3 Bleed/Purge valves	21
5.3.3.1 Special tools for valves	22
5.3.4 Electrical valves.....	22
5.3.4.1 Flow Control.....	22
5.3.4.2 Open-Close valve	22
5.3.4.3 For temperature controlling	22



5.4	Filters	23
5.5	Sensors	24
5.5.1	Pressure sensors	24
5.5.1.1	For digital signal:	24
5.5.1.2	For visualisation:	24
5.5.2	Temperature sensors	25
5.5.2.1	For digital signal:	25
5.5.2.2	For analog signal:	25
5.5.2.3	For visualisation:	25
5.5.3	Flow meters.....	26
5.5.3.1	Flow meters with graduated scale	26
5.5.3.2	Flow meters with a digital display and signal output	27
5.5.4	Leakage sensor.....	28
5.6	Quick couplings	29
5.7	Fittings.....	30
5.8	Unions with O-rings	31
5.9	Coolant.....	31
6.	Other components.....	32
6.1	Thread sealants.....	32
7.	Circuit Cleanliness.....	32
8.	Circuit Leak Testing.....	32
9.	Documentation	33
10.	Waiver to the standard	33
11.	Examples	34
11.1	Purchase list cooling fluid distribution panel	34
11.2	Installed cooling fluid distribution panel	36
11.3	Example PLC control.....	37



1. Introduction

1.1 Scope

- [R-COL-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.
- [R-COL-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.
- [R-COL-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

- [R-COL-9] This document employs several abbreviations and acronyms to refer concisely to an item, after it has been introduced. The following list is aimed to help the reader in recalling the extended meaning of each short expression:

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



1.3 Object Identifiers

[R-COL-289] Each statement in this document is labelled with an identifier following the format [R-COL-NNN], where NNN is a unique, non-speaking number.

[R-COL-290] NNN numbers do not necessarily follow a sequential order. They do not change across all versions of this document. Within this document, cross-references to an item are made by referring to the number NNN preceded by the prefix "#".



2. Related Documents

2.1 Applicable Documents

[R-COL-284] The following documents, of the exact version shown, form part of this document to the extent specified herein.

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

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

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

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

AD5 ISO 10628 Diagrams for the chemical and petrochemical industry

2.2 Reference Documents

[R-COL-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.

RD1 Sandvik – Seamless stainless tubes for hydraulic and instrumentation systems

RD2 Swagelok – Stainless Steel Seamless Tubing

RD3 Swagelok – Gaugeable Tube Fittings and Adapter fittings

RD4 Fitok – 6 Series Tube Fittings

RD5 Parker – A-Lok Tube Fittings

RD6 Swagelok – Hose and Flexible Tubing

RD7 Fitok – Hoses and Connectors

RD8 Parker – Hose, Fittings and equipment

RD9 Swagelok – Tubing Tools and Accessories



- RD10 Armacell UK Product Catalogue
- RD11 Parker Distribution Manifolds
- RD12 Smartflow Stainless Steel Manifolds
- RD13 Apollo 76-100 Series Stainless Steel Valves
- RD14 Genebre Industrial Line
- RD15 Parker – Colorflow ball valves
- RD16 IMI TA – STADT NPT valves
- RD17 Swagelok – Needle valves
- RD18 Fitok – Needle Valves
- RD19 Parker – Needle Valves
- RD20 Mecesa – Needle Valves
- RD21 TA-Scope measuring tool
- RD22 Bürkert – 2/2 way Solenoid Control Valve
- RD23 Bürkert – 2/2 way servo-assisted valve
- RD24 3M – CT Series Filter Housing
- RD25 3M – Micro-Klean Premium Resin Bonded Filter Cartridges
- RD26 ROCOL – Leak Detector Spray
- RD27 Parker – BV & PG Series Bleed/Purge Valves
- RD28 Swagelok – Bleed Valves and Purge Valves
- RD31 LOCTITE 577
- RD32 LOCTITE 5331
- RD33 SIEMENS Electro-thermal Actuator
- RD34 SIEMENS valves



3. General clarification

[R-COL-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.

[R-COL-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

[R-COL-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.

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

[R-COL-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.

[R-COL-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.

[R-COL-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

[R-COL-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.

