Date: 2/11/2008

TS-CV-DC

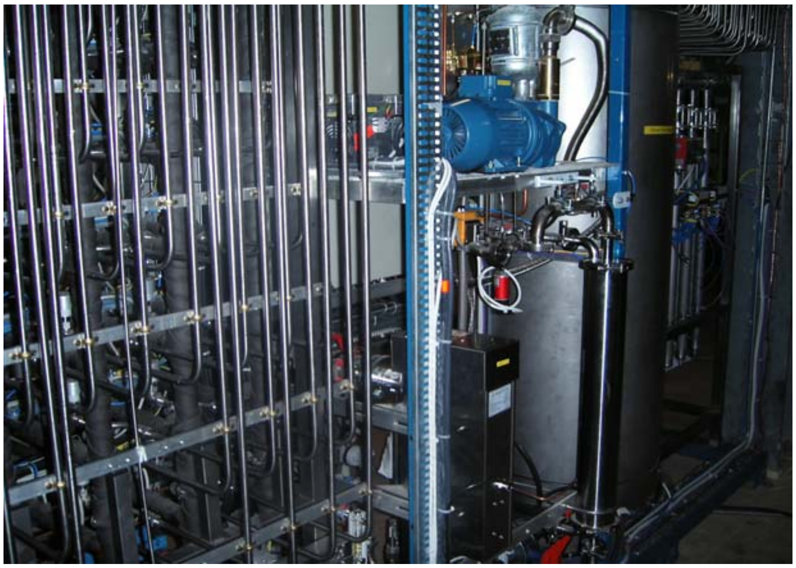
CERN
CH-1211 Geneva 23
Switzerland

EDMS 781417 v.1

TECHNICAL FOLDER

ALICE SSD AND SDD COOLING PLANT

FCUL-00002



General description and functionalities

This unit cools the SSD and SDD detectors situated at the core of the ALICE experiment. It uses demineralised, de-oxygenised and sterilised water and works according to the LCS.v2 leakless principle, developed by Michel Bosteels at CERN. The maximum cooling power is approximately 48 kW @ 15/22°C, even though the total heat dissipated by the whole SDD and SSD is only 5.8 kW.

P&I and construction drawings are available on EDMS sub-documents 867051.

Component Datasheets, Purchase and Ordering Information are available on EDMS sub-documents 867050.

Electrical Dossier is on EDMS Id 781419

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History of Changes

Rev. No.	*Date*	*Pages*	*Description of Changes*

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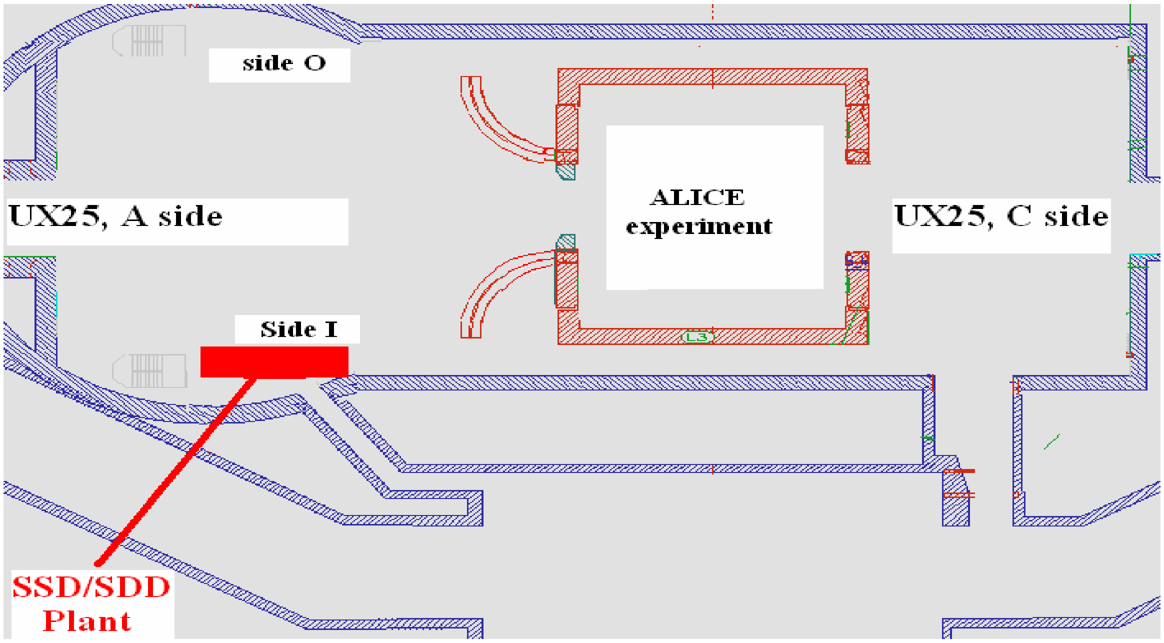
1 INTRODUCTION



PLANT LOCATION :UX25, A SIDE, SIDE I

Plant Name: FCUL-00007 (183.08) Designed by: Stephane Berry and Miguel Santos, TS/CV/DC

1.1 GENERAL DESCRIPTION

The plant consists of a 600L reservoir kept below atmospheric, one circulator pump, two heat exchangers (one for the SDD and one for the SSD) connected to the TS/CV chilled water network, six supply manifolds (four SDD and two SSD) and four return manifolds (two SDD and two SSD) with a total of 42 circuits. Each supply manifold groups 5 to 8 circuits meant to receive the same flow and therefore fed by a common balancing valve.

Base temperature regulation is done varying the chilled water flow through the exchangers. Each circuit is then temperature differentiated by a small heater (250W to 1000W according to nominal flow).

Whenever required, the atmosphere in the reservoir can be flushed with pure nitrogen. A fraction of the cooling water flow (~30%) is continuously by-passed through a mixed-bed de-ionizer, a membrane contactor for O_2 removal and an UV lamp sterilizer. Conductivity and Dissolved O_2 content of the outgoing flow is measured.

1.1.1 ASSOCIATED DOCUMENTS

P&I and construction drawings are available on EDMS sub-documents 867051.

Component Datasheets, Purchase and Ordering Information are available on EDMS sub-documents 867050.

Electrical Dossier is on EDMS Id 781419

2 NAMING & SPARE PARTS

2.1 D7I NAMING

Caption in drawing LHCF22280005	Description	D7i Name
Boitier Orange	Unite traitement air ONE 8bar	FCCAC-00001
	Pneumatic distribution bloc for supply manifold	FCCAD-00010
	Pneumatic distribution bloc for supply manifold	FCCAD-00011
	Pneumatic distribution bloc for return manifold	FCCAD-00012
	Pneumatic distribution bloc for return manifold	FCCAD-00013
CT-1	Conductivity meter, CT-1	FCCT-00010
SDD Exchanger	Heat Exchanger SDD	FCE-00041
SSD Exchanger	Heat Exchanger SSD	FCE-00042
RWA	Reservoir 600L, RWA	FCEE-00024
DM	Mixed bed de-ionizer Ministil, DM	FCF-00081
FOA-1	Strainer Stainless steel - custom made mesh: 0.1mm, FOA-1	FCF-00082
V-Db1	Sight glass SSD return, V-Db1	FCFG-00099
V-Db1	Sight glass SSD return, V-Db2	FCFG-00100
V-Sb1	Sight glass SSD return, V-Sb1	FCFG-00101
V-Sb2	Sight glass SSD return, V-Sb2	FCFG-00102
FT-1	Flowmeter water treatment, FT-1	FCFIC-00062
FT-D1	Flowmeter SDD 4-ladder groups, FT-D1	FCFIC-00063
FT-D2	Flowmeter SDD 2-ladder groups, FT-D2	FCFIC-00064
FT-D3	Flowmeter SDD 4-end ladder groups, FT-D3	FCFIC-00065
FT-D4	Flowmeter SDD 2-end ladder groups, FT-D4	FCFIC-00066
FT-S1	Flowmeter SSD 4-ladder groups, FT-S1	FCFIC-00067
FT-S2	Flowmeter SSD 5-ladder groups, FT-S2	FCFIC-00068
LW-1	Flowmeter chilled water, LW-1	FCFIC-00069
DG	Membrane Desox, DG	FCFO-00001
HTR-D11	Heater 500WLoop 1, HTR-D11	FCI-00071
HTR-D12	Heater 500WLoop 7, HTR-D12	FCI-00072
HTR-D13	Heater 500WLoop 13, HTR-D13	FCI-00073
HTR-D14	Heater 500WLoop 19, HTR-D14	FCI-00074
HTR-D15	Heater 500WLoop 25, HTR-D15	FCI-00075
HTR-D16	Heater 500WLoop 31, HTR-D16	FCI-00076
HTR-D17	Heater 500WLoop 37, HTR-D17	FCI-00077
HTR-D18	Heater 500WLoop 43, HTR-D18	FCI-00078
HTR-D21	Heater 250WLoop 2, HTR-D21	FCI-00079
HTR-D22	Heater 250WLoop 8, HTR-D22	FCI-00080
HTR-D23	Heater 250WLoop 14, HTR-D23	FCI-00081
HTR-D24	Heater 250WLoop 20, HTR-D24	FCI-00082
HTR-D25	Heater 250WLoop 26, HTR-D25	FCI-00083
HTR-D26	Heater 250WLoop 32, HTR-D26	FCI-00084
HTR-D27	Heater 250WLoop 38, HTR-D27	FCI-00085
HTR-D28	Heater 250WLoop 44, HTR-D28	FCI-00086
HTR-D31	Heater 1000WLoop 3, HTR-D31	FCI-00087

HTR-D32	Heater 1000WLoop 9, HTR-D32	FCI-00088
HTR-D33	Heater 1000WLoop 15, HTR-D33	FCI-00089
HTR-D34	Heater 1000WLoop 21, HTR-D34	FCI-00090
HTR-D35	Heater 1000WLoop 27, HTR-D35	FCI-00091
HTR-D36	Heater 1000WLoop 33, HTR-D36	FCI-00092
HTR-D37	Heater 1000WLoop 39, HTR-D37	FCI-00093
HTR-D38	Heater 1000WLoop 45, HTR-D38	FCI-00094
HTR-D41	Heater 500WLoop 4, HTR-D41	FCI-00095
HTR-D42	Heater 500WLoop 10, HTR-D42	FCI-00096
HTR-D43	Heater 500WLoop 16, HTR-D43	FCI-00097
HTR-D44	Heater 500WLoop 22, HTR-D44	FCI-00098
HTR-D45	Heater 500WLoop 28, HTR-D45	FCI-00099
HTR-D46	Heater 500WLoop 34, HTR-D46	FCI-00100
HTR-D47	Heater 500WLoop 40, HTR-D47	FCI-00101
HTR-D48	Heater 500WLoop 46, HTR-D48	FCI-00102
HTR-S11	Heater 500WLoop 5, HTR-S11	FCI-00103
HTR-S12	Heater 500WLoop 11, HTR-S12	FCI-00104
HTR-S13	Heater 500WLoop 17, HTR-S13	FCI-00105
HTR-S14	Heater 500WLoop 23, HTR-S14	FCI-00106
HTR-S15	Heater 500WLoop 29, HTR-S15	FCI-00107
HTR-S16	Heater 500WLoop 35, HTR-S16	FCI-00108
HTR-S17	Heater 500WLoop 41, HTR-S17	FCI-00109
HTR-S18	Heater 500WLoop 47, HTR-S18	FCI-00110
HTR-S21	Heater 500WLoop 6, HTR-S21	FCI-00111
HTR-S22	Heater 500WLoop 12, HTR-S22	FCI-00112
HTR-S23	Heater 500WLoop 18, HTR-S23	FCI-00113
HTR-S24	Heater 500WLoop 24, HTR-S24	FCI-00114
HTR-S25	Heater 500WLoop 30, HTR-S25	FCI-00115
HTR-S26	Heater 500WLoop 36, HTR-S26	FCI-00116
HTR-S27	Heater 500WLoop 42, HTR-S27	FCI-00117
HTR-S28	Heater 500WLoop 48, HTR-S28	FCI-00118
VR-1	Relief valve on reservoir, VR-1	FCKE-00194
LT	Reservoir Level Sensor, LT	FCLSL-00019
PP	Circulation pump, PP	FCP-00083
PPV-1	Vacuum pump reservoir, PPV-1	FCP-00084
PPV-2	Vacuum pump reservoir, PPV-2	FCP-00085
PPV-3	Liquid ring vacuum pump Desox membrane, PPV-3	FCP-00086
PI-1	Manometer reservoir, PI-1	FCPG-00104
PI-2	Manometer pump outlet, PI-2	FCPG-00105
PI-3	Manometer Desox membrane, PI-3	FCPG-00106
PS-1	Pressure switch pump outlet, PS-1	FCPS-00059
PS-3	Pressure switch N2 supply, PS-2	FCPS-00060
PT-1	Pressure transmitter reservoir, PT-1	FCPT-00245
PT-2	Pressure transmitter pump outlet, PT-2	FCPT-00246
PT-3	Pressure transmitter Desox membrane, PT-3	FCPT-00247
QP-3	Pressure regulator tap water to PPV-3, QP-1	FCPV-00431
UV	UV Lamp water sterilizer, UV	FCQC-00001
TT-Da	Temperature Sensor Pt100 SDD exchanger outlet, TT-Da	FCTT-00272
TT-Sa	Temperature Sensor Pt100 SSD exchanger outlet, TT-Sa	FCTT-00273

