Technical Definition - Draft

FULL SCALE TEST

FOR ATLAS CALORIMETER

MONOPHASE COOLING SYSTEMS

Abstract

The cooling systems of the drawers and of the front-end electronic crates in the ATLAS Tile and LAr calorimeters are foreseen to operate with water at sub-atmospheric pressure, using the so-called Leakless Cooling System v.2. Though this system is already running in many experiments at CERN and outside, the huge dimension of ATLAS and severe environment (inaccessible, high radiation, magnetic field) call for a full-scale demonstrator in order to check our calculations, to test the selected components and to develop the control system.

This paper lists the different aspect of the test, describes the foreseen layout in Building 185 and gives a technical description of all the components. It also includes a financial report.

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Distribution List

ATLAS TC mailing list
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History of Changes

Rev. No.	*Date*	*Pages*	*Description of changes*
1	24/07/2001	1	Names added in “Checked by” and “ Approved by” positions.
1	24/07/2001	5	2.1 - Reference for “ Pressure drop calculations and assumption” added.
1	24/07/2001	5	2.6 - Location of LV power supply heat sinks added.
1	24/07/2001	5 and 14	2.7 - Paragraph suppressed. One comment added in paragraph 11.
1	24/07/2001	7	4.3 - Design flows shown on the … “shown” added.
1	24/07/2001	8	4.5 - Comment on magnetic test of the pump added.
1	24/07/2001	10	5.1 - “July” changed to “summer”.
1	24/07/2001	10	5.3 - DCS equipment can be used… “be” added.
1	24/07/2001	11	6 - Comment on influence of ambient temperature on cooling water temperature added.
1	24/07/2001	11	7 - Comment on Prague’s cooling screens added.
1	24/07/2001	12 and 13	8.1 – Scaffolding provided by DELPHI, not ALEPH.
1	24/07/2001	13	8.1 – Header of table repeated at top of page.
1	24/07/2001	14	9 – Magnetic field test requirement modified

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1 Objectives

The cooling systems of the drawers and of the front-end electronic crates in the ATLAS Tile and LAr calorimeters are foreseen to operate with water at sub-atmospheric pressure, using the so-called Leakless Cooling System version 2. Although this system is already running in many experiments at CERN and outside, the huge dimension of ATLAS and severe environment (inaccessible, high radiation, magnetic field) call for a full-scale demonstrator in order to check our calculations, to test the selected components and to develop the control systems. This test will be essential in view to prepare the market surveys and the tendering documents for the final systems in ATLAS. It is part of the Work package 1 in the document ATLAS Cooling projects.

2 Scope of the test

2.1 Liquid system:

The design of the system is done according to the joined document "LCS v.2 - Pressure drop calculations and assumptions – Annexes 2 – Drawings & Notes" and some parameters or sequences have to be checked:

Dimension of the return pipe and regime of the flow --> pressure drop.

Draining of air at start.

Draining of fluid at stop.

Pressure control system.

2.2 Overall automatic control of the system

Definition, programmation, test and integration of the different control systems, active and passive: PLC, PID Controllers, SCADA, ATLAS ELMB, and Interlock for the alarms.

2.3 Safety

Relief valves

Definition of all the necessary alarms.

Failure mode and effect analysis.

Definition and test of an online analysis system to control the quality of the fluid (water).

Control of the corrosion.

Alert handling within the SCADA Application.

2.4 Material

All the components have to be tested in the real conditions:

-On the full scale demonstrator.

-In magnetic field for sensible components

-Approved radiation resistant.

2.5 Heating system for the Tile Drawer

All TileCal modules will be calibrated at the same temperature. The same thermal conditions must be verified in ATLAS. A system of heaters (R&D developped by Clermont-Ferrand) is thus forseen to compensate for the temperature gradient in the cavern.

2.6 Cooling of the LV Power supply

The Tile Drawers are powered by Low Voltage power supplies located in the Tile Fingers. These power supplies are cooled by means of water circulating heatsinks. These heatsinks are connected in series at the outlet of the hydraulic circuit of the Tile Drawers.

3 Layout of the hydraulic test

3.1 LCS v.2 operating principle

The liquid is held in a storage tank (3) maintained below atmospheric pressure by a vacuum pump (2). A check valve (5) discharges any excess air in the event of drainage and prevents the pressure in the storage tank from rising above atmospheric pressure. The liquid is moved into the exchangers (1) incorporated through the electronic system by a circulator (4).

The pressure at the various points of the circuit depends on the head losses and hydrostatic pressures.

At start-up, if the pressure in the storage tank is not low enough the vacuum pump is activated. While the later is in operation, in the event of an air intake for instance, the circulator cannot run. The pressure throughout the circuit still equal to the pressure in the storage tank.

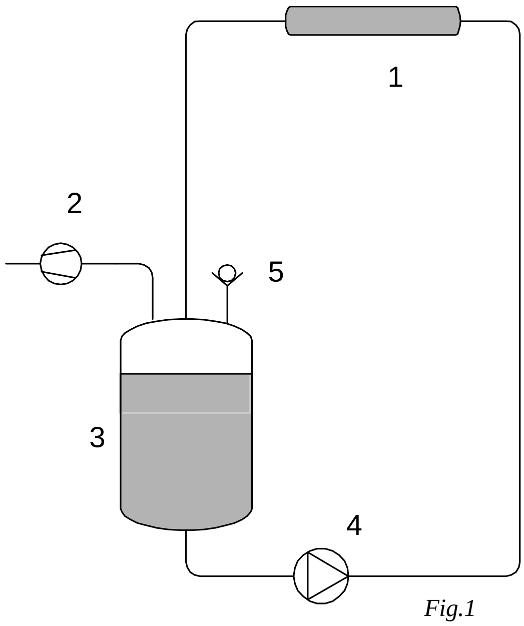


Fig.1

3.2 Foreseen layout in UX15

Drawings 186.5.08, 186.5.09, 186.9.18 and 186.9.20 show the current layout of the cooling systems and their piping for the ATLAS Calorimeters -LAr and Tile - in UX15. The cooling stations, consisting of the tank, circulator, heat exchanger and pneumatic pressure regulators are located on the floor of the cavern. The pipes can go up to ~ 15 m to distribute the liquid in the heat exchangers on the electronics. The detectors are divided in 6 sectors with the aim to have a pressure head of 2 to 3m in each sector. Each sector has a pressure transmitter and an isolating valve and will feed 8 or 12 drawers for the tile calorimeter and 2 or 3 crates for the LAr calorimeter.

According to the LCS v.2 principle, the overpressure (1 to 2 bar) will be limited to the inlet pipes, from the pump at the cooling station to the arrival in the corresponding sector. The distribution lines in the sectors, the heat exchangers in the electronics and the return pipes will run in sub-atmospheric mode (0 to -700 mbar).

3.3 Layout in building 185

Figure 186.10.01 shows the layout of the demonstrator in Building 185. The total height, the level differences and the distances between the simulating heat exchangers are similar to those planned in UX15.

The cooling unit with all its components is described in Figure 186.10.02. Note that there is not any heat exchanger, as it is not planned to have heat exchange in this test.

4 Description of the key components

This chapter concerns only the hydraulic part of the test.

All the components are selected from known industrial solutions with the objective of:

The quality of selected materials.

The compliance with international standards.

The reliability of components in motion.

The long term product policy and spare parts availability.

4.1 Pneumatic ball valve

(Item 10, 29, 32 in Figures 186.10.01 & 186.10.02)

Bleeding liquid in the circuit as well as draining of air from the circuit are the most delicate sequences in the cooling system, not speaking of the leak test. In this way it is very comfortable to separate the large circuit in smaller circuit with isolating valve.

As one can see on the layout of the test we put isolating valve on each line at the departure and on the return on the cooling unit and also on the inlet and outlet on the platform. These valves are remote controlled by the PLC via pneumatic distributor. We are aware that space is very critical inside the detector so we choose for the latest a special space saving in line design valve.