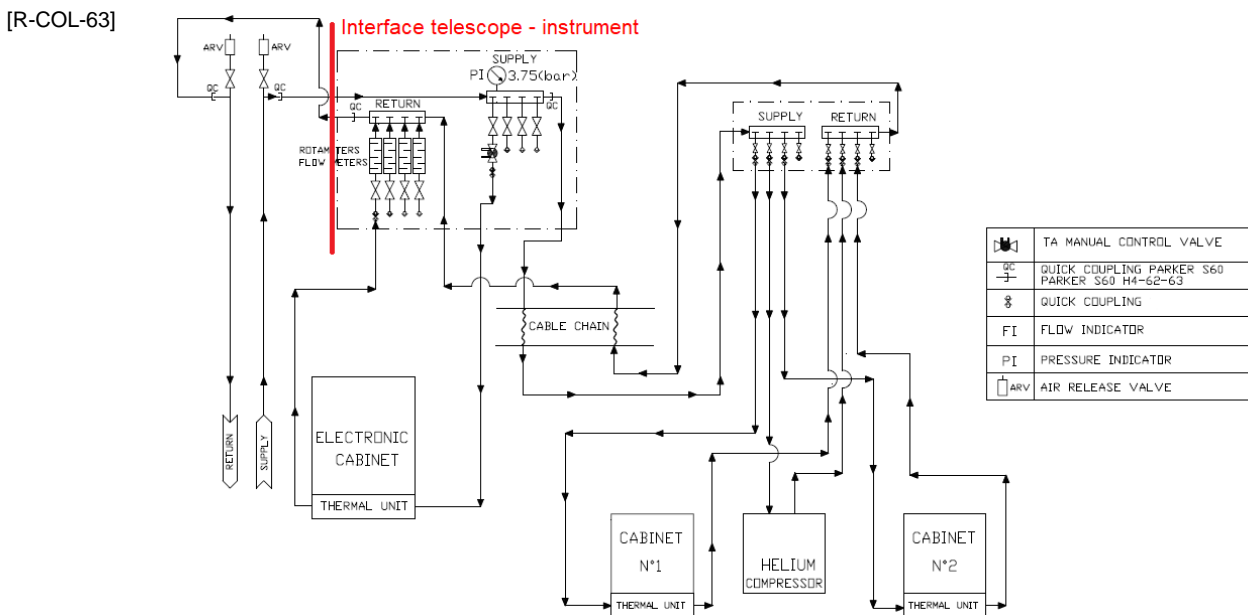


Figure 1: P&I diagram of a typical instrument cooling circuit

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

[R-COL-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.

[R-COL-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.

[R-COL-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.



[R-COL-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

[R-COL-70] The circuits shall be designed for the required maximum working pressure and the components shall be selected accordingly.

Definition:

The Maximum Working Pressure is the highest pressure which can occur during normal operation in the cooling circuit during its lifetime.

[R-COL-71] Metallic components, tubes and fittings shall withstand a test pressure of a factor of 1.2 higher than the maximum working pressure.

[R-COL-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.

[R-COL-73] Elastomeric or plastic components such as hoses shall have a test pressure of a factor of 1.5 higher than maximum working pressure.

[R-COL-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.

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

[R-COL-76] A cooling circuit layout drawing shall be part of the documentation, see chapter 9.

[R-COL-77] The design parameters for the cooling circuit design shall comply with the corresponding ICD of the telescope.

In Table 1 the Maximum Working Pressures for selected cooling systems are listed.



[R-COL-286]

Cooling system	Maximum Working Pressure
VLT UT	10 bar
VLT AT	4 bar
VLTI	10 bar
VISTA	8 bar
VST	8 bar
ELT	10 bar *

Table 1: Maximum working Pressures for selected cooling systems

*) this value is valid for the complete ELT except the connections to the cooling system in the telescope pier. In particular the following rooms are affected:

- Telescope Supply Room,
- Coudé Auxiliary Rooms 01 and 02
- Coudé Rooms 01 and 02.

For these connections the maximum working pressure is 11 bar because of its low altitude position inside the telescope.

[R-COL-78] List of design parameters with examples:

- Interface (hose, pipe, quick coupling...)
- Interface diameter (1/2" pipe, 3/8" quick coupling...)
- Maximum 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...)