TT-Win	Temperature Sensor Pt100 supply chilled water, TT-Win	FCTT-00274
TT-D11	Temperature Sensor Pt100 Loop 1, TT-D11	FCTT-00275
TT-D12	Temperature Sensor Pt100 Loop 7, TT-D12	FCTT-00276
TT-D13	Temperature Sensor Pt100 Loop 13, TT-D13	FCTT-00277
TT-D14	Temperature Sensor Pt100 Loop 19, TT-D14	FCTT-00278
TT-D15	Temperature Sensor Pt100 Loop 25, TT-D15	FCTT-00279
TT-D16	Temperature Sensor Pt100 Loop 31, TT-D16	FCTT-00280
TT-D17	Temperature Sensor Pt100 Loop 37, TT-D17	FCTT-00281
TT-D18	Temperature Sensor Pt100 Loop 43, TT-D18	FCTT-00282
TT-D21	Temperature Sensor Pt100 Loop 2, TT-D21	FCTT-00283
TT-D22	Temperature Sensor Pt100 Loop 8, TT-D22	FCTT-00284
TT-D23	Temperature Sensor Pt100 Loop 14, TT-D23	FCTT-00285
TT-D24	Temperature Sensor Pt100 Loop 20, TT-D24	FCTT-00286
TT-D25	Temperature Sensor Pt100 Loop 26, TT-D25	FCTT-00287
TT-D26	Temperature Sensor Pt100 Loop 32, TT-D26	FCTT-00288
TT-D27	Temperature Sensor Pt100 Loop 38, TT-D27	FCTT-00289
TT-D28	Temperature Sensor Pt100 Loop 44, TT-D28	FCTT-00290
TT-D31	Temperature Sensor Pt100 Loop 3, TT-D31	FCTT-00291
TT-D32	Temperature Sensor Pt100 Loop 9, TT-D32	FCTT-00292
TT-D33	Temperature Sensor Pt100 Loop 15, TT-D33	FCTT-00293
TT-D34	Temperature Sensor Pt100 Loop 21, TT-D34	FCTT-00294
TT-D35	Temperature Sensor Pt100 Loop 27, TT-D35	FCTT-00295
TT-D36	Temperature Sensor Pt100 Loop 33, TT-D36	FCTT-00296
TT-D37	Temperature Sensor Pt100 Loop 39, TT-D37	FCTT-00297
TT-D38	Temperature Sensor Pt100 Loop 45, TT-D38	FCTT-00298
TT-D41	Temperature Sensor Pt100 Loop 4, TT-D41	FCTT-00299
TT-D42	Temperature Sensor Pt100 Loop 10, TT-D42	FCTT-00300
TT-D43	Temperature Sensor Pt100 Loop 16, TT-D43	FCTT-00301
TT-D44	Temperature Sensor Pt100 Loop 22, TT-D44	FCTT-00302
TT-D45	Temperature Sensor Pt100 Loop 28, TT-D45	FCTT-00303
TT-D46	Temperature Sensor Pt100 Loop 34, TT-D46	FCTT-00304
TT-D47	Temperature Sensor Pt100 Loop 40, TT-D47	FCTT-00305
TT-D48	Temperature Sensor Pt100 Loop 46, TT-D48	FCTT-00306
TT-S11	Temperature Sensor Pt100 Loop 5, TT-S11	FCTT-00307
TT-S12	Temperature Sensor Pt100 Loop 11, TT-S12	FCTT-00308
TT-S13	Temperature Sensor Pt100 Loop 17, TT-S13	FCTT-00309
TT-S14	Temperature Sensor Pt100 Loop 23, TT-S14	FCTT-00310
TT-S15	Temperature Sensor Pt100 Loop 29, TT-S15	FCTT-00311
TT-S16	Temperature Sensor Pt100 Loop 35, TT-S16	FCTT-00312
TT-S17	Temperature Sensor Pt100 Loop 41, TT-S17	FCTT-00313
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TT-S24	Temperature Sensor Pt100 Loop 24, TT-S24	FCTT-00318
TT-S25	Temperature Sensor Pt100 Loop 30, TT-S25	FCTT-00319
TT-S26	Temperature Sensor Pt100 Loop 36, TT-S26	FCTT-00320
TT-S27	Temperature Sensor Pt100 Loop 42, TT-S27	FCTT-00321
TT-S28	Temperature Sensor Pt100 Loop 48, TT-S28	FCTT-00322

VEA-2	Electrovalve 3-way for vacuum pump start-up, VEA-2	FCV-01496
VEA-3	Electrovalve 3-way for vacuum pump start-up, VEA-3	FCV-01497
VEA-4	Electrovalve 3-way for N2 supply membrane, VEA-4	FCV-01498
VEA-5	Electrovalve 3-way for N2 supply reservoir, VEA-5	FCV-01499
QR-1	Hand valve for draining, QR-1	FCV-01500
QR-2	Reservoir containment hand valve, QR-2	FCV-01501
VMA-S	Chilled water regulation 2-way valve for SSD, VMA-S	FCV-01502
VMA-D	Chilled water regulation 2-way valve for SDD, VMA-D	FCV-01503
VP-1	Pneumatic valve into water treatment, VP-1	FCV-01504
VP-2	Pneumatic valve supply tap water to Liquid ring pump, VP-2	FCV-01505
VP-3	Pneumatic valve vacuum Desox membrane, VP-3	FCV-01506
VTA-1	Balancing valve water treatment, VTA-1	FCV-01507
VTA-D1	Balancing valve SDD 4-ladder groups, VTA-D1	FCV-01508
VTA-D2	Balancing valve SDD 2-ladder groups, VTA-D2	FCV-01509
VTA-D3	Balancing valve SDD 4-end ladder groups, VTA-D3	FCV-01510
VTA-D4	Balancing valve SDD 2-end ladder groups, VTA-D4	FCV-01511
VTA-S1	Balancing valve SSD 4-ladder groups, VTA-S1	FCV-01512
VTA-S2	Balancing valve SSD 5-ladder groups, VTA-S2	FCV-01513
VP-D11a	Pneumatic bellow shut-off valve SL 1, VP-D11a	FCV-01514
VP-D12a	Pneumatic bellow shut-off valve SL 7, VP-D12a	FCV-01515
VP-D13a	Pneumatic bellow shut-off valve SL 13, VP-D13a	FCV-01516
VP-D14a	Pneumatic bellow shut-off valve SL 19, VPD14a	FCV-01517
VP-D15a	Pneumatic bellow shut-off valve SL 25, VP-D15a	FCV-01518
VP-D16a	Pneumatic bellow shut-off valve SL 31, VP-D16a	FCV-01519
VP-D17a	Pneumatic bellow shut-off valve SL 37, VP-D17a	FCV-01520
VP-D18a	Pneumatic bellow shut-off valve SL 43, VP-D18a	FCV-01521
VP-D21a	Pneumatic bellow shut-off valve SL 2, VP-D21a	FCV-01522
VP-D22a	Pneumatic bellow shut-off valve SL 8, VP-D22a	FCV-01523
VP-D23a	Pneumatic bellow shut-off valve SL 14, VP-D23a	FCV-01524
VP-D24a	Pneumatic bellow shut-off valve SL 20, VP-D24a	FCV-01525
VP-D25a	Pneumatic bellow shut-off valve SL 26, VP-D25a	FCV-01526
VP-D26a	Pneumatic bellow shut-off valve SL 32, VP-D26a	FCV-01527
VP-D27a	Pneumatic bellow shut-off valve SL 38, VP-D27a	FCV-01528
VP-D28a	Pneumatic bellow shut-off valve SL 44, VP-D28a	FCV-01529
VP-D31a	Pneumatic bellow shut-off valve SL 3, VP-D31a	FCV-01530
VP-D32a	Pneumatic bellow shut-off valve SL 9, VP-D32a	FCV-01531
VP-D33a	Pneumatic bellow shut-off valve SL 15, VP-D33a	FCV-01532
VP-D34a	Pneumatic bellow shut-off valve SL 21, VP-D34a	FCV-01533
VP-D35a	Pneumatic bellow shut-off valve SL 27, VP-D35a	FCV-01534
VP-D36a	Pneumatic bellow shut-off valve SL 33, VP-D36a	FCV-01535
VP-D37a	Pneumatic bellow shut-off valve SL 39, VP-D37a	FCV-01536
VP-D38a	Pneumatic bellow shut-off valve SL 45, VP-D38a	FCV-01537
VP-D41a	Pneumatic bellow shut-off valve SL 4, VP-D41a	FCV-01538
VP-D42a	Pneumatic bellow shut-off valve SL 10, VP-D42a	FCV-01539
VP-D43a	Pneumatic bellow shut-off valve SL 16, VP-D43a	FCV-01540
VP-D44a	Pneumatic bellow shut-off valve SL 22, VP-D44a	FCV-01541
VP-D45a	Pneumatic bellow shut-off valve SL 28, VP-D45a	FCV-01542
VP-D46a	Pneumatic bellow shut-off valve SL 34, VP-D46a	FCV-01543
VP-D47a	Pneumatic bellow shut-off valve SL 40, VP-D47a	FCV-01544