So, on the cooling unit the valves are pneumatic spring return actuate with a positioner to return a position signal, common standard in the industry.

Short description of El-O-Matic actuator is given in Annexes.

The special on line valves are HP220X series from Danfoss. Technical data is given in Annexes.

4.2 Thermal flowmeter

(Item 11 in Figure 186.10.01)

Flowmeter is always one of the main request from users of cooling system in term of control as when a problem arise with the temperature on the electronics one wants to be sure that the liquid is circulating in the heat exchangers.

Common flowmeter like turbine is already about 500 CHF / line and is not resistant to magnetic field. Massflowmeter, Ultrasonic or Coriolis flowmeters cost at least 2,000 CHF / line so we cannot afford them.

We have at ST/CV already developed low cost thermal flowmeter for gases based on Pt100 and PLC algorithms. Preliminary tests on liquid show that it could be possible to apply the same principle to liquids but there is a lot of development to do. This development is part of the plans for the future.

4.3 Balancing valve

(Item 12 in Figure 186.10.01)

Design flows shown on the pipe drawings must be confirmed experimentally. To obtain the required flows in the heat exchangers at different height level, they must be measured in real conditions and adjusted.

TA Hydronics STAD balancing valves and the CBI^{II} balancing instrument are designed for pre-setting of flow, flow measuring and pressure reading.

Technical description of the STAD is in Annexes as well as the CBI^{II}.

4.4 Pressure transmitter & pressure switch

(Item 13, 22, 26 in Figures 186.10.01 & 186.10.02)

We have been using these components from Huba Control for a long time without any special problem. The 691 series uses ceramic technology and has gone through severe electromagnetic tests.

Dimension problems could appear since we need these sensors inside the detector. The various plastic and elastomere must be radiation compliant.

Operating instructions and electromagnetic compatibility are in Annexes.

4.5 Pump

(Item 24 in Figure 186.10.02)

We know by experience that the leakage in shaft seal is the main failure of the conventional circulators. This failure would be catastrophic in UX15 during run period so we choose magnetic drive pump to avoid this problem.

We need for the test 4 m3/h @ 4 bar. We already use Iwaki pump for small application and have a Sanwa pump that will be tested on a fluorocarbon circuit for the TRT.

So the aim is to test a KSB Multimagno pump with the characteristics described in Annexes.

This component will be certified under magnetic field condition as described in Chapter 9.

4.6 Differential pressure regulator

(Item 28 in Figure 186.10.02)

A circuit with its pump is designed for an operating flow at an operating pressure but it happens in many cases that the whole circuit is not running, so one has to adapt the flow. We usually do this by controlling the pump speed via a frequency variator or inverter. Due to the severe electromagnetic environment in UX15, we prefer to use a pure mechanical system; a differential pressure regulator will run as a discharge valve in order to maintain a constant pressure drop in the circuit.

We have a short description of the SART 5362 series in Annexes.

4.7 Multilayer "Mepla" tube

(Item 33, 34, and 35 in Figure 186.10.02)

The multilayer tube has become a standard in the cooling and heating installation as it combines the advantages of plastic polyethylene and aluminium:

- Internally and externally corrosion resistant
- Can be manually bent many times, the shape remains the same
- Extremely resistant to atmospheric agents
- Extremely resistant to ageing
- Not sensitive to stray current
- Very light and easy to install
- Easy to connect, without threading and welding. Compression or crimp fitting.

One has to be sure that the tube is acceptable regarding radiation.

Technical characteristics are in Annexes.

4.8 Pneumatic control valve & converter

(Item 38, 39 in Figure 186.10.02)

The principle of the LCS v.2 is to adjust the inlet pressure in the heat exchangers inside the electronics just below the atmospheric pressure. To minimise the effect of height difference the detector is divided in sectors regarding the maximum height of 3m (see final layout in UX15). That's why we have 3 platforms in the test. Due to the lack of space inside the detector each sector has its inlet line controlled by a valve directly at the departure on the cooling unit. This valve will be pneumatic actuated by a PID controller via an E->P converter. The pressure signal comes from a pressure sensor fitted at the lowest point of each sector. This material is a standard in the Building heating installations.

Technical characteristics of Sauter pneumatic valve drive AV42, control valve V6R and E-P converter are in Annexes.

4.9 Pressure controller

(Item 40 in Figure 186.10.02)

To actuate the pressure control valve from the pressure transmitter we need a process tool.

We will start the test with our standard PID auto-tuning controller REX-G9 from RCK, which we know, works very well. It is accurate at the 0.1% level, multi-area with contact input and provides remote set point, retransmission output and serial communication.

Next step will be the use of a special PID algorithm directly on the PLC. This solution will be much cheaper but needs a lot of development.

Technical characteristics of the REX-G9 are in Annexes.

4.10 P.L.C.

(Item 41 in Figure 186.10.02)

A PLC is a component used for industrial controls. The structure of a PLC is that of a computer; it consists of a Central Processing Unit (CPU), a memory, input/output modules and an internal bus. The peripherals and the programming are conceived to be adapted to industrial process control. The functions implemented by a PLC are written in the form of programs stored in memory. A PLC receives input signals from process equipment to be controlled (switches, sensors), processes them according to a precise model defined by programs and provides output signals to the process equipment such as relays, Motor starters, etc...

Schneider and Siemens provide the 2 supported solutions at CERN and our group is used to work with the Schneider Premium PLC.

Recommendations for the use of PLCs at CERN from the Working Group on Programmable Logic Controllers are in Annexes.

4.11 Water treatment & control

(Item 42, 43 in Figure 186.10.02)

The heat exchangers and the cooling screens inside the electronics are planned to be in Aluminium and we know by experience that the corrosion is a big concern in such a circuit. We thus decided to use simple demineralized water (around 0.5/1 µS/cm). The level will be controlled by a transmitter and a secondary circuit going through resin filter.

The corrosion rate can be analysed by spectroscopy and electrochemical analysis on water sample at regular intervals that have to be determined.

An example of a conductivity transmitter is in Annexes with the Burkert Digital inductive conductivity transmitter type 8226.

4.12 Tank liquid level transmitter

(Item 44 in Figure 186.10.02)

Like for the flowmeter this component is very critical considering the fact that the common standard in the industry is not magnetic resistant. Nevertheless this is an important device for safety in our system as a continuous control of the liquid level in the storage tank allows the detection of leak or failure in the piping. The aim is to test an alternative solution, e.g. a capacitive probe with demineralized water in order to check its relevance.

Technical description of the Burkert RF Capacitance level transmitter type 8100 is in Annexes.

5 Monitoring of the Cooling System

The purpose is to provide the needed tools to monitor the running parameters of the cooling system (e.g. water temperature, flows, pressure and water analysis) and the operation conditions of the Tilecal modules (temperature of the electronics inside the drawers).

The monitoring will be implemented using the standard ATLAS Detector Control System (DCS) tools, in terms of both, software (SW), using PVSS-II and hardware (HW), using the ATLAS Embedded Local Monitor Box (ELMB).

PVSS-II is a commercial software package chosen by the Joint Controls Project (JCOP) at CERN to implement the DCS of the four LHC experiments. The ELMB is a key element in the implementation of the FE of the ATLAS subdetectors. It is a IO concentrator called to provide standardisation amongst the different subdetectors, flexibility and keeping a low cost per channel. The estimate is of about 5000 ELMB nodes in the final installation of the ATLAS experiment.