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

[R-COL-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

- [R-COL-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
- [R-COL-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.
- [R-COL-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
- [R-COL-85] The possibility to install a spare circuit is highly recommended.
- [R-COL-86] **It is not allowed to connect cooling fluid consumers to the telescope without a possibility to balance the flow.**
- [R-COL-87] All lines shall be labelled. The return and supply lines shall be clearly identified.
- [R-COL-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.

[R-COL-89]

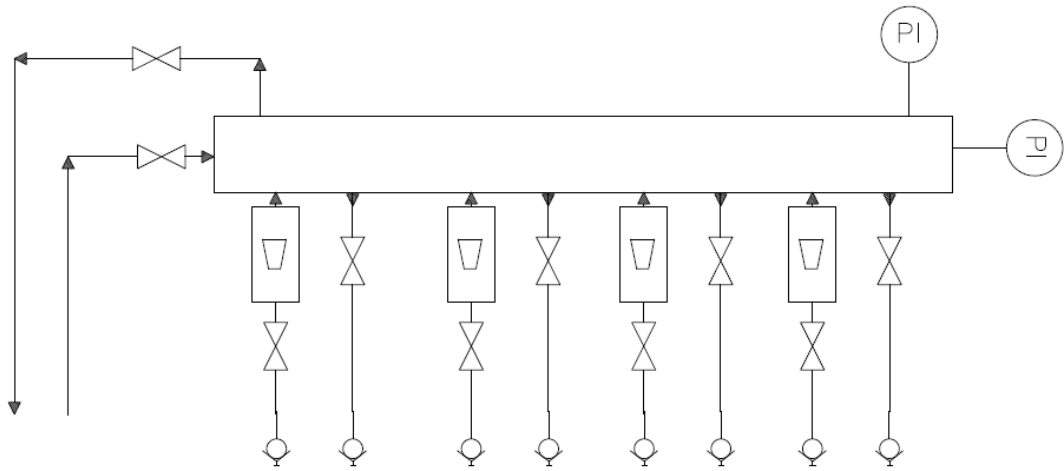


Figure 2: example of a cooling fluid circuit schematic using a MAGRA manifold, see chapter 5.2

4.4 Design of temperature controlled circuits

- [R-COL-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.
- [R-COL-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.
- [R-COL-94] If there is a technical need to make use of a 3-way-valve the decision shall be assessed in cooperation with ESO.
- [R-COL-95]