VP-D48a	Pneumatic bellow shut-off valve SL 46, VP-D48a	FCV-01545
VP-S11a	Pneumatic bellow shut-off valve SL 5, VP-S11a	FCV-01546
VP-S12a	Pneumatic bellow shut-off valve SL 11, VP-S12a	FCV-01547
VP-S13a	Pneumatic bellow shut-off valve SL 17, VP-S13a	FCV-01548
VP-S14a	Pneumatic bellow shut-off valve SL 23, VP-S14a	FCV-01549
VP-S15a	Pneumatic bellow shut-off valve SL 29, VP-S15a	FCV-01550
VP-S16a	Pneumatic bellow shut-off valve SL 35, VP-S16a	FCV-01551
VP-S17a	Pneumatic bellow shut-off valve SL 41, VP-S17a	FCV-01552
VP-S18a	Pneumatic bellow shut-off valve SL 47, VP-S18a	FCV-01553
VP-S21a	Pneumatic bellow shut-off valve SL 6, VP-S21a	FCV-01554
VP-S22a	Pneumatic bellow shut-off valve SL 12, VP-S22a	FCV-01555
VP-S23a	Pneumatic bellow shut-off valve SL 18, VP-S23a	FCV-01556
VP-S24a	Pneumatic bellow shut-off valve SL 24, VP-S24a	FCV-01557
VP-S25a	Pneumatic bellow shut-off valve SL 30, VP-S25a	FCV-01558
VP-S26a	Pneumatic bellow shut-off valve SL 36, VP-S26a	FCV-01559
VP-S27a	Pneumatic bellow shut-off valve SL 42, VP-S27a	FCV-01560
VP-S28a	Pneumatic bellow shut-off valve SL 48, VP-S28a	FCV-01561
VP-D1121b	Pneumatic bellow shut-off valve RL 1+2, VP-D1121b	FCV-01562
VP-D1222b	Pneumatic bellow shut-off valve RL 7+8, VP-D1222b	FCV-01563
VP-D1323b	Pneumatic bellow shut-off valve RL 13+14, VP-D1323b	FCV-01564
VP-D1424b	Pneumatic bellow shut-off valve RL 19+20, VP-D1424b	FCV-01565
VP-D1525b	Pneumatic bellow shut-off valve RL 19+20, VP-D1424b	FCV-01566
VP-D1626b	Pneumatic bellow shut-off valve RL 25+26, VP-D1525b	FCV-01567
VP-D1727b	Pneumatic bellow shut-off valve RL 31+32, VP-D1626b	FCV-01568
VP-D1828b	Pneumatic bellow shut-off valve RL 37+38, VP-D1727b	FCV-01569
VP-D3141b	Pneumatic bellow shut-off valve RL 43+44, VP-D1828b	FCV-01570
VP-D3242b	Pneumatic bellow shut-off valve RL 3+4, VP-D3141b	FCV-01571
VP-D3343b	Pneumatic bellow shut-off valve RL 9+10, VP-D3242b	FCV-01572
VP-D3444b	Pneumatic bellow shut-off valve RL 15+16, VP-D3343b	FCV-01573
VP-D3545b	Pneumatic bellow shut-off valve RL 21+22, VP-D3444b	FCV-01574
VP-D3646b	Pneumatic bellow shut-off valve RL 27+28, VP-D3545b	FCV-01575
VP-D3747b	Pneumatic bellow shut-off valve RL 33+34, VP-D3646b	FCV-01576
VP-D3848b	Pneumatic bellow shut-off valve RL 39+40, VP-D3747b	FCV-01577
VP-S11b	Pneumatic bellow shut-off valve RL 45+46, VP-D3848b	FCV-01578
VP-S12b	Pneumatic bellow shut-off valve RL 5, VP-S11b	FCV-01579
VP-S13b	Pneumatic bellow shut-off valve RL 11, VP-S12b	FCV-01580
VP-S14b	Pneumatic bellow shut-off valve RL 17, VP-S13b	FCV-01581
VP-S15b	Pneumatic bellow shut-off valve RL 23, VP-S14b	FCV-01582
VP-S16b	Pneumatic bellow shut-off valve RL 29, VP-S15b	FCV-01583
VP-S17b	Pneumatic bellow shut-off valve RL 35, VP-S16b	FCV-01584
VP-S18b	Pneumatic bellow shut-off valve RL 41, VP-S17b	FCV-01585
VP-S21b	Pneumatic bellow shut-off valve RL 47, VP-S18b	FCV-01586
VP-S22b	Pneumatic bellow shut-off valve RL 6, VP-S21b	FCV-01587
VP-S23b	Pneumatic bellow shut-off valve RL 12, VP-S22b	FCV-01588
VP-S24b	Pneumatic bellow shut-off valve RL 18, VP-S23b	FCV-01589
VP-S25b	Pneumatic bellow shut-off valve RL 24, VP-S24b	FCV-01590
VP-S26b	Pneumatic bellow shut-off valve RL 30, VP-S25b	FCV-01591
VP-S27b	Pneumatic bellow shut-off valve RL 36, VP-S26b	FCV-01592
VP-S28b	Pneumatic bellow shut-off valve RL 42, VP-S27b	FCV-01593

QR-3	Pneumatic bellow shut-off valve RL 48, VP-S28b	FCV-01594
QR-4	Hand valve return to reservoir from water treatment, QR-3	FCV-01595
QR-5	Hand valve into deionizer water treatment, QR-4	FCV-01596
	Hand valve out UV water treatment, QR-5	FCCAC-00001

2.2 SPARE PART LIST

2.2.1 FILTRE DEMINERALIZATEUR

Supplier/manufacturer: CHRIST
Reference: Ministil P-42
MTBF:? hours of continuous operation
Suggested preventive **REGENERATION**: based on monitoring
Cost of regeneration: ? CHF

2.2.2 SHAFT SEAL FOR CIRCULATOR PUMP

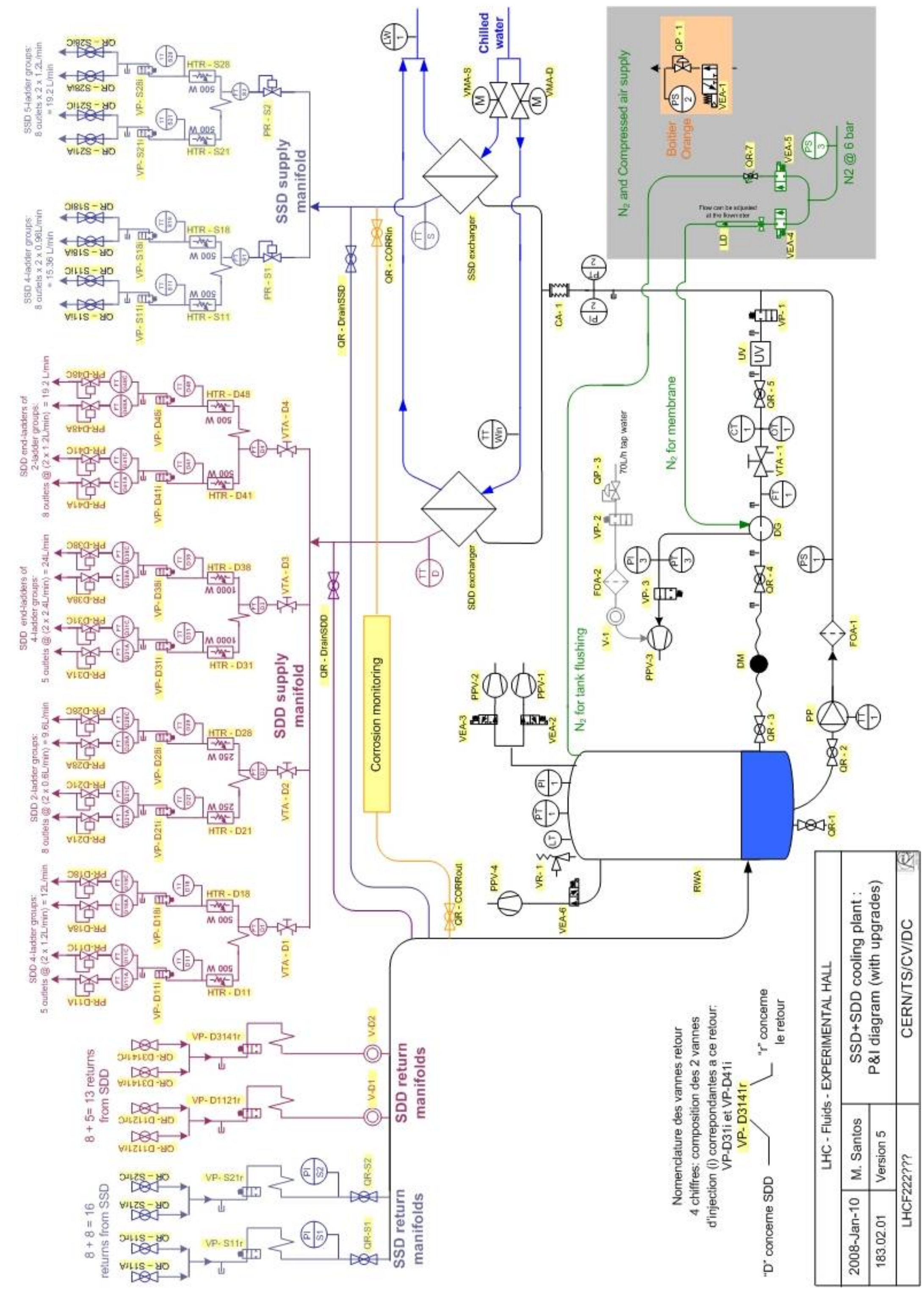
Supplier/manufacturer: Grundfos
Reference: HUBE
MTBF:? hours of continuous operation
Suggested preventive replacement:
Cost:330 CHF

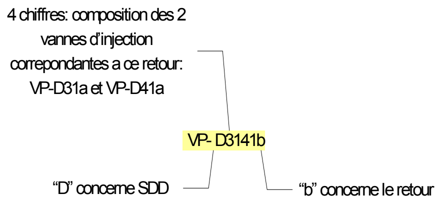
2.2.3 VACUUM PUMP

Supplier/manufacturer: KNF
Reference: pump NPK0100
MTBF:? hours of continuous operation
Suggested preventive replacement:
Cost:1200 CHF