The monitoring of the Tilecal cooling pilot project will be carried by the DCS group and Tilecal DCS group from Clermont Ferrand. The activity can be divided in three different tasks:

5.1 Monitoring of the Cooling System of the Tilecal modules calibration in building 185

This system will be used to calibrate the totality of the modules with a cesium source. In this calibration, one transfer line of the cooling system will be instrumented with 6 NTC probes and one differential pressure meter, that will measure the temperature and pressure differences of the cooling liquid along the cooling pipes as well as the temperature of the Low Voltage (LV) system. These sensors and the status of the different devices (vacuum pump, circulator, flowmeter, etc) composing the cooling unit will be read by an ELMB. This node will be interfaced to PVSS by means of the ATLAS CANopen OPC Server. This application will also interface to the HV Control application (implemented in Labview by the Tilecal group from Clermont-Ferrand) via DLL[1], in order to read the temperatures inside the drawers measured by the HV system.

What follows lists the different components need for this activity:

- A Windows NT (SP4) PC with 128 MB of RAM running PVSS-II (Provided by Tilecal).
- A National Instruments (NICAN-II) interface card (~1400 CHF provided by Tilecal).
- ATLAS CANopen OPC Server (Provided by DCS).
- ATLAS ELMB and Motherboard (250 + 150 CHF Provided by DCS).
- NTC sensors (Provided by ST/CV).
- 1 pressure meter (Provided by ST/CV)

This activity started in December 2000 with the preparation of the cabling (Clermont-Ferrand), and signal adapters needed for the ELMB and sensors (DCS). The assembling of the cooling pipes, calibration of the temperature probes and the final version of the PVSS-II SW are expected to be ready April 2001.

The application will be extended to monitor the cooling system during the calibration of 12% of the modules in SPS/H8 beam line in Summer 2001 where six super-drawers will be cooled down and the monitoring of each of the six cooling pipes is needed.

5.2 Monitoring of the Real Size Hydraulic test described in this document

The control of the cooling will be performed by a Schneider Programmable Logical Controller (PLC), see figure 186.10.01. A special PVSS application will be developed with the purpose of interfacing the PLC by means of a Schneider OPC[2] server in order to visualise and store system parameters and status. No additional HW equipment is needed for this application. The ST/CV group must specify which parameters must be exchanged with the PVSS application. Both, Schneider PLC and OPC server are not yet available. The estimated time scale for this activity is second half of 2001.

5.3 Monitoring in Magnetic and Radiation Test

The aim of the DCS team is to make the ELMB usable for the MDT subdetector, implying operability in presence of magnetic field and radiation. It has been already proven that the ELMB could access sensor and actuators by means of cables up to 30 m long. This will give the possibility of placing the ELMB wherever the radiation magnetic tolerance limits allow it and access signals of the Tile Calorimeter.

The previous generation of the ELMB modules, LMB has been satisfactory tested for a magnetic field of 1 T. The electronics used in the current implementation of the ELMB is the same and hence, the same quota looks achievable. Several radiation tests with the ELMB are ongoing and a final qualification of the modules, according to the ATLAS radiation tolerance rules, is expected by the end of 2001.

DCS equipment can be used in both, final implementation of the monitoring of the cooling of the Tilecal detector and assisting the ST/CV group during testing of the equipment employed in the system. In the latter case, the ST/CV group must define the equipment (e.g. sensor, actuator, electronics), parameters to monitor (voltages, current, temperatures, status) and timescale.

[1] Dynamic Link Library
[2] OPC stands for OLE for Process Control.

6 Heating system for the Tile drawers

A stable temperature inside the TileCal drawers is required for many reasons (stability of the electronics; gain stability of the PMTs - the variation gain for the tubes used in the TileCal is about 0.2% per °C and the goal is to have a relative gain variation no bigger than 0.5%; on the PMT test benches, characteristics are evaluated at a precise temperature; the TileCal modules calibration: each module will be calibrated with ^{137}Cs at a common temperature). The same thermal conditions must be respected when the TileCal will be assembled so as to use calibration data for the correspondence current-energy.

In 2000 test beam data acquisition, using the LAr cooling station with long (50m + 50m) non-insulated pipe, it was observed a clear effect of ambient temperature ($\Delta T = 5$ between night and day) on the temperature inside the drawer ($\Delta T = 2$).

In 2001, with the new installed cooling station in Bd.185, 3 different lines (20m + 20m) will be connected:

- One with standard hose PVC Ø10-16mm.
- One with standard hose PVC Ø10-16mm fully insulated with Armaflex IT thickness 6mm.
- One made with multilayer pipe Ø11.5-16mm as foreseen in the test installation.

The variation on the temperature will be monitored as function of the ambient temperature for the different type of pipe. Full set of measurement will be available beginning of 2002.

As seen in Figure 186.9.20 and 186.9.18 the water distribution will be divided in 24 sectors, some including 8 drawers, others 12. The temperature is nonetheless not constant inside the detector: a +6°C gradient from top to bottom (19°C to 25°C) is expected [ATL-TC-ER-0012-00]. This induces variations on the water tubes that will feed each sector: the input and output temperatures of the water in the drawers vary from drawer to drawer, depending on its location. Since this feature disagrees with the previous points, it is proposed to use heaters to correct for the gradient temperature effect.

Clermont-Ferrand, now in charge of the cooling distribution circuit inside the drawers wishes to study this heater system (R&D phase). It would be made of:

- A heater; power: 1 kW (enough for a sector of 8 to 12 drawers). This kind of heater does not exist yet and will require a dedicated R&D phase
- A relay for the driving of the heater as well as cable (the orders on the relay will be applied from the ELMB).
- Temperature probes (four at upmost) to monitor the temperature along the tubes (monitored through the ELMB).
- A cooling unit (the existing unit made for the calibration in build. 185).
- Tubes to flow water (length to be defined)
- A PC to monitor the system (already exists for the cooling unit monitoring).
- A system to simulate the heat exchange of the drawers.

The estimated cost, in charge to Clermont-Ferrand, including the heater and the elements necessary for its inclusion in the hydraulic circuit, is (at upmost) 2500 CHF. The cable and the relay should in total cost less than 400 CHF. Including all other items should not exceed the 12000 CHF allocated to Clermont-Ferrand for this R&D phase.

7 Cooling of the Low Voltage power supply

The Tile Drawers are powered by Low Voltage power supplies located in the Tile Fingers. These power supplies are cooled by means of water circulating heatsinks. These heatsinks are connected in series in the hydraulic cooling circuit of the Tile Drawers, and is monitored by the drawers cooling slow control system.

The Finger Power Supplies are a currently under development by the Tile Collaboration. The technology used is targetted for radiation tolerance, which limits the efficiency to 70%. The maximum total power that must be supplied to a superdrawer is 320W (this incorporates all the safety factors).

Different kinds of heatsinks are being considered, and the final choice will depend on space constrains inside the finger. A default solution already used in the test beam runs is based on machined Aluminium heatsinks plates, 20mm thick, with circulating water. Alternative solutions are being considered, like flat Aluminium or stainless steel heatsinks with circulating water. The number of heatsinks per power supply will be one or two, depending on geometrical dimensions of the developped converters.

The cost of the power supplies cooling system and the space constraints are unknown at this stage of the development because a technology hasn’t been selected yet.

This being studied by the Prague and Barcelona teams and ST/CV group.

The first test with 6 heatsinks manufactured by Prague team will be done in Summer 2001.