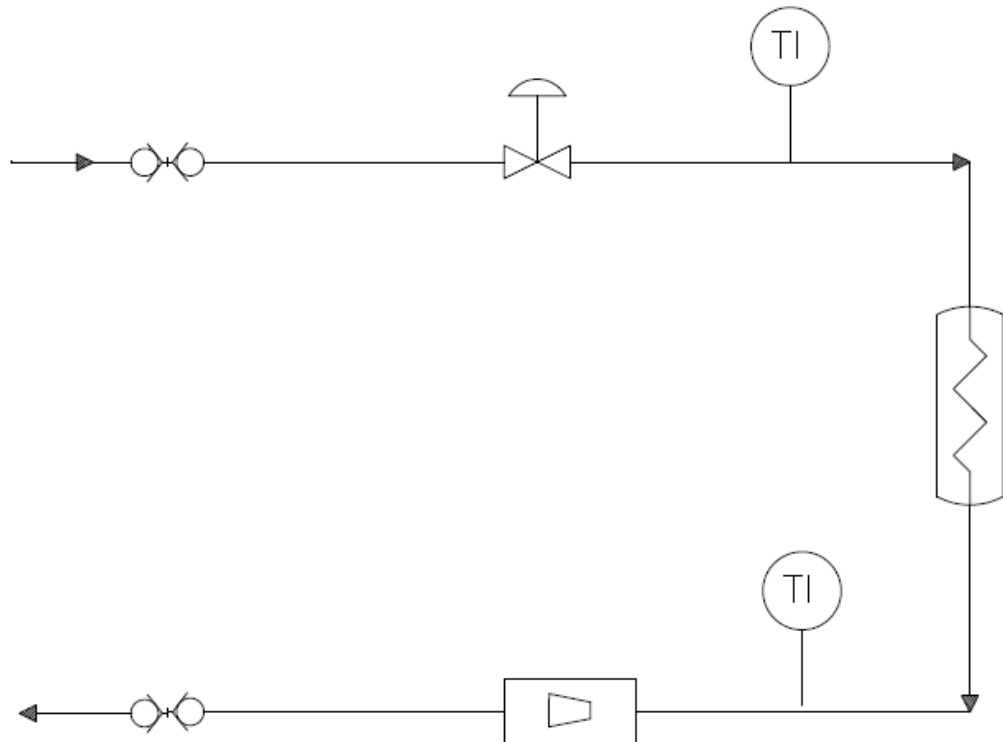


Figure 4: example of a temperature control via controlled cooling fluid flow



5. Main Components

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

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

[R-COL-99] Specific requirements for each components are in the following chapters.

[R-COL-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 maximum working pressure than 10 Bar.

Components which are not listed shall be approved by ESO.

5.1 Piping work

[R-COL-102] This standard covers rigid tubes and flexible hoses.

5.1.1 Rigid Tube

5.1.1.1 Dimensional requirements

[R-COL-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

[R-COL-106] The pressure resistance shall be a minimum factor of 1.2 higher than the maximum working pressure, defined in the relevant ICD.



5.1.1.2 Materials

[R-COL-108] Seamless fully annealed stainless steel shall be used. The tubing shall be suitable for bending. Bending work is acceptable as long as it is done adequately. The following grades covered in AD3 or of higher-grade can be used:

EN	ASTM
1.4306	304L
1.4401	316
1.4404	316L

[R-COL-109] At the time of writing RD1 and RD2 brands meet the above requirements.

5.1.2 Tube fittings

[R-COL-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.

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

[R-COL-113] • Dimensions of unions shall be in millimetres.

[R-COL-114] • Threads for fittings shall meet AD1

[R-COL-115] • Tools for installation of compression fittings are not available at Paranal

5.1.3 Hoses

5.1.3.1 General Purpose Hoses

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

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

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

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

[R-COL-119] The three series of hoses and end fittings are interchangeable.

[R-COL-120] Only push-on hose connection shall be used.

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

[R-COL-122] **Comment:**

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

[R-COL-123] A regular inspection of the hoses shall be added to the maintenance manual.

[R-COL-124] To minimise maintenance the use of hoses shall be minimised where ever it is possible.

5.1.3.2 Special Tools

[R-COL-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

[R-COL-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

[R-COL-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.

[R-COL-130]

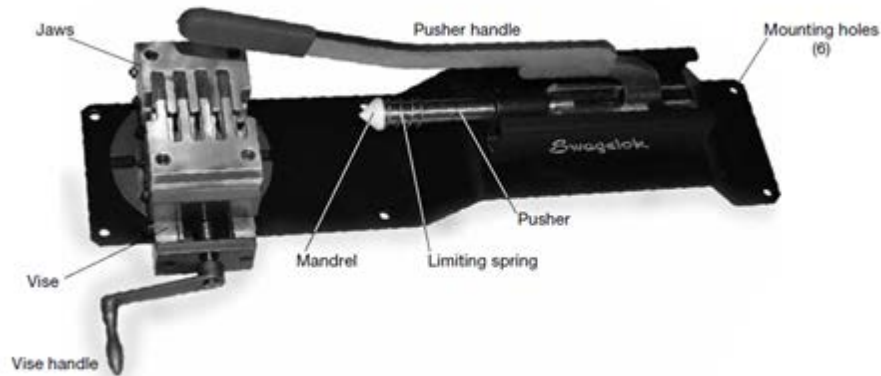


Figure 5: Swagelok push-on tool



5.1.3.2.2 Tools for rigid pipes

[R-COL-132] The following tools in RD9 or equivalent can be used:

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

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

[R-COL-135] Armacell elastomeric insulation for pipes (RD10) shall be used for hoses and tubes insulation.

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

5.2 Distribution Manifolds

[R-COL-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.

[R-COL-139] Parker manifolds (RD11) and Smartflow manifolds (RD12) meet the above requirements.

[R-COL-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.