3 HYDRAULIC DOSSIER

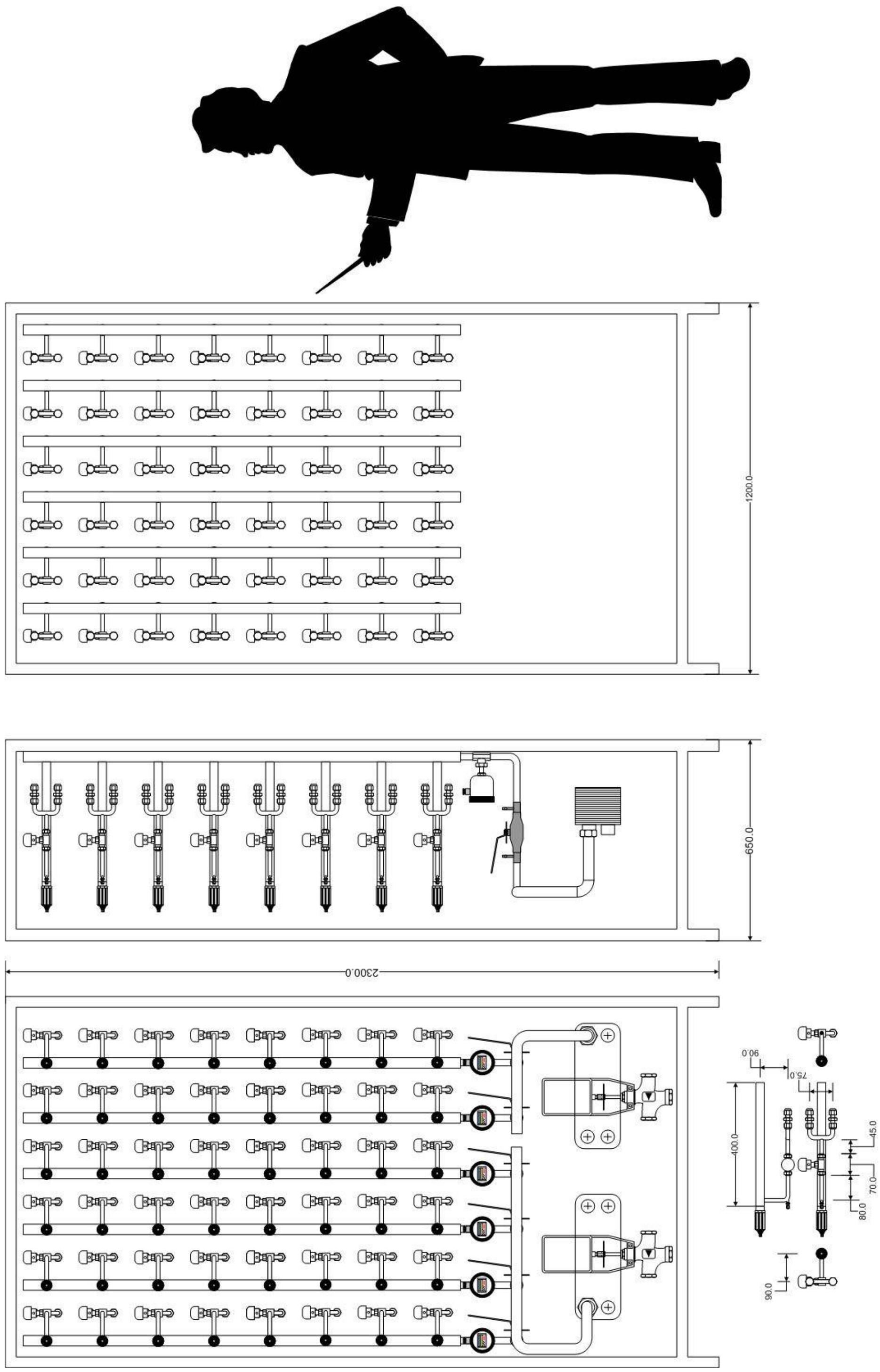
3.1 P&I

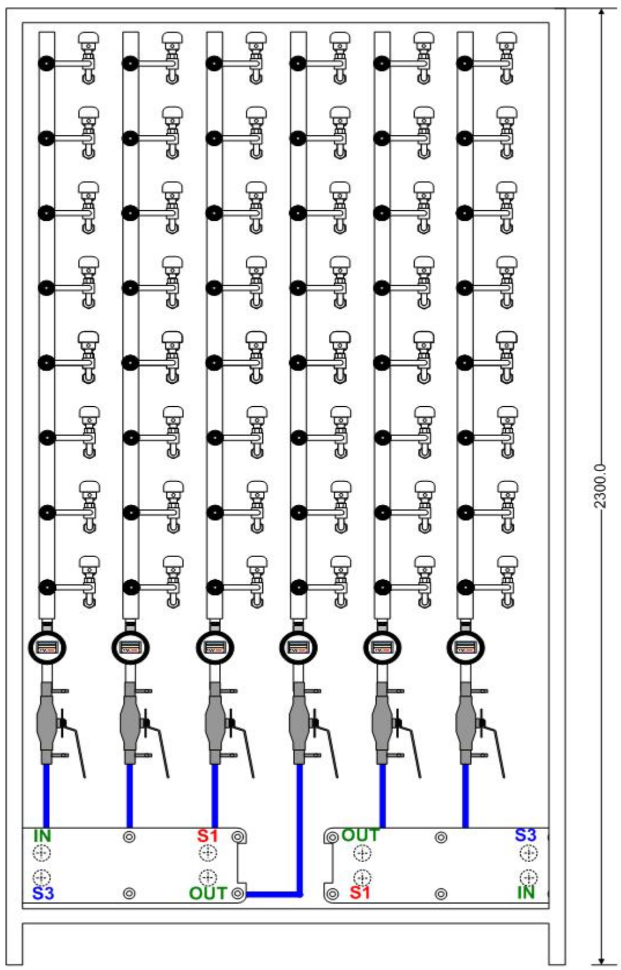


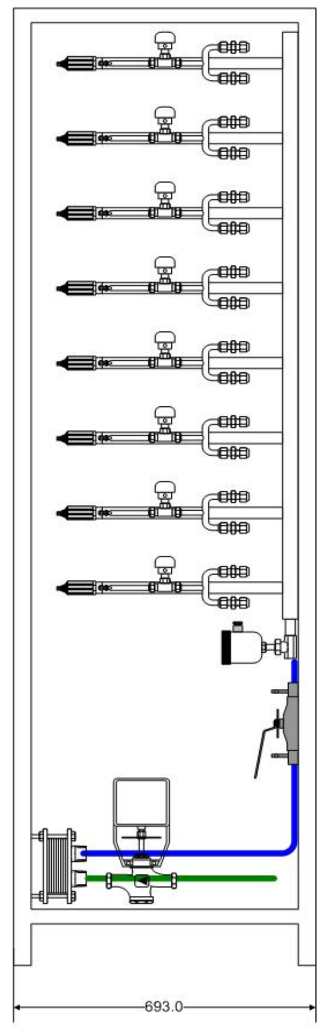


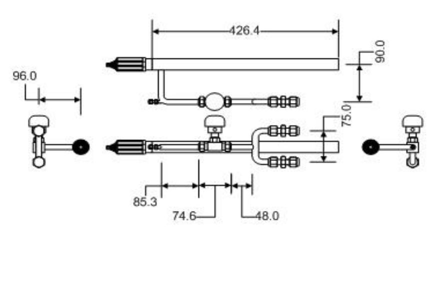
Toutes les vannes d'injection portent la lettre ˝a˝ a la fin du repère dessin. Ex : VP-S11a
Toutes les vannes de retour portent la lettre ˝b˝ a Note sur le P&I :
Les lettres S et D indiquent SSD ou SDD. Exemple : HTR-S28, HTR-D28
Pour la SDD, chaque vanne de retour appartient a deux circuits. La vanne de retour est nommée par combinaison des 2 digits des vannes d'injection. Exemple : VP-D3141b est le retour de VP-D31a et VP-D41a

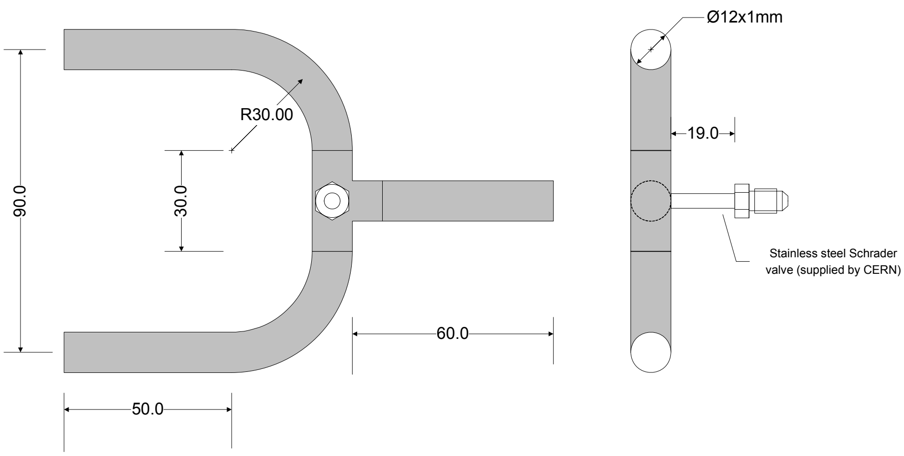
3.2 CONSTRUCTION AND ASSEMBLY DRAWINGS

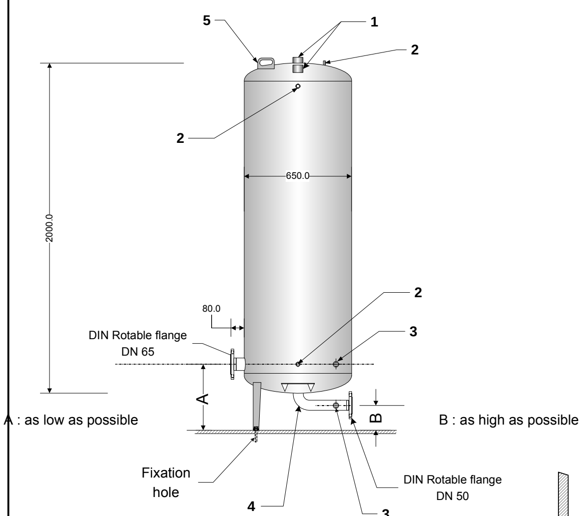



IN
S3
S1
OUT
OUT
S1
S3
IN
2300.0

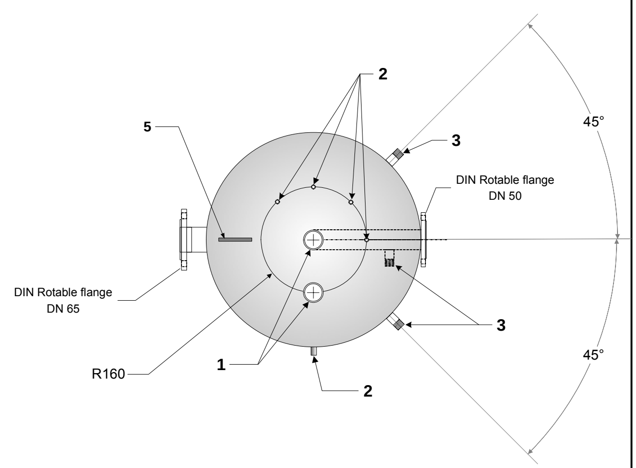

693.0


426.4
90.0
96.0
75.0
85.3
74.6
48.0

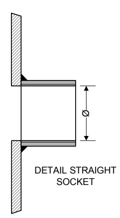




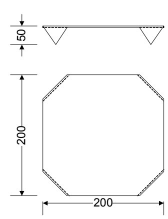
Scale 1/20



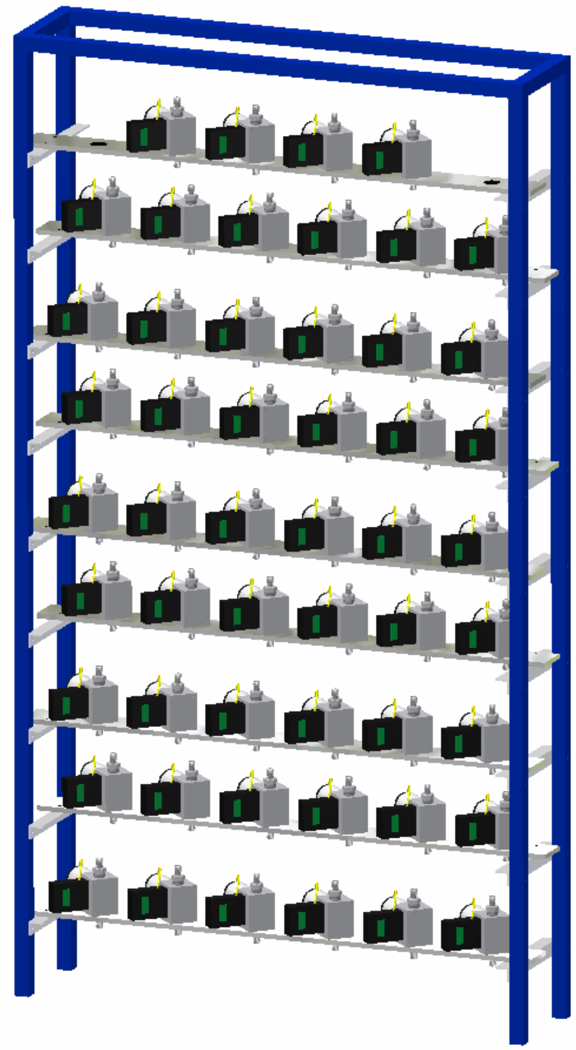
Scale 1/10



DETAIL STRAIGHT SOCKET



Detail deflector



3.3 SERVICES

The services required by this cooling plant are:

- 7 m^3/h, ΔP=2bar of chilled water
- 31kVA, 400V from the TS-CV standard power distribution
- 700W, 220V from TS-CV UPS power distribution
- compressed air at 6bar (consumption is negligible).
- 0.5 m3/h N_2
- Tap water, 60L/h
- TCP/IP connection

ELECTRICAL DOSSIER

3.4 FUNCTIONAL ANALYSIS

3.4.1 DESCRIPTION GÉNÉRALE:

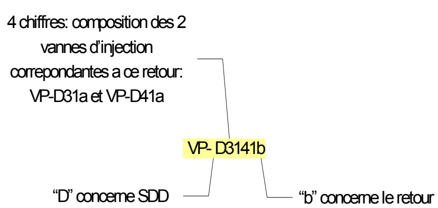
Cette installation refroidie, purifie et pompe de l'eau vers les détecteurs de physique SSD et SDD. Le fonctionnement de ce système est conforme au modèle « Leackless v2.0 » mis en œuvre habituellement par la section TS-CV-DC.

Le contrôle des fuites de cette installation est renforcée par des algorithmes de surveillance avancés. Une séquence d'autodiagnostic permet la recherche de fuites automatique par circuit.

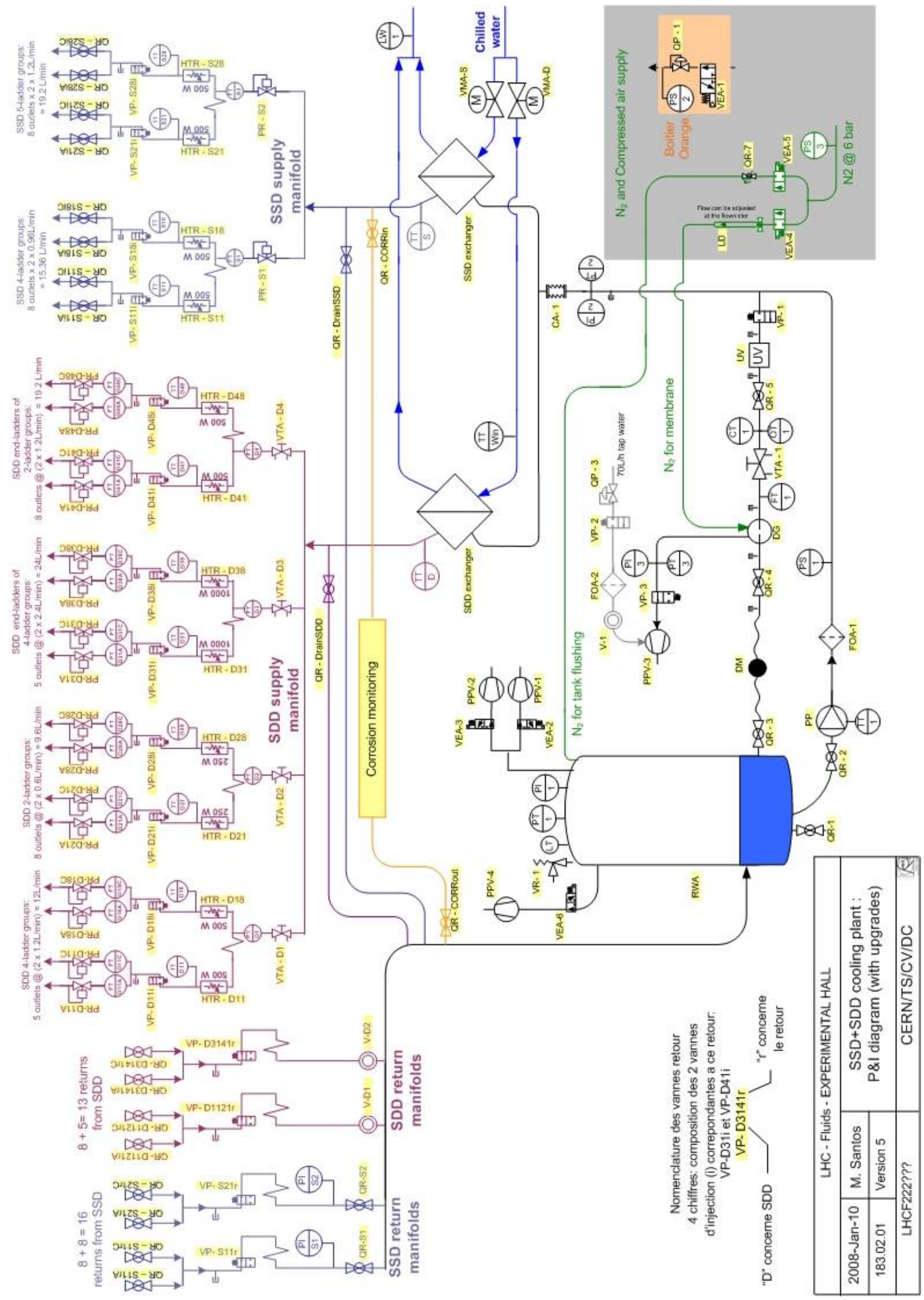
Une partie du débit total circule sur une séquence de filtres de purification. La température de l'eau envoyée vers les détecteurs est contrôlée par des chauffages individuels pour chaque circuit.