8 Budget/Manpower.

8.1 Materials described in section 4.

Component	Supplier	Unit price	Qty	Price	Drawing	Item	Comment
Pneumatic on line valve HP 3/4" - spring return	Danfoss	345	6	2070	186.10.01	10	
Thermal flowmeter	CERN-ST/CV R&D	0	6	0	186.10.01	11	To be deve lopped
Balancing valve STAD1/2”F - Kvs 2.52	RIBAT	46.40	6	278	186.10.01	12	
Balancing Instrument TA Hydronics	RIBAT	4636	1	4636			Provided by ST/CV
Pressure transmitter -1/5 bar, 4-20mA	Huba Control	217.40	3	652.20	186.10.01	13	
Scaffolding from DELPHI	DELPHI Experiment				186.10.01	14	Provided by DELPHI
Tank stainless steel 750l	DEPOSITOS COBALLES SL	1773	1	1773	186.10.02	20	
Check valve 10mbar	40.10.30.106.3	75	1	75	186.10.02	21	
Pressostat -50/-600, Art.625.64301121	Huba Control	75.50	2	151	186.10.02	22	
Butterfly valve Lug DN50	Zurcher-Technik	152	1	152	186.10.02	23	
Magnetic drive pump 4m3/h @46m	KSB Zurich SA	7512	1	7512	186.10.02	24	
Stainless steel strainer 0.5 DN32	TECOFI	417	1	417	186.10.02	25	
Pressure transmitter -1/5 bar, 4-20mA	Huba Control	217.40	1	217.40	186.10.02	26	
Manometer blondelle ech.-1+5b, D100	22.41.21.300.9	80	1	80	186.10.02	27	
Diff.pressure regul. SART DN20	Zurcher-Technik	2637	1	2637	186.10.02	28	

Component	Supplier	Unit price	Qty	Price	Drawing	Item	Comment
Ball valve 316 - 3/4” with spring return pneumatic actuator and position indicator	Zurcher-Technik	270	3	810	186.10.02	29	
Ball valve brass 1”	40.40.64.216.6	19	3	57	186.10.02	30	
Sight flow indicator VCYL 39 S 1 1/8” ODF	Paulus AG	33.30	3	100	186.10.02	31	
Ball valve 316 - 1/2” with pneumatic spring return actuator and position indicator	Zurcher-Technik	250	4	1000	186.10.02	32	
Mepla tube Alu/PE Ø26/20	GEBERIT SA	7.95	150	1192.5	186.10.02	33	
Mepla tube Alu/PE Ø16/11.5	GEBERIT SA	4.05	100	405	186.10.02	34	
Mepla tube Alu/PE Ø20/15	GEBERIT SA	5.85	150	877.5	186.10.02	35	
Mepla fitting Ø16X1/2”	GEBERIT SA	18	10	180			
Mepla fitting Ø20X1/2”	GEBERIT SA	18	25	450			
Mepla fitting Ø26X3/4”	GEBERIT SA	21	20	420			
Mepla Te fitting Ø20X1/2”XØ20	GEBERIT SA	18	6	108			
Mepla Equal Te fitting Ø20	GEBERIT SA	18	10	180			
Mepla Equal Te fitting Ø26	GEBERIT SA	18	10	180			
Vacuum pump KNF N026 220v	KNF(CH) NEUBERGER	366.80	1	366.80	186.10.02	36	
Leakless control accessories	ST/CV stock	200	1	200			
Pneumatic distributor 3/2	BACHOFEN	140	3	1820	186.10.02	37	
Control valve V6R 1m3/h with pneum.actuator	SAUTER SA	533.70	3	1601.1	186.10.02	38	
Converter E->P XEP 4-20mA	SAUTER SA	311.40	3	934.20	186.10.02	39	
Regulateur REX G9 4/20,3al,cons.ext.	Thermotronic AG - VOGTLIN	1630	3	4890	186.10.02	40	
PLC Premium, 16 Analog, 32 TOR	SCHNEIDER ELECTRIC SA	10395	1	10395	186.10.02	41	
PLC Accessories, rack, cables, etc..	CERN Stores	3150	1	3150	186.10.02	41	
Demineralisation unit 50 liters	AQUAZUR	11348	1	11348	186.10.02	42	not in Bd.185
Cartridge filter 10” Stainless steel	40.15.08.210.7	685	1	685	186.10.02	42	
Filtre de déminéralisation	COLE - PARMER	44	1	44	186.10.02	42	
Mepla Bending tool Ø16 to 50	MGF - Macchine & Ustensili	405	1	405			Provided by ST/CV
Conductivity transmitter	BACHOFEN	2470	1	2470	186.10.02	43	
Prop. liquid level transmitter	DIMAT	1043	1	1043	186.10.02	44	
Tubes & accessories for manifolds	CERN STores	2000	1	2000			

Scaffolding 0.6m X 5m X 13m Alu: 18,700CHF (offer 2001-1112 from CERN's supplier Alu'It). To avoid this extra cost we will use the scaffolding from DELPHI detector after the dismantling of the experiment. This will be available in September 2001.

The total cost of the components described in the table excluding the tools provided by ST/CV, the scaffolding (provided by DELPHI), the flowmeter (to be developed by ST/CV), the demineralisation unit (not mandatory for this test) is **51,440CHF.**

This also exclude the costs related with the tests described in section 5 (monitoring of the cooling system), section 6 (heating system for the Tile drawers) and section 7 (cooling of the low voltage power supply) that will be taken in charge by the CERN-Tilecal, Clermont Ferrand-Tile and ATLAS DCS groups.

8.2 **Manpower** (External staff)

Cooling unit:	mechanical part:	160H X 55 CHF = 8800
	Electrical & programming part:	120H X 55CHF = 6600
Bd.185:	Piping:	80H X 55CHF = 4400
	Start and test:	40H X 55CHF = 2200
Total		400H X 55CHF = **22,000CHF**

9 List of components to be tested in magnetic field

The magnetic field in the TileCal achieves its maximum of 0.5 - 1 Tesla in the iron structure of the girders. Inside the girders where the drawers will be installed with the cooling pipes and the temperature probes, the magnetic field is around 0.1 Tesla. The pressure transmitters and the pneumatic on-line valves will be located near the crack between the Barrel and the Extended Barrel where the field is around 0.08 Tesla maximum. On the floor of the UX15 cavern where will be located the cooling station (radius 12m) the maximum magnetic field is 0.05 - 0.07 Tesla at z = 0 and decreases to 0.02 Tesla at z = 14.5m. The exact location of the cooling stations in z is not yet defined.

The components that need to be tested in magnetic field in extreme condition are listed.

- At 0.5 Tesla:
  - Pressure transmitter
  - Pneumatic on-line valve
- At 0.07 Tesla
  - Magnetic drive pump
  - Pressostat
  - Ball valve and control valve - with pneumatic actuator and position indicator
  - Proportional liquid level transmitter
  - Dew point transmitter

Before starting these tests, contact with ATLAS TC is needed to agree on a common procedure and safety factors to take into account. This is also valid for radiation test described in chapter 10.

In section 5.3 are described the specific tests under way for the monitoring components.

10 List of components to be tested with radiation

The neutron integrated and gamma dose close to the Tile girder region (r = 4m) are about 10^{11} neutron/cm^2/year and 1 Gy/year respectively.

The following components need to be tested to those radiation levels:

- Pressure transmitter
- Multilayer tube

- Pneumatic on-line valve

11 Timescale

The main steps of the project are:

- May 2001: submit the project to Joint Cooling & Ventilation committee (JCOV) to get financed (details in section 8.1 and 8.2)
- June 2001: Purchase. The status of this will depend of the outcome of the finance of this project.
- September-November 2001: Construction and installation in building 185
- December 2001-June 2002: Tests and development. The radiation and magnetic field tests can be done in parallel.
- October 2002: All Tender documents ready to be released (PRR cooling review). This will be a necessary step for the market survey and tendering for the final system in UX15.