[R-COL-141] Material: stainless steel

[R-COL-142] Thread connection: infrastructure side: IN / OUT: 1" NPT; consumer side: in / out 1/2" NPT

[R-COL-143] Quantity of connections: 2 IN / 2 OUT; 4 (or 6) in / 4 (or 6) out



[R-COL-144]



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

[R-COL-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

[R-COL-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 maximum working pressure, see relevant ICD.

[R-COL-149] Apollo (RD13), Fitok or Genebre (RD14) meet the above requirements.



5.3.2 Flow regulation and measuring valves

[R-COL-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.

[R-COL-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

[R-COL-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.

[R-COL-155] The valve end connection shall be NPT (AD1) or a compression fitting.

[R-COL-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

[R-COL-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

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

5.3.4.1 Flow Control

[R-COL-162] • Bürkert 2836 2/2 way solenoid control valve shall be used. They shall be of stainless steel with FKM seal material (see RD22)

5.3.4.2 Open-Close valve

[R-COL-164] • Bürkert 6213 2/2 way shall be used. They shall be of stainless steel with FKM seal material (see RD23)

5.3.4.3 For temperature controlling

[R-COL-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 RD34 & RD33) and the cable ASY23L100HF (Siemens nr. S55174-A136) or to purchase the version including cable if it is long enough for the application.

[R-COL-168] This type of actuator is very reliable and allows operation in all orientations. The cable is halogen free.

[R-COL-170]



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

[R-COL-171] See chapter 4.4 (electronic cabinet temperature controlling)



[R-COL-172] **Comment:**

Valves from Heimeier shall not be used 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.

[R-COL-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

[R-COL-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.

[R-COL-176] The filter cartridge shall be Micro-Klean III 20" long for a nominal 10 μ m particle (see RD25).

[R-COL-177]



Figure 8: filter pair installed at Paranal

5.5 Sensors

[R-COL-179] This chapters refers to temperature, pressure and flow sensors and flow meters.

[R-COL-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:

[R-COL-183] KOBOLD SEN-8730B085 with the following details:

Body material: Stainless Steel

Thread connection: BSP G ¼"

Pressure range: 0 – 16 bar

5.5.1.2 For visualisation:

[R-COL-185] Pressure gauge with pressure range 0- 16 Bar (app.)

[R-COL-186] Connection thread ¼" NPT or ½" NPT

[R-COL-187] Material: Stainless Steel

[R-COL-188]



Figure 9: Example WIKA 68124315

5.5.2 Temperature sensors

5.5.2.1 For digital signal:

[R-COL-191] KOBOLD TDA series with the following details:

[R-COL-192] Body material: Stainless Steel

[R-COL-193] Thread connection: NPT male

[R-COL-194] Temperature display (if any): °C

5.5.2.2 For analog signal:

[R-COL-196] PT100 pipe sensor

[R-COL-197]



Figure 10: Example Sensorshop24 and POLLIN 180029

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

[R-COL-199] No exact type of sensor is prescribed.

5.5.2.3 For visualisation:

[R-COL-201] Bimetal temperature sensor

[R-COL-202] Connection thread ¼" or ½" NPT

[R-COL-203] Material: Stainless Steel

[R-COL-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

[R-COL-207] KOBOLD VKG series with the following details:

[R-COL-208] Body material: Stainless Steel

[R-COL-209] Thread connection: NPT

[R-COL-210] Installation orientation: any

[R-COL-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.

[R-COL-212]



Figure 12: KOBOLD VKG flow meter (viscosity compensated)

[R-COL-213] **Comment:**

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

[R-COL-214] Only for the use in European laboratories, not in Chile, the flowmeters from TACONOVA Tacosetter are recommended.

[R-COL-215] Body material: brass

[R-COL-216] Thread connection: BSP

[R-COL-217]



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

5.5.3.2 Flow meters with a digital display and signal output

[R-COL-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, 1x analogue signal, 1x IO-link

Or

IFM SM6004 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, 2x analogue signal

If a higher flow is needed the following flow meter shall be used:

IFM SM7000 Magnetic-inductive flow meter / 0,2...50 l/min / resolution 0,1 l/min / ¾" BSP thread / including temperature sensor -20 to 80 °C, Pmax 16 bar, 1x analogue signal, 1x IO-link

Or

IFM SM7004 Magnetic-inductive flow meter / 0,2...50 l/min / resolution 0,1 l/min / ¾" BSP thread / including temperature sensor -20 to 80 °C, Pmax 16 bar, 2x analogue signal.