3.4.2 SCHÉMA DE PRINCIPE :

Explication des repères dessin :



Toutes les vannes d'injection portent la lettre ˝a˝ a la fin du repère dessin. Ex : VP-S11a
Toutes les vannes de retour portent la lettre ˝b˝ a la fin du repère dessin. Ex : VP-S11b
Les lettres S et D indiquent SSD ou SDD. Exemple : HTR-S28, HTR-D28
Pour la SDD, chaque vanne de retour appartient a deux circuits. La vanne de retour est nommée par combinaison des 2 digits des vannes d'injection. Exemple : VP-D3141b est le retour de VP-D31a et VP-D41a


SSD supply manifold
SDD supply manifold
SSD return manifolds
SDD return manifolds
SSD exchanger
SDD exchanger
Chilled water
Corrosion monitoring
N2 and Compressed air supply
N2 for membrane
N2 for tank flushing
N2 @ 6 bar
Boitier Orange
RWA
LHC - Fluids - EXPERIMENTAL HALL
SSD+SDD cooling plant : P&I diagram (with upgrades)
2008-Jan-10
M. Santos
183.02.01
Version 5
LHCF222???
CERN/TS/CV/DC

3.4.3 CORRESPONDANCE ENTRE VANNES ET CIRCUITS

(suivre le schéma de principe de gauche vers droite)

183/02.VP-S21a	*vanne d'injection SSD circuit **05***	***Remarque :*** ***Chaque circuit SSD = une vanne d'injection + une vanne de retour***
183/02.VP-S11b	*vanne de retour SSD circuit **05***	
183/02.VP-S11a	*vanne d'injection SSD circuit **06***	
183/02.VP-S12b	*vanne de retour SSD circuit **06***	
183/02.VP-S22a	*vanne d'injection SSD circuit **11***	
183/02.VP-S13b	*vanne de retour SSD circuit **11***	
183/02.VP-S12a	*vanne d'injection SSD circuit **12***	
183/02.VP-S14b	*vanne de retour SSD circuit **12***	
183/02.VP-S23a	*vanne d'injection SSD circuit **17***	
183/02.VP-S15b	*vanne de retour SSD circuit **17***	
183/02.VP-S13a	*vanne d'injection SSD circuit **18***	
183/02.VP-S16b	*vanne de retour SSD circuit **18***	
183/02.VP-S24a	*vanne d'injection SSD circuit **23***	
183/02.VP-S17b	*vanne de retour SSD circuit **23***	
183/02.VP-S14a	*vanne d'injection SSD circuit **24***	
183/02.VP-S18b	*vanne de retour SSD circuit **24***	
183/02.VP-S25a	*vanne d'injection SSD circuit **29***	
183/02.VP-S21b	*vanne de retour SSD circuit **29***	
183/02.VP-S15a	*vanne d'injection SSD circuit **30***	
183/02.VP-S22b	*vanne de retour SSD circuit **30***	
183/02.VP-S26a	*vanne d'injection SSD circuit **35***	
183/02.VP-S23b	*vanne de retour SSD circuit **35***	
183/02.VP-S16a	*vanne d'injection SSD circuit **36***	
183/02.VP-S24b	*vanne de retour SSD circuit **36***	
183/02.VP-S27a	*vanne d'injection SSD circuit **41***	
183/02.VP-S25b	*vanne de retour SSD circuit **41***	
183/02.VP-S17a	*vanne d'injection SSD circuit **42***	
183/02.VP-S26b	*vanne de retour SSD circuit **42***	
183/02.VP-S28a	*vanne d'injection SSD circuit **47***	
183/02.VP-S27b	*vanne de retour SSD circuit **47***	
183/02.VP-S18a	*vanne d'injection SSD circuit **48***	
183/02.VP-S28b	*vanne de retour SSD circuit **48***	

183/02.VP-D11a	*vanne d'injection SDD circuit **04***	
183/02.VP-D12a	*vanne d'injection SDD circuit **10***	
183/02.VP-D13a	*vanne d'injection SDD circuit **16***	
183/02.VP-D14a	*vanne d'injection SDD circuit **22***	
183/02.VP-D15a	*vanne d'injection SDD circuit **28***	
183/02.VP-D16a	*vanne d'injection SDD circuit **34***	
183/02.VP-D17a	*vanne d'injection SDD circuit **40***	
183/02.VP-D18a	*vanne d'injection SDD circuit **46***	
183/02.VP-D21a	*vanne d'injection SDD circuit **03***	
183/02.VP-D22a	*vanne d'injection SDD circuit **09***	
183/02.VP-D23a	*vanne d'injection SDD circuit **15***	
183/02.VP-D24a	*vanne d'injection SDD circuit **21***	
183/02.VP-D25a	*vanne d'injection SDD circuit **27***	
183/02.VP-D26a	*vanne d'injection SDD circuit **33***	
183/02.VP-D27a	*vanne d'injection SDD circuit **39***	
183/02.VP-D28a	*vanne d'injection SDD circuit **45***	
183/02.VP-D31a	*vanne d'injection SDD circuit **02***	
183/02.VP-D32a	*vanne d'injection SDD circuit **08***	
183/02.VP-D33a	*vanne d'injection SDD circuit **14***	
183/02.VP-D34a	*vanne d'injection SDD circuit **20***	
183/02.VP-D35a	*vanne d'injection SDD circuit **26***	
183/02.VP-D36a	*vanne d'injection SDD circuit **32***	
183/02.VP-D37a	*vanne d'injection SDD circuit **38***	
183/02.VP-D38a	*vanne d'injection SDD circuit **44***	
183/02.VP-D41a	*vanne d'injection SDD circuit **01***	
183/02.VP-D42a	*vanne d'injection SDD circuit **07***	
183/02.VP-D43a	*vanne d'injection SDD circuit **13***	
183/02.VP-D44a	*vanne d'injection SDD circuit **19***	
183/02.VP-D45a	*vanne d'injection SDD circuit **25***	
183/02.VP-D46a	*vanne d'injection SDD circuit **31***	
183/02.VP-D47a	*vanne d'injection SDD circuit **37***	
183/02.VP-D48a	*vanne d'injection SDD circuit **43***	
183/02.VP-D1121b	*vanne de retour SSD circuit **03+04***	
183/02.VP-D1222b	*vanne de retour SSD circuit **09+10***	
183/02.VP-D1323b	*vanne de retour SSD circuit **15+16***	
183/02.VP-D1424b	*vanne de retour SSD circuit **21+22***	
183/02.VP-D1525b	*vanne de retour SSD circuit **27+28***	
183/02.VP-D1626b	*vanne de retour SSD circuit **33+34***	
183/02.VP-D1727b	*vanne de retour SSD circuit **39+40***	
183/02.VP-D1828b	*vanne de retour SSD circuit **45+46***	
183/02.VP-D3141b	*vanne de retour SSD circuit **01+02***	
183/02.VP-D3242b	*vanne de retour SSD circuit **07+08***	
183/02.VP-D3343b	*vanne de retour SSD circuit **13+14***	
183/02.VP-D3444b	*vanne de retour SSD circuit **19+20***	
183/02.VP-D3545b	*vanne de retour SSD circuit **25+26***	
183/02.VP-D3646b	*vanne de retour SSD circuit **31+32***	
183/02.VP-D3747b	*vanne de retour SSD circuit **37+38***	
183/02.VP-D3848b	*vanne de retour SSD circuit **43+44***	

Remarque :
Chaque circuit SDD = 2 vannes d'injection + 1 vanne de retour

3.4.4 ARMOIRES:

3.4.4.1 ARMOIRE ELECTRIQUE FCTIR-00024:

Départ puissance pour l'alimentation de l'armoire de contrôle

400v. tri+N. 31 kW depuis réseau normal (EDF/EOS)

Ce coffret est situé dans PX24 (voir plans d'intégration ALI SRCR_0010)

3.4.4.2 ARMOIRE ÉLECTRIQUE TS-CV2 UPS*:*

Départ puissance pour l'alimentation de l'armoire de contrôle.

220v. mono. 700W depuis secours (UPS)

Ce coffret est situé dans PX24 (voir plans d'intégration ALI SRCR_0010)

3.4.4.3 ARMOIRE ÉLECTRIQUE ET CONTRÔLE FCTIR-00032:

Armoire de contrôle integrant l'automate, les alimentations TBT, le relayage, les modules d'entrees /sorties ainsi que l'interface utilisateur.

Cette armoire est situé dans PX24, elle est alimenté depuis **FCTIR-00024** et **TS-CV2 UPS**.

3.4.4.4 ARMOIRE ÉLECTRIQUE FCTIR-00033:

Armoire de contrôle integrant les relais statiques des resistances de chauffage.

Cette armoire est située dans PX24, elle est alimenté depuis **FCTIR-00032**.

3.4.5 LISTE DES ENTRÉES/SORTIES AUTOMATE:

3.4.5.1 INTERNES A L'ARMOIRE DE CONTRÔLE:

- Capteurs :

Référence:	*Description:*	*Type*	*Gamme*
disj1a…3a	*Défaut disjoncteurs 1a-3a (Puissance secourue)*	*TOR*	
disj4a…7a	*Défaut disjoncteurs 4a-7a (Puissance secourue)*	*TOR*	
disj 1…4	*Défaut disjoncteurs 1-4 (Puissance Normal)*	*TOR*	
	Retour de marche du variateur de fréquence	*TOR*	
	Défaut variateur de fréquence	*TOR*	
Rel.08	*Surveillance secteur (détection de panne de courant)*	*TOR*	
	Thermostat du coffret des relais statiques	*TOR*	

3.5 STATION DE REFROIDISSEMENT:

- Capteurs :