12 Annexes 1

Drawing N° 186.10.01 Layout of the full scale test in Bd.185

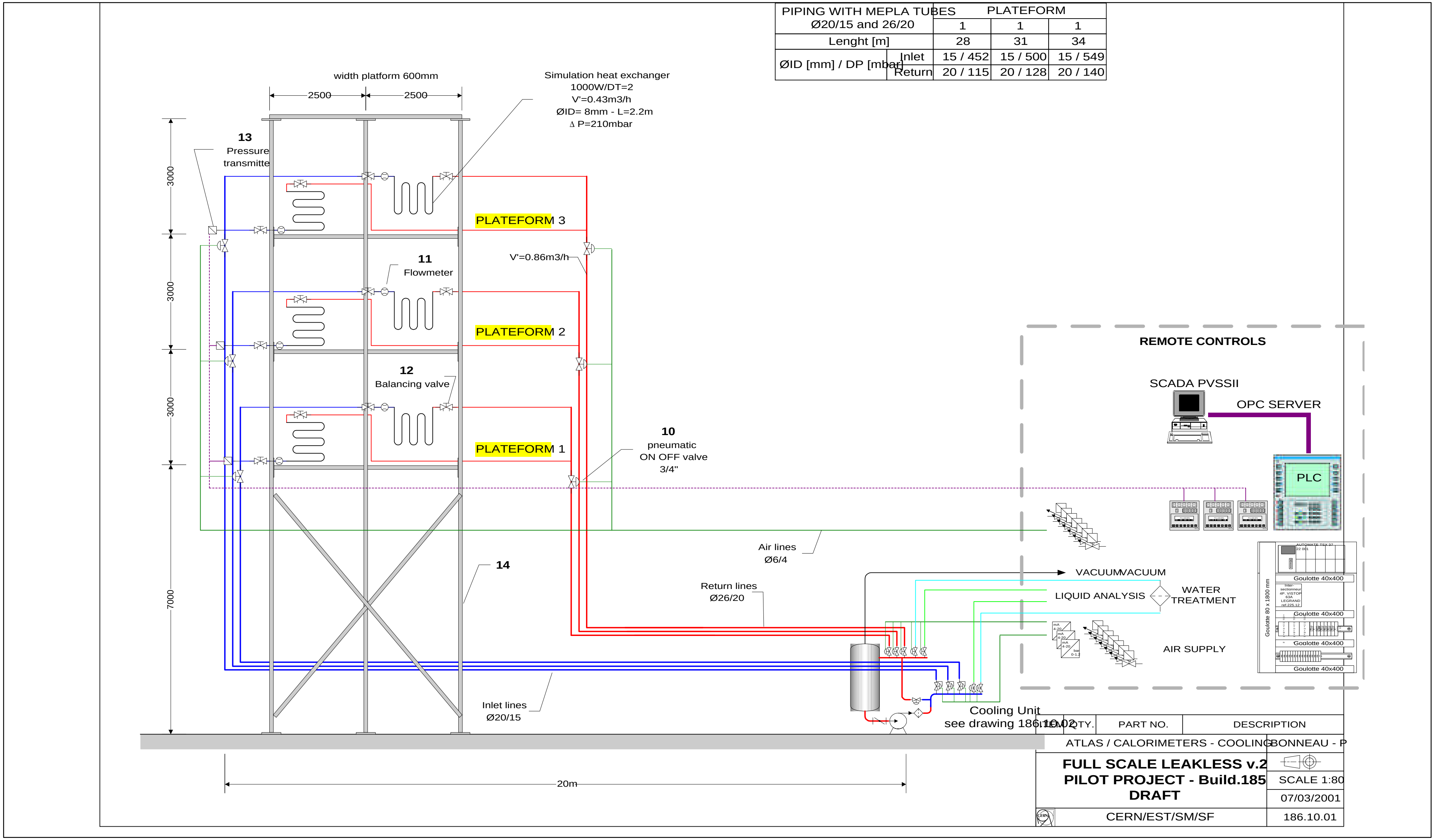
Drawing N° 186.10.02 Cooling unit Bd.185

Drawing N° 186.9.18 TILE Calorimeter / Extended - Layout cooling circuit in UX15

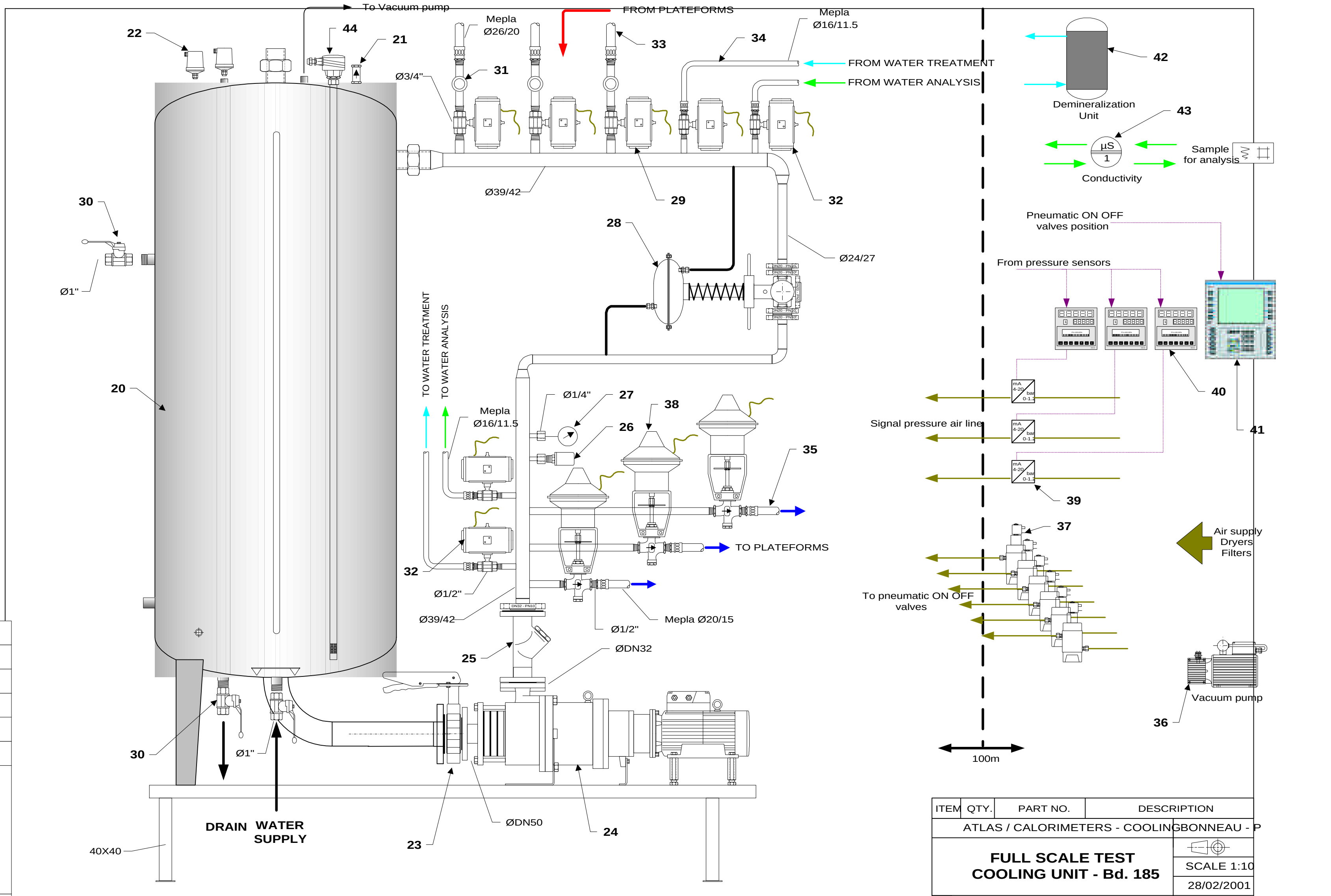
Drawing N° 186.9.20 TILE Calorimeter / Barrel - Layout cooling circuit in UX15