[R-COL-287] **Comment:**

The maximum length of a IO-link connection is 20 m. If this is not sufficient or no IO-link is available the device without IO-link should be chosen.

[R-COL-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, including check-valve functionality.

[R-COL-221]



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

[R-COL-222] **Comment:**

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

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

5.5.4 Leakage sensor

[R-COL-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.

[R-COL-230] It is recommended to make use of the following leakage sensors:

- OMRON K7L Series

[R-COL-231]

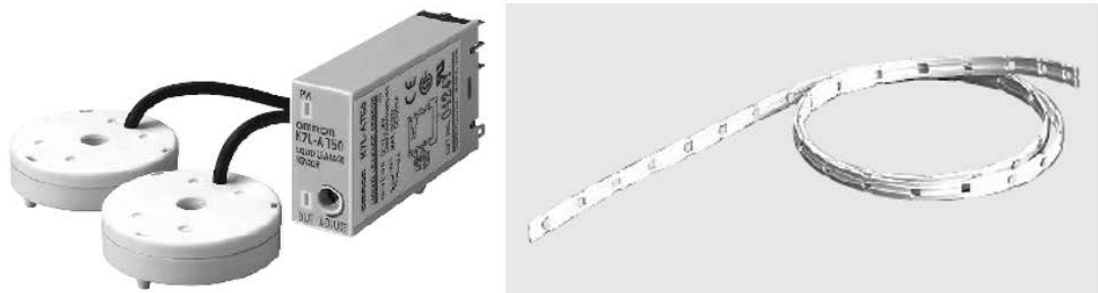


Figure 16: OMRON point and surface leakage sensor

[R-COL-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

[R-COL-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".

[R-COL-235] Sealing must be suitable for cooling water with 35% glycol like for example EPDM or VITON.

[R-COL-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

[R-COL-237]



Figure 17: Example RECTUS 73 KB stainless steel 3/4" NPT

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

[R-COL-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 always tight connection operation, low spill during connection and a slim form factor. The thread gender needs to be chosen according to the use case.

[R-COL-240]



Figure 18: alternative quick coupling STÄUBLI RME 09

[R-COL-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

[R-COL-241] The use of CPC quick couplings shall be avoided because of a lack of quality and reliability.

[R-COL-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.

[R-COL-243] **Clarification:**

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

5.7 Fittings

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

[R-COL-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

[R-COL-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).

[R-COL-249]

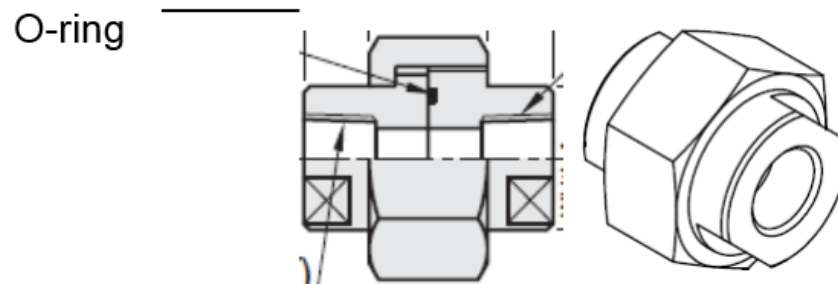


Figure 19: union with O-ring

5.9 Coolant

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

[R-COL-252] Additional anticorrosion and biocide additives are needed.

[R-COL-253] The correct concentration shall be monitored annual.
The cooling fluid needs to be clean and transparent.

[R-COL-254] The pH value shall be monitored and must be between 7 – 9.

[R-COL-255] Parameters like pressure and temperature ranges are given in the related ICD.



6. Other components

6.1 Thread sealants

[R-COL-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.

[R-COL-259] To bond plastic-plastic or plastic-metal fitting connection LOCTITE 5331 shall be used.

7. Circuit Cleanliness

[R-COL-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.

[R-COL-263] If there are specifications on the cleanliness given in the relevant ICD the ICD overrules this chapter.

8. Circuit Leak Testing

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

[R-COL-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 $\pm 3\%$ 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.