Référence:	*Description:*	*Type*	*Gamme*	*Symb. sur schéma*
183/02.PS-2	*Pressostat air comprimé dans boîtier orange*	*TOR*	*1-10 bara*	PS 2
183/02.PS-1	*Pressostat en sortie de pompe liquide*	*TOR*	*1-6 bara*	PS 1
183/02.LW-1	*Compteur de débit d'eau glacé*	*TOR*	*0-10m^3/h*	LW 1
183/02.PS-3	*Pressostat alimentation de N2*	*TOR*	*1-10 bara*	PS 3
néant	*Thermostat combiné resistances HTR-xxx*	*TOR*		*néant*
183/02.PT-1	*Capteur de pression réservoir*	*4-20 mA*	*0-2 bara*	PT 1
183/02.LT	*Capteur de niveau liquide dans le réservoir*	*4-20mA*	*0 - 600 Litres*	LT
183/02.PT-2	*Capteur de pression sortie pompe*	*4-20 mA*	*0-11 bara*	PT 2
183/02.OT-1	*Capteur de oxygène*	*4-20 mA*	*0-20mg/L*	OT 1
183/02.CT-1	*Capteur de résistivité*	*4-20 mA*	*0.05-20 MΩ.cm*	CT 1
183/02.FT-1	*Capteur de débit de purification*	*4-20 mA*	*0 - 30 l/mn*	FT 1
183/02.PT-3	*Capteur de pression membrane*	*4-20 mA*	*0-2 bara*	PT 3
183/02.FT-S1	*Capteur de débit ˝SSD 5-ladder groups˝*	*4-20 mA*	*0 - 30 l/mn*	FT S1
183/02.FT-S2	*Capteur de débit ˝SSD 4-ladder groups˝*	*4-20 mA*	*0 - 30 l/mn*	FT S2
183/02.FT-D1	*Capteur de débit ˝SDD 2-ladder groups˝*	*4-20 mA*	*0 - 30 l/mn*	FT D1
183/02.FT-D2	*Capteur de débit ˝SDD 2-endladder groups˝*	*4-20 mA*	*0 - 30 l/mn*	FT D2
183/02.FT-D3	*Capteur de débit ˝SDD 4-ladder groups˝*	*4-20 mA*	*0 - 30 l/mn*	FT D3
183/02.FT-D4	*Capteur de débit ˝SDD 4-endladder groups˝*	*4-20 mA*	*0 - 30 l/mn*	FT D4
183/02.TT-1	*Température du moteur pompe*	*PT100*	*0-50 Cº*	TT 1
183/02.TT-Sa	*Température de sortie échangeur SSD*	*PT100*	*0-50 Cº*	TT Sa
183/02.TT-Da	*Température de sortie échangeur SDD*	*PT100*	*0-50 Cº*	TT Da
183/02.TT-Win	*Température de entrée d'eau glacé*	*PT100*	*0-50 Cº*	TT Win
183/02.TT-S11	*Température départ SSD circuit01*	*PT100*	*0-50 Cº*	TT S11
183/02.TT-S12	*Température départ SSD circuit02*	*PT100*	*0-50 Cº*	*néant*
183/02.TT-S13	*Température départ SSD circuit03*	*PT100*	*0-50 Cº*	*néant*
183/02.TT-S14	*Température départ SSD circuit04*	*PT100*	*0-50 Cº*	*néant*
183/02.TT-S15	*Température départ SSD circuit05*	*PT100*	*0-50 Cº*	*néant*

183/02.TT-S16	Température départ SSD circuit06	PT100	0-50 C°	néant
183/02.TT-S17	Température départ SSD circuit07	PT100	0-50 C°	néant
183/02.TT-S18	Température départ SSD circuit08	PT100	0-50 C°	TT S18
183/02.TT-S21	Température départ SSD circuit09	PT100	0-50 C°	TT S21
183/02.TT-S22	Température départ SSD circuit10	PT100	0-50 C°	néant
183/02.TT-S23	Température départ SSD circuit11	PT100	0-50 C°	néant
183/02.TT-S24	Température départ SSD circuit12	PT100	0-50 C°	néant
183/02.TT-S25	Température départ SSD circuit13	PT100	0-50 C°	néant
183/02.TT-S26	Température départ SSD circuit14	PT100	0-50 C°	néant
183/02.TT-S27	Température départ SSD circuit15	PT100	0-50 C°	néant
183/02.TT-S28	Température départ SSD circuit16	PT100	0-50 C°	TT S28
183/02.TT-D11	Température départ SDD circuit17	PT100	0-50 C°	TT D11
183/02.TT-D12	Température départ SDD circuit18	PT100	0-50 C°	néant
183/02.TT-D13	Température départ SDD circuit19	PT100	0-50 C°	néant
183/02.TT-D14	Température départ SDD circuit20	PT100	0-50 C°	néant
183/02.TT-D15	Température départ SDD circuit21	PT100	0-50 C°	néant
183/02.TT-D16	Température départ SDD circuit22	PT100	0-50 C°	néant
183/02.TT-D17	Température départ SDD circuit23	PT100	0-50 C°	néant
183/02.TT-D18	Température départ SDD circuit24	PT100	0-50 C°	TT D18
183/02.TT-D21	Température départ SDD circuit25	PT100	0-50 C°	TT D21
183/02.TT-D22	Température départ SDD circuit26	PT100	0-50 C°	néant
183/02.TT-D23	Température départ SDD circuit27	PT100	0-50 C°	néant
183/02.TT-D24	Température départ SDD circuit28	PT100	0-50 C°	néant
183/02.TT-D25	Température départ SDD circuit29	PT100	0-50 C°	néant
183/02.TT-D26	Température départ SDD circuit30	PT100	0-50 C°	néant
183/02.TT-D27	Température départ SDD circuit31	PT100	0-50 C°	néant
183/02.TT-D28	Température départ SDD circuit32	PT100	0-50 C°	TT D28
183/02.TT-D31	Température départ SDD circuit33	PT100	0-50 C°	TT D31
183/02.TT-D32	Température départ SDD circuit34	PT100	0-50 C°	néant
183/02.TT-D33	Température départ SDD circuit35	PT100	0-50 C°	néant
183/02.TT-D34	Température départ SDD circuit36	PT100	0-50 C°	néant
183/02.TT-D35	Température départ SDD circuit37	PT100	0-50 C°	néant
183/02.TT-D36	Température départ SDD circuit38	PT100	0-50 C°	néant
183/02.TT-D37	Température départ SDD circuit39	PT100	0-50 C°	néant
183/02.TT-D38	Température départ SDD circuit40	PT100	0-50 C°	TT D38
183/02.TT-D41	Température départ SDD circuit41	PT100	0-50 C°	TT D41
183/02.TT-D42	Température départ SDD circuit42	PT100	0-50 C°	néant
183/02.TT-D43	Température départ SDD circuit43	PT100	0-50 C°	néant
183/02.TT-D44	Température départ SDD circuit44	PT100	0-50 C°	néant
183/02.TT-D45	Température départ SDD circuit45	PT100	0-50 C°	néant
183/02.TT-D46	Température départ SDD circuit46	PT100	0-50 C°	néant
183/02.TT-D47	Température départ SDD circuit47	PT100	0-50 C°	néant
183/02.TT-D48	Température départ SDD circuit48	PT100	0-50 C°	TT D48

- Actionneurs :

Référence:	Description:	Type	Gamme
183/02.PP	*Pilotage PID variateur de fréquence pompe*	*4-20mA*	
183/02.VMA-S	*Pilotage PID vanne régulation eau glacée VMA-S*	*4-20mA*	
183/02.VMA-D	*Pilotage PID vanne régulation eau glacée VMA-D*	*4-20mA*	
183/02.PP	*Commande pompe liquide (on/off) vers variateur*	*TOR*	
183/02.PP	*Reset variateur pompe liquide*	*TOR*	
183/02.PPV-1	*Commande pompe à vide PPV-1*	*TOR*	
183/02.PPV-2	*Commande pompe à vide PPV-2*	*TOR*	
183/02.PPV-3	*Commande pompe à vide PPV-3*	*TOR*	
183/02.UV	*Commande lampe UV*	*TOR*	
183/02.VMA-S	*Commande alim. vanne de régulation eau glacée VMA-S*	*TOR*	
183/02.VMA-D	*Commande alim. vanne de régulation eau glacée VMA-D*	*TOR*	
183/02.VEA-1	*Commande vanne d'air comprimé boîtier orange*	*TOR*	
183/02.VEA-2	*Commande vanne 3 voies pompe à vide PPV-1*	*TOR*	
183/02.VEA-3	*Commande vanne 3 voies pompe à vide PPV-2*	*TOR*	
183/02.VEA-4	*Commande vanne arrivée N2 pour membrane*	*TOR*	
183/02.VEA-5	*Commande vanne arrivée N2 pour réservoir*	*TOR*	

Commandes par profibus (à définir dans PBY 100)

183/02.VP-S21a	*Commande vanne d'injection SSD circuit05*	*TOR*	
183/02.VP-S11b	*Commande vanne de retour SSD circuit05*	*TOR*	
183/02.VP-S11a	*Commande vanne d'injection SSD circuit06*	*TOR*	
183/02.VP-S12b	*Commande vanne de retour SSD circuit06*	*TOR*	
183/02.VP-S22a	*Commande vanne d'injection SSD circuit11*	*TOR*	
183/02.VP-S13b	*Commande vanne de retour SSD circuit11*	*TOR*	
183/02.VP-S12a	*Commande vanne d'injection SSD circuit12*	*TOR*	
183/02.VP-S14b	*Commande vanne de retour SSD circuit12*	*TOR*	
183/02.VP-S23a	*Commande vanne d'injection SSD circuit17*	*TOR*	
183/02.VP-S15b	*Commande vanne de retour SSD circuit17*	*TOR*	
183/02.VP-S13a	*Commande vanne d'injection SSD circuit18*	*TOR*	
183/02.VP-S16b	*Commande vanne de retour SSD circuit18*	*TOR*	
183/02.VP-S24a	*Commande vanne d'injection SSD circuit23*	*TOR*	
183/02.VP-S17b	*Commande vanne de retour SSD circuit23*	*TOR*	
183/02.VP-S14a	*Commande vanne d'injection SSD circuit24*	*TOR*	
183/02.VP-S18b	*Commande vanne de retour SSD circuit24*	*TOR*	
183/02.VP-S25a	*Commande vanne d'injection SSD circuit29*	*TOR*	
183/02.VP-S21b	*Commande vanne de retour SSD circuit29*	*TOR*	
183/02.VP-S15a	*Commande vanne d'injection SSD circuit30*	*TOR*	
183/02.VP-S22b	*Commande vanne de retour SSD circuit30*	*TOR*	
183/02.VP-S26a	*Commande vanne d'injection SSD circuit35*	*TOR*	
183/02.VP-S23b	*Commande vanne de retour SSD circuit35*	*TOR*	
183/02.VP-S16a	*Commande vanne d'injection SSD circuit36*	*TOR*	
183/02.VP-S24b	*Commande vanne de retour SSD circuit36*	*TOR*	
183/02.VP-S27a	*Commande vanne d'injection SSD circuit41*	*TOR*	
183/02.VP-S25b	*Commande vanne de retour SSD circuit41*	*TOR*	
183/02.VP-S17a	*Commande vanne d'injection SSD circuit42*	*TOR*	
183/02.VP-S26b	*Commande vanne de retour SSD circuit42*	*TOR*	
183/02.VP-S28a	*Commande vanne d'injection SSD circuit47*	*TOR*	
183/02.VP-S27b	*Commande vanne de retour SSD circuit47*	*TOR*	