Drawing N° 186.5.08 LAr Calorimeter / Barrel - Layout cooling circuit in UX15

Drawing N° 186.5.09 LAr Calorimeter / End cap - Layout cooling circuit in UX15



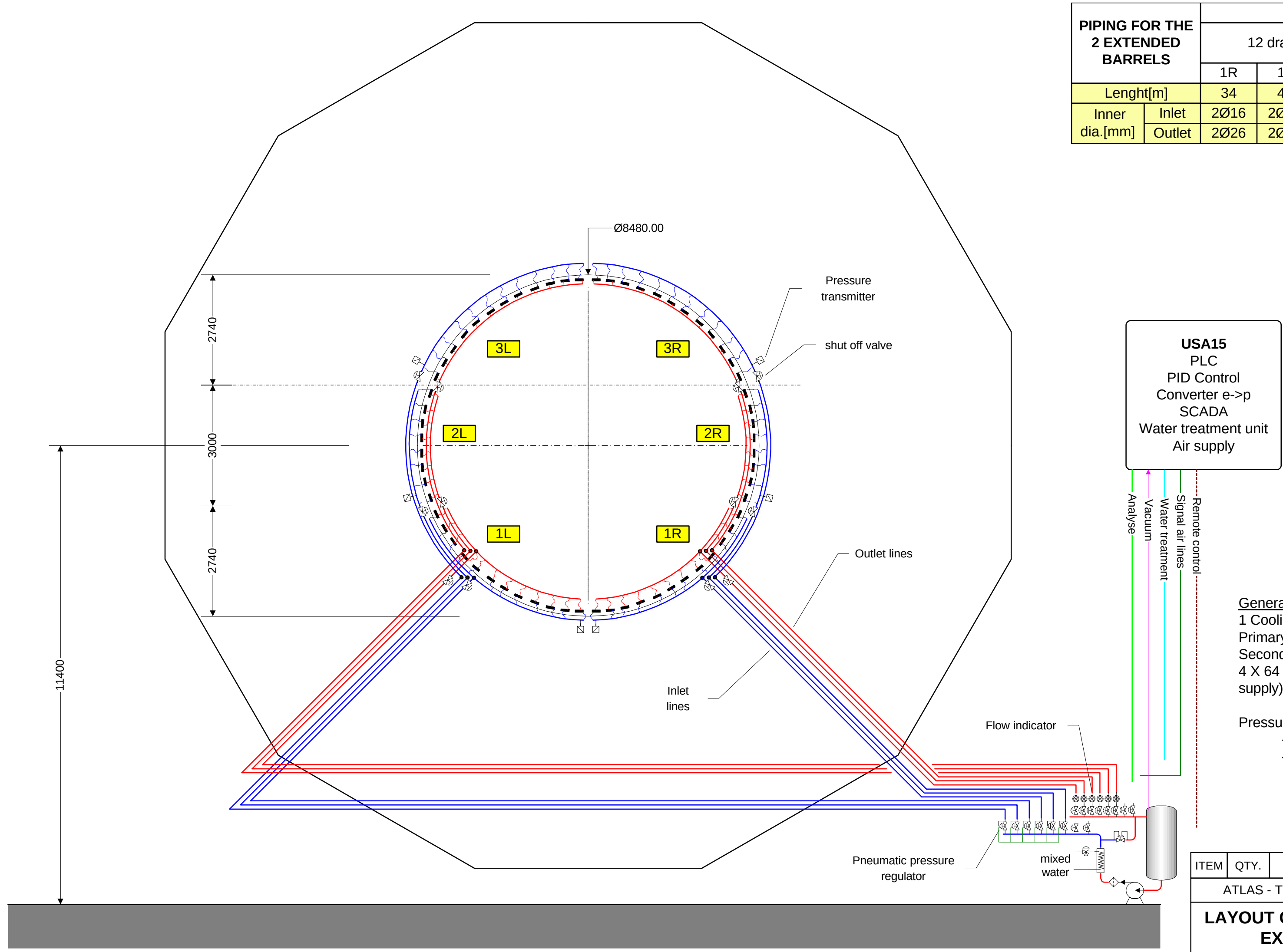
PIPING WITH MEPLA TUBES Ø20/15 and 26/20		PLATEFORM		
		1	1	1
Lenght [m]		28	31	34
ØID [mm] / DP [mbar]	Inlet	15 / 452	15 / 500	15 / 549
	Return	20 / 115	20 / 128	20 / 140



ITEM	QTY.	PART NO.	DESCRIPTION
ATLAS / CALORIMETERS - COOLING			BONNEAU - P
FULL SCALE TEST COOLING UNIT - Bd. 185			SCALE 1:10
			28/02/2001
CERN/EST/SM/SF			186.10.02

GENERAL TOLERANCES	>1	>30	>120	>315	>1000	>2000
MACHINING	±0.2	±0.3	±0.5	±0.8	±1.2	±2
SHEET METAL WORK / WELDING	±0.5	±0.8	±1	±2	±3	±4

PIPING FOR THE 2 EXTENDED BARRELS		SECTORS						Total volume of the piping
		12 drawers = 3600W				8 drawers = 2400W		
		1R	1L	3R	3L	2R	2L	
Lenght[m]		34	49	40.5	55.5	35.5	50.5	420 [l]
Inner dia.[mm]	Inlet	2Ø16	2Ø18	2Ø17	2Ø18	2Ø14	2Ø15	
	Outlet	2Ø26	2Ø29	2Ø27	2Ø29	2Ø23	2Ø25	