- [R-COL-267] ii. A hydraulic leak test according to DIN EN 806-4 shall verify the tightness of the system. The standard cooling fluid shall be used to avoid circuit contamination. The system shall be able to maintain the maximum working pressure * 1.1 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 maximum working pressure is given in the relevant ICD or in Table 1.
- [R-COL-268] iii. The leak test procedure and parameters used and the test results shall be documented in a test report.

9. Documentation

- [R-COL-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.
- [R-COL-271] To ensure an efficient troubleshooting one P&I diagram shall be placed at the SCP.

10. Waiver to the standard

- [R-COL-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.



11. Examples

11.1 Purchase list cooling fluid distribution panel

[R-COL-276] Please find below an example for a purchase list for a cooling fluid distribution panel. All threads are NPT. This list is only an example:

description	thread	producer	part number producer	vendor	part number vendor	quantity	cost /pc. €
<i>hose for panel connection:</i>							
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
<i>hose instrument side</i>							
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
<i>sensors</i>							
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
<i>manifold</i>							
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 x 1 Male NPT SS	NPT	FITOK	SS-PSE-NS8-NS16	HPS	SS-PSE-NS8-NS16	2	67.26
<i>instrument side</i>							



Standard Components and Guidelines for Cooling Circuits

Doc. Number: ESO-254314

Doc. Version: 6

Released on: 2021-11-09

Page: 35 of 37

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 x 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 x 3/8 Male NPT SS	NPT	FITOK	SS-PHN-NS8-NS6	HPS	SS-PHN-NS8-NS6	6	8.07
<i>NGC & TMP & small electronic & APD rack</i>							
Female Elbow, 3/8 Female NPT x 3/8 Female NPT SS	NPT	FITOK	SS-PE-NS6	HPS	SS-PE-NS6	4	16.60
Hex Coupling 3/8 Female NPT x 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

[R-COL-278]