183/02.VP-S18a	*Commande vanne d'injection SSD circuit48*	*TOR*	
183/02.VP-S28b	*Commande vanne de retour SSD circuit48*	*TOR*	
183/02.VP-D11a	*Commande vanne d'injection SDD circuit04*	*TOR*	
183/02.VP-D21a	*Commande vanne d'injection SDD circuit03*	*TOR*	
183/02.VP-D1121b	*Commande vanne de retour SSD circuit 03+04*	*TOR*	
183/02.VP-D12a	*Commande vanne d'injection SDD circuit10*	*TOR*	
183/02.VP-D22a	*Commande vanne d'injection SDD circuit09*	*TOR*	
183/02.VP-D1222b	*Commande vanne de retour SSD circuit 09+10*	*TOR*	
183/02.VP-D13a	*Commande vanne d'injection SDD circuit16*	*TOR*	
183/02.VP-D23a	*Commande vanne d'injection SDD circuit15*	*TOR*	
183/02.VP-D1323b	*Commande vanne de retour SSD circuit 15+16*	*TOR*	
183/02.VP-D14a	*Commande vanne d'injection SDD circuit22*	*TOR*	
183/02.VP-D24a	*Commande vanne d'injection SDD circuit21*	*TOR*	
183/02.VP-D1424b	*Commande vanne de retour SSD circuit 21+22*	*TOR*	
183/02.VP-D15a	*Commande vanne d'injection SDD circuit28*	*TOR*	
183/02.VP-D25a	*Commande vanne d'injection SDD circuit27*	*TOR*	
183/02.VP-D1525b	*Commande vanne de retour SSD circuit 27+28*	*TOR*	
183/02.VP-D16a	*Commande vanne d'injection SDD circuit34*	*TOR*	
183/02.VP-D26a	*Commande vanne d'injection SDD circuit33*	*TOR*	
183/02.VP-D1626b	*Commande vanne de retour SSD circuit 33+34*	*TOR*	
183/02.VP-D17a	*Commande vanne d'injection SDD circuit40*	*TOR*	
183/02.VP-D27a	*Commande vanne d'injection SDD circuit39*	*TOR*	
183/02.VP-D1727b	*Commande vanne de retour SSD circuit 39+40*	*TOR*	
183/02.VP-D18a	*Commande vanne d'injection SDD circuit46*	*TOR*	
183/02.VP-D28a	*Commande vanne d'injection SDD circuit45*	*TOR*	
183/02.VP-D1828b	*Commande vanne de retour SSD circuit 45+46*	*TOR*	
183/02.VP-D31a	*Commande vanne d'injection SDD circuit02*	*TOR*	
183/02.VP-D41a	*Commande vanne d'injection SDD circuit01*	*TOR*	
183/02.VP-D3141b	*Commande vanne de retour SSD circuit 01+02*	*TOR*	
183/02.VP-D32a	*Commande vanne d'injection SDD circuit08*	*TOR*	
183/02.VP-D42a	*Commande vanne d'injection SDD circuit07*	*TOR*	
183/02.VP-D3242b	*Commande vanne de retour SSD circuit 07+08*	*TOR*	
183/02.VP-D33a	*Commande vanne d'injection SDD circuit14*	*TOR*	
183/02.VP-D43a	*Commande vanne d'injection SDD circuit13*	*TOR*	
183/02.VP-D3343b	*Commande vanne de retour SSD circuit 13+14*	*TOR*	
183/02.VP-D34a	*Commande vanne d'injection SDD circuit20*	*TOR*	
183/02.VP-D44a	*Commande vanne d'injection SDD circuit19*	*TOR*	
183/02.VP-D3444b	*Commande vanne de retour SSD circuit 19+20*	*TOR*	
183/02.VP-D35a	*Commande vanne d'injection SDD circuit26*	*TOR*	
183/02.VP-D45a	*Commande vanne d'injection SDD circuit25*	*TOR*	
183/02.VP-D3545b	*Commande vanne de retour SSD circuit 25+26*	*TOR*	
183/02.VP-D36a	*Commande vanne d'injection SDD circuit32*	*TOR*	
183/02.VP-D46a	*Commande vanne d'injection SDD circuit31*	*TOR*	
183/02.VP-D3646b	*Commande vanne de retour SSD circuit 31+32*	*TOR*	
183/02.VP-D37a	*Commande vanne d'injection SDD circuit38*	*TOR*	
183/02.VP-D47a	*Commande vanne d'injection SDD circuit37*	*TOR*	
183/02.VP-D3747b	*Commande vanne de retour SSD circuit 37+38*	*TOR*	
183/02.VP-D38a	*Commande vanne d'injection SDD circuit44*	*TOR*	
183/02.VP-D48a	*Commande vanne d'injection SDD circuit43*	*TOR*	
183/02.VP-D3848b	*Commande vanne de retour SSD circuit 43+44*	*TOR*	

183/02.VP-1	Commande vanne de purification	TOR	
183/02.VP-2	Commande vanne eau pour pompe anneau liquide	TOR	
183/02.VP-3	Commande vanne entrée pompe anneau liquide	TOR	

3.5.1.1 DSS INTERLOCKS

- Capteurs :

Référence :	*Description :*	*Type :*	*Gamme :*
183/02.DSS_in	*Interlock depuis DSS*	*TOR*	

- Actionneurs :

Référence:	*Description:*	*Type :*	*Gamme :*
183/02.DSS_out01	*Commande d'interlock vers DSS*	*TOR*	
183/02.DSS_out02	*Commande d'interlock vers DSS*	*TOR*	

N.B. une sortie DSS par circuit (=1 si ˝open˝) n'est pas faisable vue le grand nombre de circuits. D'autre part, dans le détecteur l'alimentation électrique est commune à plusieurs circuits (en moyenne 5 circuits par alim. – 8 alim pour tout le détecteur - donc très peu de sélectivité).

3.5.2 FONCTIONNALITÉS ET RÉGULATION

3.5.2.1 DÉFINITION DES 3 ÉTATS POSSIBLE POUR UN CIRCUIT : *OPEN*, *CLOSED* ET *LOCKED*

Un circuit est **open** si la vanne d'injection et la vanne de retour sont ouvertes.

Un circuit est **closed** si la vanne d'injection est fermée mais la vanne de retour est ouverte.

Un circuit est **locked** si la vanne d'injection et la vanne de retour sont fermées.

Puisque toutes les vannes de retour SDD sont partagées entre 2 circuits, pour les pairs de circuits suivants – que l' on appellera ˝ **twin circuits**˝ -

01 et 02
03 et 04
07 et 08
09 et 10
13 et 14
15 et 16
19 et 20
21 et 22
25 et 26
27 et 28
31 et 32
33 et 34
37 et 38
39 et 40
43 et 44
45 et 46

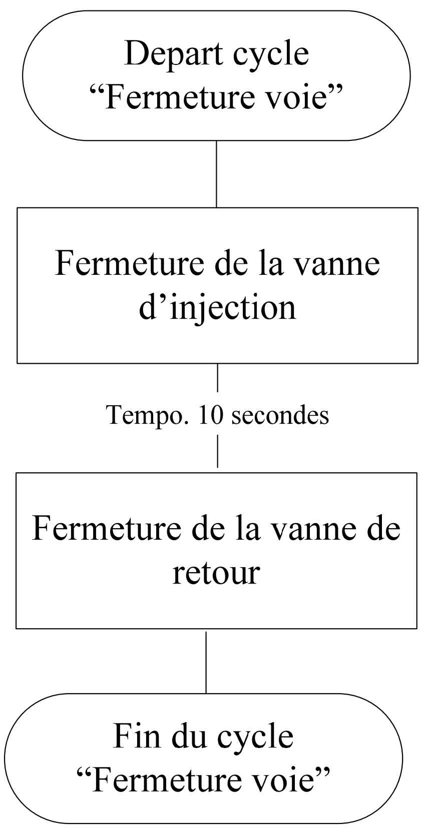
…le status d'un circuit conditionne l'autre circuit

Status Circuit #1	Status Circuit #2	
open	open	possible
open	closed	possible
open	locked	**impossible**
closed	closed	possible
closed	locked	**impossible**
locked	locked	possible

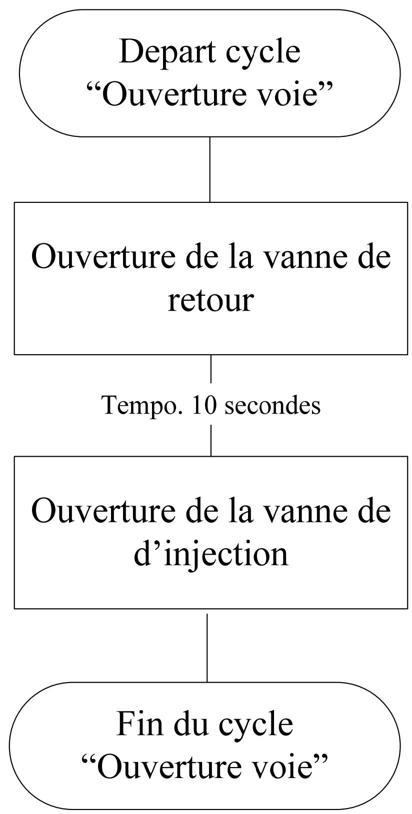
Conclusion : ˝twin circuits˝ seront toujours locked ensemble.

3.6 TRANSITION D'ÉTATS D'UN CIRCUIT

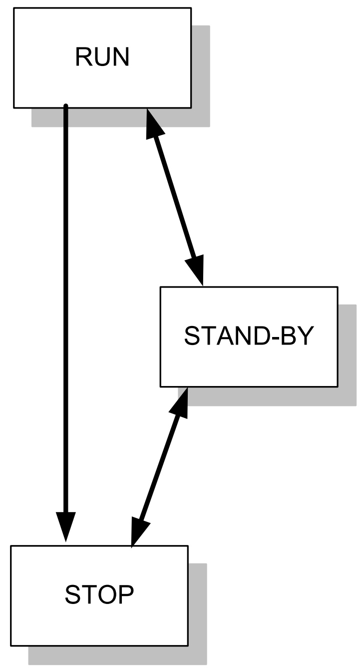
Lors de la fermeture total d'une voie :
(c.a.d. *open* vers *locked*).



Lors de l'ouverture d'une voie
(*locked* ou *closed* vers *open*).



3.7 MODES (OU CYCLES) DE FONCTIONNEMENT:



3.8 CYCLE **STOP** :

(Conditions Initiales)

Ce cycle correspond à l'état par défaut de l'automate à la mise sous tension, et ce, jusqu'à ce que l'opérateur sélectionne un autre cycle.

Ce cycle sera lancé automatiquement pour l'arrêt du système sur apparition d'alarme majeure ou défauts majeurs non maîtrises (voir table de défauts et Alarmes)

Dès passage en STOP, les circuits se positionnent tous en ˝closed˝, sauf pour les circuits ˝locked˝.

L'utilisateur ne peut pas changer l'état des voies.

Le cycle STOP est sélectionnable par l'opérateur ou automatiquement depuis STAND-BY ou RUN.

Dès action sur départ cycle :

Référence:	Description:	Status :
183/02.PPV-1	*pompe à vide PPV-1 (fonction LEAKLESS)*	*Arrêtée*
183/02.PPV-2	*pompe à vide PPV-2 (fonction LEAKLESS)*	*Arrêtée*

183/02.PPV-3	*pompe à vide PPV-3 (fonction dégazage)*	*Arrêtée*
183/02.VEA-2	*vanne 3 voies entrée pompe à vide PPV-1*	*Pompe - atmosphère (position de repos)*
183/02.VEA-3	*vanne 3 voies pompe à vide PPV-2*	*Pompe - atmosphère (position de repos)*
183/02.PP	*pompe liquide PP*	*Arrêtée*
183/02.VMA-S	*vanne régulation eau glacée VMA-S*	*Fermée (position de repos)*
183/02.VMA-D	*vanne régulation eau glacée VMA-D*	*Fermée (position de repos)*
183/02.UV	*lampe UV*	*éteinte*
183/02.VEA-1	*vanne d'air comprimé boîtier orange*	*Ouvert (il faut l'air pour garder les circuits locked)*
183/02.VEA-4	*vanne arrivée N2 pour membrane*	*Fermée (position de repos)*
183/02.VEA-5	*vanne arrivée N2 pour réservoir*	*Fermée (position de repos)*
183/02.VP-1	*vanne de purification*	*Fermée (position de repos)*
183/02.VP-2	*vanne eau pour pompe anneau liquide*	*Fermée (position de repos)*
183/02.VP-3	*vanne entrée pompe anneau liquide*	*Fermée (position de repos)*
183/02.VP-_ _a	*vanne d'injection circuit n*	*Fermées (position de repos)*
183/02.VP-_ _b	*vanne de retour circuit m*	*Ouvertes (position de repos) Sauf voies « Locked »*
183/02.DSS_out01	*Sortie relais d'Interlock DSS 01*	*Ouvert*
183/02.DSS_out02	*Sortie relais d'Interlock DSS 02*	*Ouvert*
183/02.DSS_out03	*Sortie relais d'Interlock DSS 03*	*Ouvert*
183/02.DSS_out04	*Sortie relais d'Interlock DSS 04*	*Ouvert*
183/02.DSS_out05	*Sortie relais d'Interlock DSS 05*	*Ouvert*
183/02.DSS_out06	*Sortie relais d'Interlock DSS 06*	*Ouvert*
183/02.DSS_out07	*Sortie relais d'Interlock DSS 07*	*Ouvert*

3.9 CYCLE STAND-BY :

Système en attente, pas de circulation d'eau (pompe PP est arrêtée) mais fonction Leakless est en service donc toute l'installation est soumise à la basse pression (circuits inclus, à l'exception des voies ˝Locked˝)

Le contrôle de fuites (chute de niveau dans le réservoir) n'est pas actif.

Sur la boucle de purification, la lampe UV est éteinte mais le vide derrière la membrane est maintenu. La membrane n'est pas alimenté en N_2.

L'utilisateur peut passer les circuits entre ˝open˝, ˝ closed˝ et˝ locked˝.

Ce cycle sera lancé automatiquement pour mise en sécurité du système sur apparition de certaines Alarmes ou défauts non maîtrisés (voir table de défauts et Alarmes)

Le cycle STAND-BY est sélectionnable par l'opérateur depuis n'importe lequel des autres cycles.