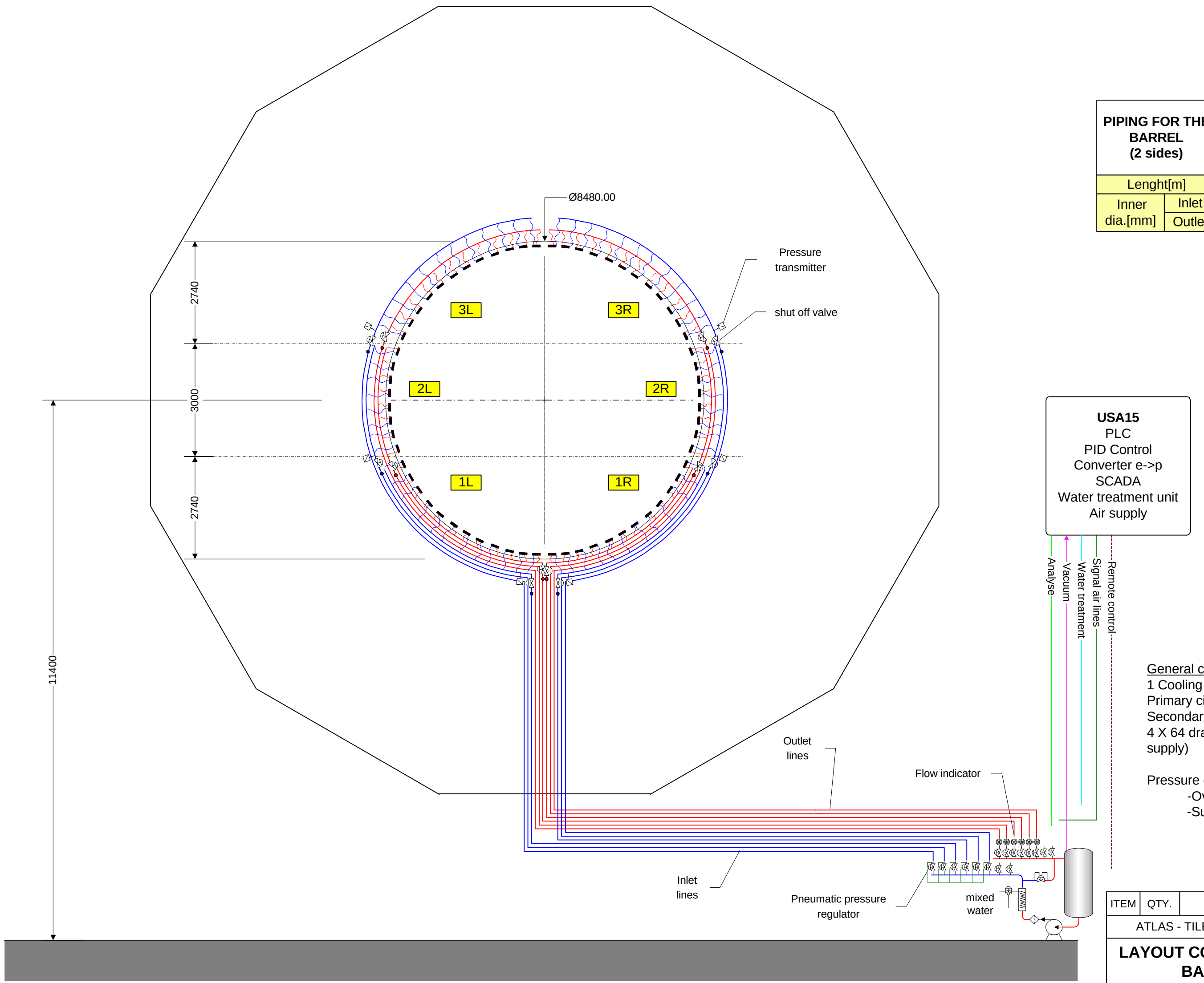


<u>General characteristics:</u>
1 Cooling unit 77 kW
Primary circuit: mixed water - 13/17 °C - 16.5 m3/h
Secondary: Water - 18/20 °C - 33 m3/h
4 X 64 drawers 300W (200W in drawer + 100W power supply)

Pressure drops distribution:
- -Overpressure: 1 bar in inlet pipe + head difference
- -Subpressure: -300mbar head difference in sector
  - -200mbar heat exchanger drawer
  - -100mbar outlet line

ITEM	QTY.	PART NO.	DESCRIPTION
ATLAS - TILE CALORIMETER COOLING			BONNEAU - P
LAYOUT COOLING CIRCUIT UX15 EXTENDED SHOWN Modularity 6 sectors			SCALE 1:100
			08/03/2001
CERN/EST/SM/SF			186.9.18

PIPING FOR THE BARREL (2 sides)		SECTORS			Total volume of the piping
		12 drawers = 3600W		8 drawers = 2400W	
		1R / 1L	3R / 3L	2R / 2L	
Lenght[m]		35	43	38	
Inner dia.[mm]	Inlet	4Ø16	4Ø17	4Ø15	350 [l]
	Outlet	4Ø27	4Ø28	4Ø23	

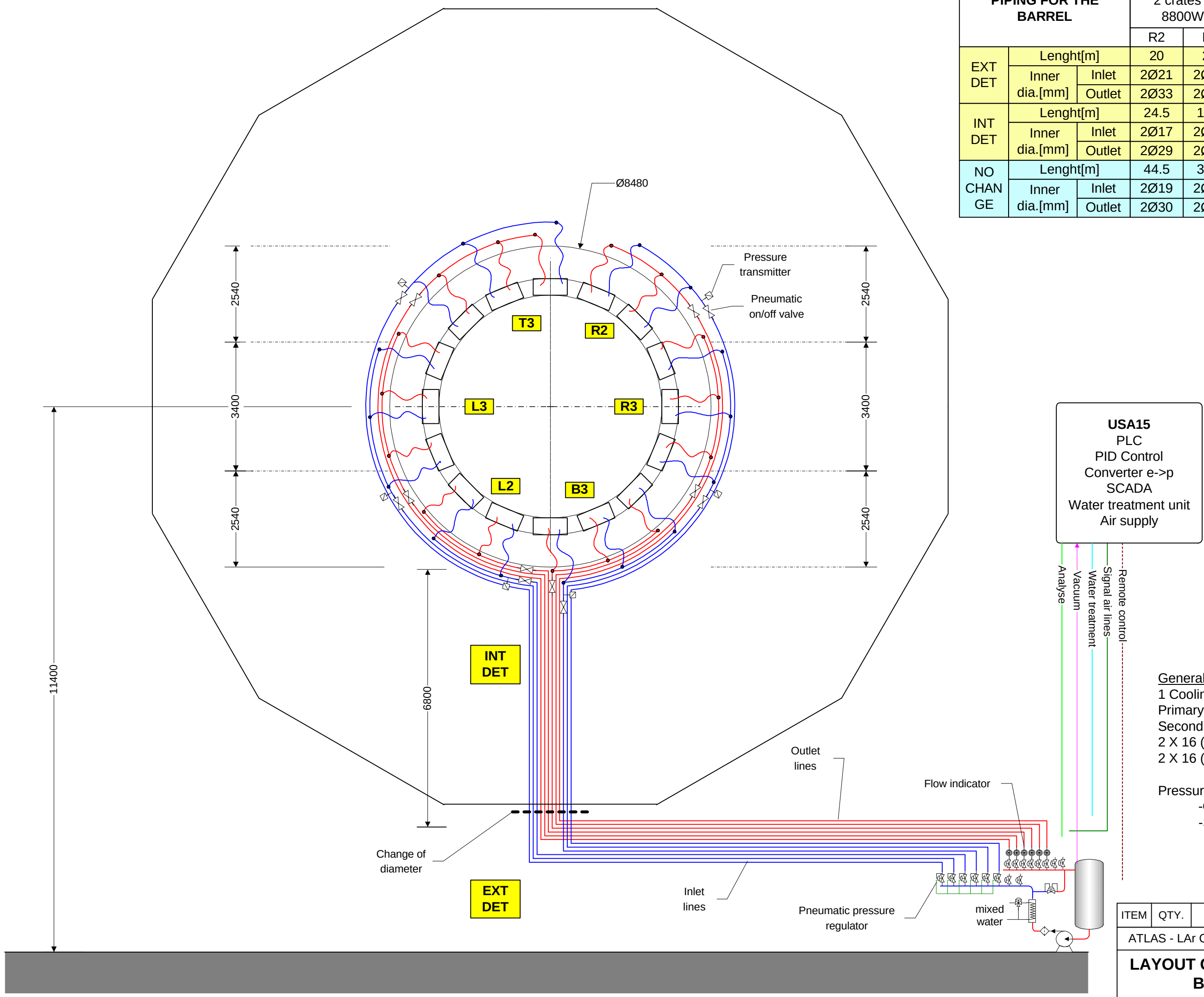


General characteristics:
1 Cooling unit 77 kW
Primary circuit: mixed water - 13/17 °C - 16.5 m3/h
Secondary: Water - 18/20 °C - 33 m3/h
4 X 64 drawers 300W (200W in drawer + 100W power supply)

Pressure drops distribution:
-Overpressure: 1 bar in inlet pipe + head difference
-Subpressure: -300mbar head difference in sector
-200mbar heat exchanger drawer
-100mbar outlet line

ITEM	QTY.	PART NO.	DESCRIPTION
ATLAS - TILE CALORIMETER COOLING			BONNEAU - P
LAYOUT COOLING CIRCUIT UX15 BARREL SHOWN Modularity 6 sectors			SCALE 1:100
			08/03/2001
CERN/EST/SM/SF			186.9.20

PIPING FOR THE BARREL			SECTORS						Total volume of the piping
			2 crates = 8800W		3 crates = 13200W				
			R2	L2	B3	L3	T3	R3	
EXT DET	Lenght[m]		20	20	20	20	20	20	590 [l]
	Inner dia.[mm]	Inlet	2Ø21	2Ø21	2Ø24	2Ø24	2Ø24	2Ø24	
		Outlet	2Ø33	2Ø33	2Ø38	2Ø38	2Ø38	2Ø38	
INT DET	Lenght[m]		24.5	14.5	14.5	19.5	24.5	19.5	
	Inner dia.[mm]	Inlet	2Ø17	2Ø16	2Ø18	2Ø20	2Ø21	2Ø20	
		Outlet	2Ø29	2Ø25	2Ø30	2Ø32	2Ø33	2Ø32	
NO CHANGE	Lenght[m]		44.5	34.5	34.5	39.5	44.5	39.5	550 [l]
	Inner dia.[mm]	Inlet	2Ø19	2Ø18	2Ø21	2Ø21	2Ø22	2Ø21	
		Outlet	2Ø30	2Ø29	2Ø33	2Ø34	2Ø35	2Ø34	