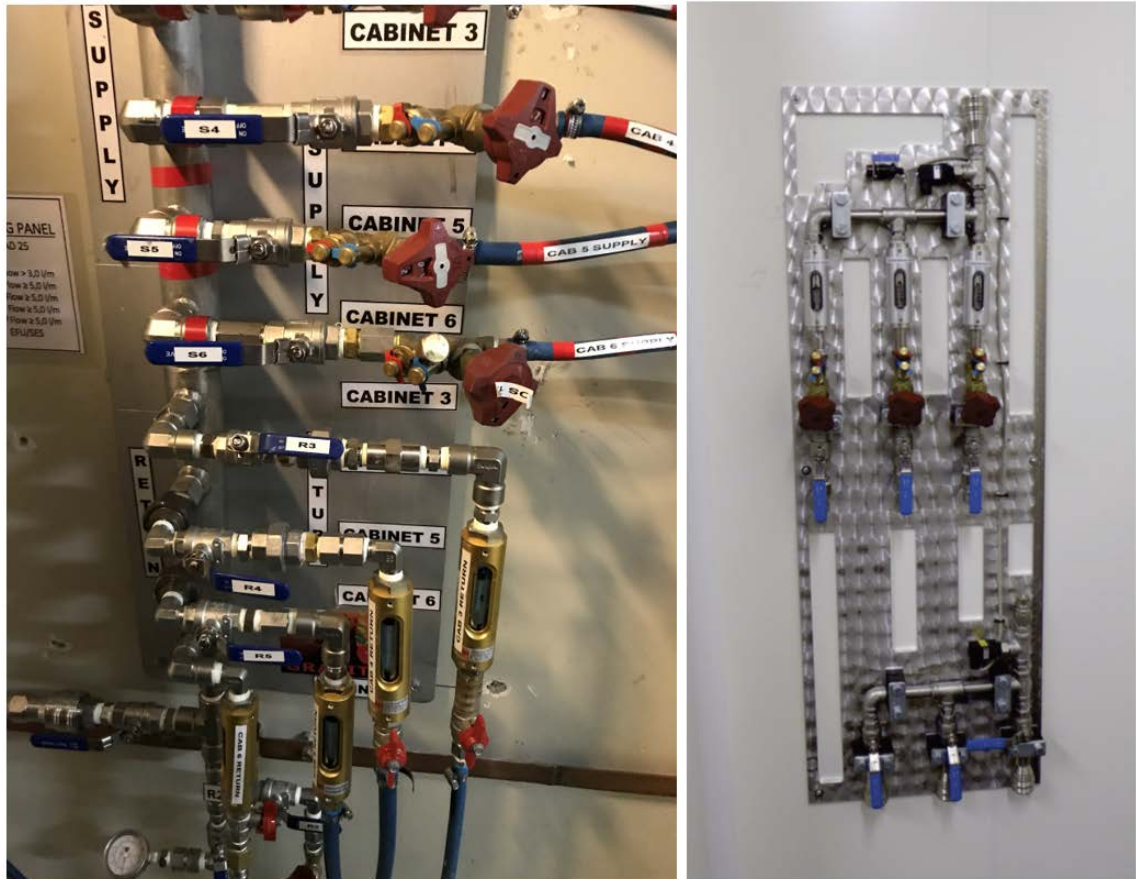


Figure 20: examples of cooling fluid distribution panels in VLTI Lab

11.3 Example PLC control

[R-COL-280]

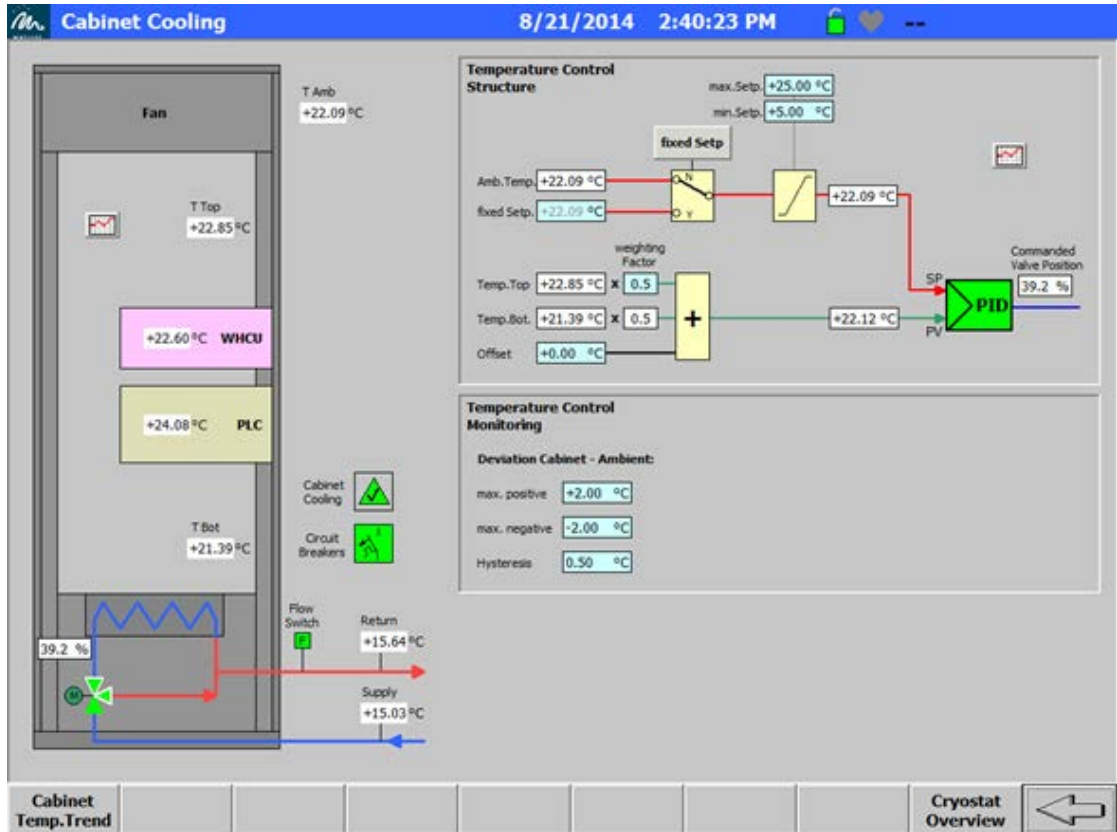


Figure 21: elect. cabinet temperature control via SIEMENS PLC

[R-COL-281] --- End of document ---