General characteristics:

1 Cooling unit 255 kW
Primary circuit: chilled water - 6/12 °C - 36.5 m3/h
Secondary: Water - 14/18 °C - 55 m3/h
2 X 16 (barrel) + 2 X 13 (end caps) crates 3.6kW
2 X 16 (barrel) + 2 X 13 (end caps) power supply 0.8kW

Pressure drops distribution:
-Overpressure: 1 bar in inlet pipe + head difference
-Subpressure: -300mbar head difference in sector
-200mbar heat exchanger drawer
-100mbar outlet line

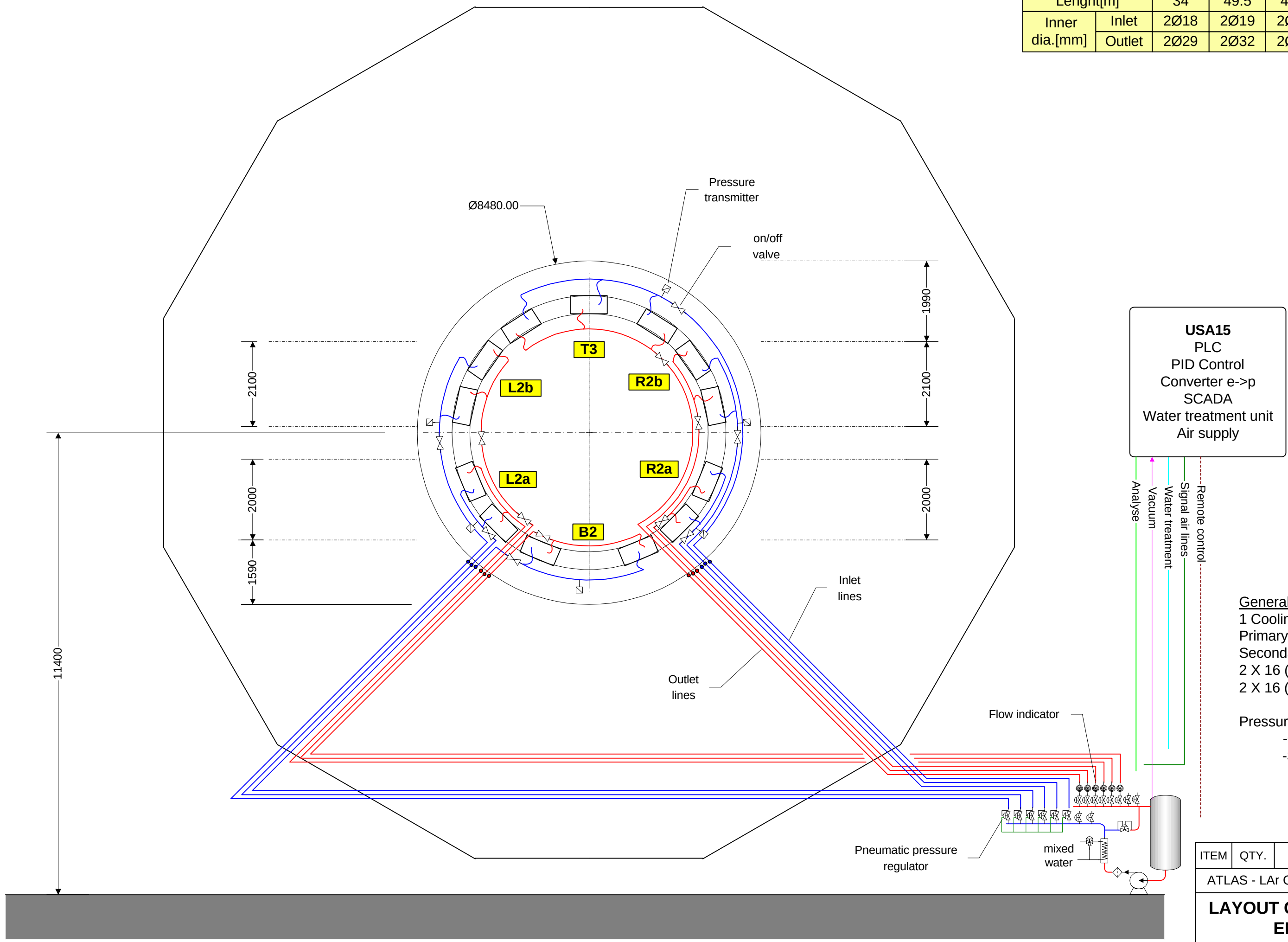
ITEM	QTY.	PART NO.	DESCRIPTION

ATLAS - LAr CALORIMETER BOXES COOLING | BONNEAU - P

LAYOUT COOLING CIRCUIT UX15
BARREL SHOWN
Modularity 6 sectors

SCALE 1:100
08/03/2001
CERN/EST/SM/SF
186.5.08

PIPING FOR THE END CAPS		SECTORS						Tota volun of th pipin
		2 crates = 8800W					3 crates = 13200W	
		R2a	L2a	B2	L2b	R2b	T3	
Lenght[m]		34	49.5	49.5	52.5	37	40	570 |
Inner dia.[mm]	Inlet	2Ø18	2Ø19	2Ø19	2Ø20	2Ø18	2Ø21	
	Outlet	2Ø29	2Ø32	2Ø32	2Ø32	2Ø30	2Ø35	



General characteristics:
1 Cooling unit 255 kW
Primary circuit: chilled water - 6/12 °C - 36.5 m3/h
Secondary: Water - 14/18 °C - 55 m3/h
2 X 16 (barrel) + 2 X 13 (end caps) crates 3.6kW
2 X 16 (barrel) + 2 X 13 (end caps) power supply 0.8kW

Pressure drops distribution:
-Overpressure: 1 bar in inlet pipe + head differen
-Subpressure: -300mbar head difference in secto
-200mbar heat exchanger drawer
-100mbar outlet line

ITEM	QTY.	PART NO.	DESCRIPTION
ATLAS - LAr CALORIMETER BOXES COOLING			BONNEAU - P
LAYOUT COOLING CIRCUIT UX15 END CAP SHOWN Modularity 6 sectors			SCALE 1:100
			08/03/2001
CERN/EST/SM/SF			186.5.09

13 Annexes 2

pdf documents.

13.1 Drawings & Notes

Drawing N° 186.10.01 Layout of the full scale test in Bd.185

Drawing N° 186.10.02 Cooling unit Bd.185

Drawing N° 186.9.18 TILE Calorimeter / Extended - Layout cooling circuit in UX15

Drawing N° 186.9.20 TILE Calorimeter / Barrel - Layout cooling circuit in UX15

Drawing N° 186.5.08 LAr Calorimeter / Barrel - Layout cooling circuit in UX15

Drawing N° 186.5.09 LAr Calorimeter / End cap - Layout cooling circuit in UX15

Drawing ATLLLMA_0001 Drawer patch panel

Drawing ATLLLMW_0001 Superdrawer cooling

LCS v.2 - Pressure drop calculations and assumptions

13.2 Supplier's doc

Short description of El-O-Matic pneumatic actuator

Technical data of Danfoss HP220X pneumatic valve

Technical description of STAD balancing valve

Technical description of the balancing instrument CBI^{II}

Huba pressure sensor 691 series

KSB Multimagno pump MTM-S2 2/3 C/110-20

SART direct acting pressure regulators

Multilayer Mepla pipe from Geberit

Technical characteristics of Pneumatic valve drive AV42, control valve V6R and E-P converter

Technical characteristics of the REX-G9

Recommendations for the use of PLCs at CERN from the Working Group on Programmable Logic Controllers

Technical description of the Burkert Digital inductive conductivity transmitter type 8226

Technical description of the Burkert RF Capacitance level transmitter type 8100