Dès action sur départ cycle :

Référence:	Description:	Status :
183/02.PPV-1	*pompe à vide PPV-1 (fonction LEAKLESS)*	*En service*
183/02.PPV-2	*pompe à vide PPV-2 (fonction LEAKLESS)*	*En service*
183/02.PPV-3	*pompe à vide PPV-3 (fonction vide derrière membrane)*	*En service*
183/02.VEA-2	*vanne 3 voies entrée pompe à vide PPV-1*	*Pompe – réservoir quand pompe tourne (délai au démarrage)*
183/02.VEA-3	*vanne 3 voies pompe à vide PPV-2*	*Pompe – réservoir quand pompe tourne (délai au démarrage)*

183/02.PP	pompe liquide PP	Arrêtée
183/02.VMA-S	vanne régulation eau glacée VMA-S	Fermée (position de repos)
183/02.VMA-D	vanne régulation eau glacée VMA-D	Fermée (position de repos)
183/02.UV	lampe UV	éteinte
183/02.VEA-1	vanne d'air comprimé boîtier orange	Ouvert (il faut l'air pour garder les circuits locked)
183/02.VEA-4	vanne arrivée N2 pour membrane	Fermée (position de repos)
183/02.VEA-5	vanne arrivée N2 pour réservoir	Fermée (position de repos)
183/02.VP-1	vanne de purification	Fermée (position de repos)
183/02.VP-2	vanne eau pour pompe anneau liquide	Ouverte
183/02.VP-3	vanne entrée pompe anneau liquide	Ouverte
183/02.VP-_ _a	vanne d'injection circuit n	Sous contrôle utilisateur
183/02.VP-_ _b	vanne de retour circuit m	Sous contrôle utilisateur
183/02.DSS_out01	Sortie relais d'Interlock DSS 01	Ouvert
183/02.DSS_out02	Sortie relais d'Interlock DSS 02	Ouvert
183/02.DSS_out03	Sortie relais d'Interlock DSS 03	Ouvert
183/02.DSS_out04	Sortie relais d'Interlock DSS 04	Ouvert
183/02.DSS_out05	Sortie relais d'Interlock DSS 05	Ouvert
183/02.DSS_out06	Sortie relais d'Interlock DSS 06	Ouvert
183/02.DSS_out07	Sortie relais d'Interlock DSS 07	Ouvert

3.10 CYCLE **RUN** :

Système en fonctionnement normal.

L'eau circule, la fonction Leakless est en service.

Le système est soumis à la basse pression, le contrôle de fuite est activé (chute de niveau dans le réservoir).

La régulation de température de base (sortie des échangeurs) ainsi que pour chaque circuit ˝open˝ est en service (voir régulations).

L'eau circule par la boucle de purification, la lampe UV est allumée, le vide derrière la membrane est maintenu et elle est alimentée en N_2.

L'utilisateur peut passer les circuits entre ˝open˝, ˝ closed˝ et˝ locked˝.

Le cycle RUN est sélectionnable par l'opérateur depuis le cycle STAND-BY uniquement.

Dès action sur départ cycle :

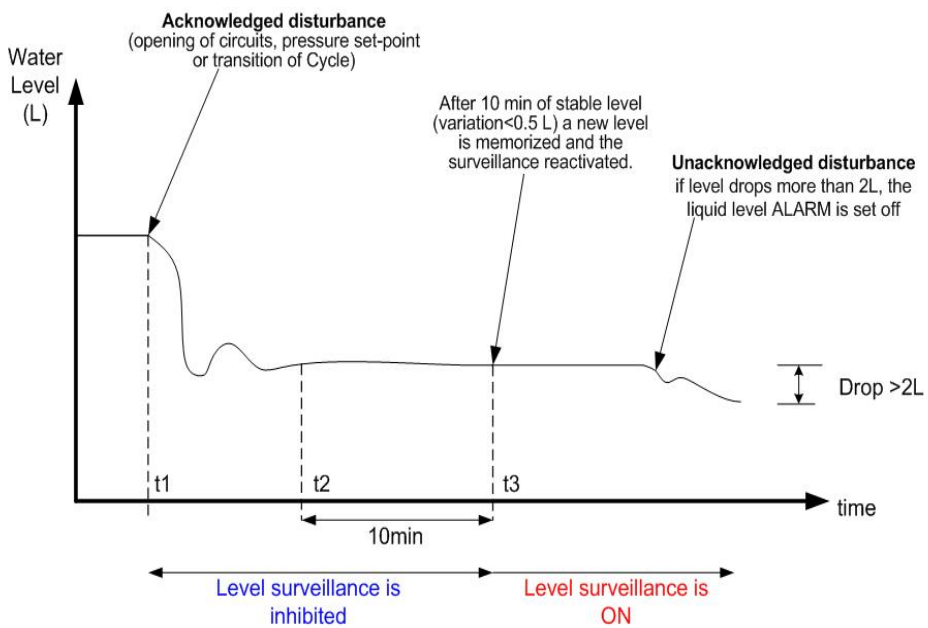
Référence:	Description:	Status :
183/02.PPV-1	pompe à vide PPV-1 (fonction LEAKLESS)	En service
183/02.PPV-2	pompe à vide PPV-2 (fonction LEAKLESS)	En service
183/02.PPV-3	pompe à vide PPV-3 (fonction vide derrière membrane)	En service
183/02.VEA-2	vanne 3 voies entrée pompe à vide PPV-1	Pompe – réservoir quand pompe tourne (délai au démarrage)
183/02.VEA-3	vanne 3 voies pompe a vide PPV-2	Pompe – réservoir quand pompe tourne (délai au démarrage)
183/02.PP	pompe liquide PP	En service
183/02.VMA-S	vanne régulation eau glacée VMA-S	En service
183/02.VMA-D	vanne régulation eau glacée VMA-D	En service
183/02.UV	lampe UV	allumée
183/02.VEA-1	vanne d'air comprimé boîtier orange	Ouverte
183/02.VEA-4	vanne arrivée N2 pour membrane	Ouverte

183/02.VEA-5	vanne arrivée N2 pour réservoir	Fermée (position de repos)
183/02.VP-1	vanne de purification	Ouverte
183/02.VP-2	vanne eau pour pompe anneau liquide	Ouverte
183/02.VP-3	vanne entrée pompe anneau liquide	Ouverte
183/02.VP-_ _a	vanne d'injection circuit n	Sous contrôle utilisateur
183/02.VP-_ _b	vanne de retour circuit m	Sous contrôle utilisateur
183/02.DSS_out01	Sortie relais d'Interlock DSS 01	Ouvert
183/02.DSS_out02	Sortie relais d'Interlock DSS 02	Ouvert
183/02.DSS_out03	Sortie relais d'Interlock DSS 03	Ouvert
183/02.DSS_out04	Sortie relais d'Interlock DSS 04	Ouvert
183/02.DSS_out05	Sortie relais d'Interlock DSS 05	Ouvert
183/02.DSS_out06	Sortie relais d'Interlock DSS 06	Ouvert
183/02.DSS_out07	Sortie relais d'Interlock DSS 07	Fermée

3.10.1DETECTION DE FUITES D'EAU

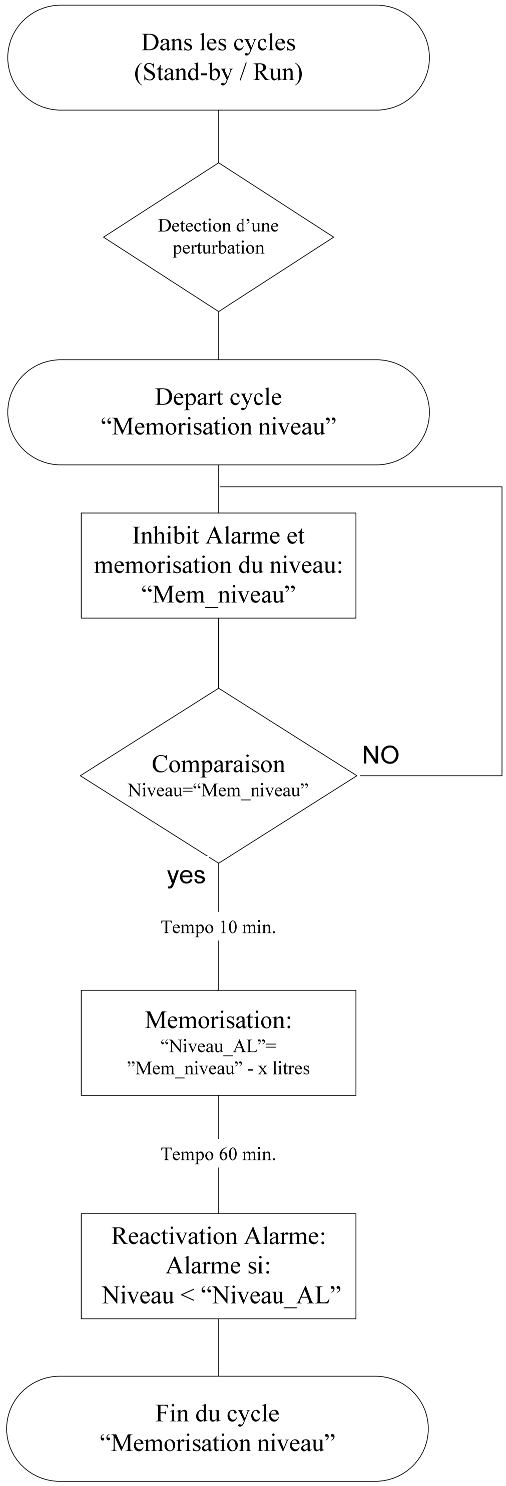
En RUN, le programme surveille le niveau dans le réservoir en permanence afin de donner une alarme "Fuite de liquide" en cas de perte d'eau supérieure à quelques litres.

Toutefois, le niveau peut varier sans être due à une fuite. C'est ce qui arrive lors de l'ouverture/fermeture d'une voie, changement de point de consigne de pression ou pendant les premiers instants après le passage en RUN lors du démarrage de la pompe. Apres chacun de ces changements, l'automate surveille l'évolution du niveau de liquide, dés que ce niveau est stabilisé, il est mémorisé et sert de référence à la boucle de contrôle. A partir de ce moment, toute diminution du niveau supérieur à: "niveau mémorisé" - x litres, donne une Alarme (voir graphique ci-dessous).



Normal and abnormal variations of the water level in the reservoir

Séquence :


Dans les cycles
(Stand-by / Run)
Detection d'une perturbation
Depart cycle
"Memorisation niveau"
Inhibit Alarme et memorisation du niveau:
"Mem_niveau"
Comparaison
Niveau="Mem_niveau"
NO
yes
Tempo 10 min.
Memorisation:
"Niveau_AL"=
"Mem_niveau" - x litres
Tempo 60 min.
Reactivation Alarme:
Alarme si:
Niveau < "Niveau_AL"
Fin du cycle
"Memorisation niveau"

3.11 REGULATIONS

3.11.1REG 01 : PRESSION DU RESERVOIR DE STOCKAGE (FONCTION LEAKLESS)

Mesure: Capteur de pression PT-1, gamme 0/+2 bara

Contrôle: PLC (TOR)

Action : Commande (on/off) des 2 pompes à vide PPV-1 et PPV-2 ainsi que des électrovannes associées VEA-2 et VEA-3.

Plage 01: Pression de service : 400 mbara.

Précision: ± 50 mbar.

Pulse mini.: 10 secondes.

Protections: Protection software sur dépassement consigne.

3.11.2REG 02 : PRESSION DE LA MEMBRANE DE DEGAZAGE

Mesure: Capteur de pression PT-3, gamme 0/+2 bara

Contrôle: PLC (TOR)

Action : Commande (on/off) de la pompe à vide PPV-3 ainsi que des vannes VP-2 et VP-3.

Plage 01: Pression de service : 70 mbara (50mm Hg abs).

Précision: ± 20 mbar.

Pulse mini.: 10 secondes.

Protections: Protection software sur dépassement consigne.

3.11.3REG 03 : PRESSION DE SORTIE DE POMPE

Mesure: Capteur de pression PT-2, gamme 0/+11 bara

Contrôle: PLC + Variateur de fréquence

Action : Commande PID d'ouverture de la vitesse de la pompe PP

Plage 01: Pression de service entre 3 et 4 bara, dans le cycle RUN
Plage 02: Pression de service entre 2 et 3 bara, dans le cycle PURIFICATION

☐Les 2 ajustable par l'utilisateur

Précision: ± 100 mbar

Pulse mini.: Contrôle continu.

Protections: Protection software sur dépassement consigne.

3.11.4REG 04 :TEMPERATURE DE SORTIE ECHANGEUR SSD

Mesure: 1 mesure de température PT100, capteur TT-Sa

Contrôle: PLC

Action : Commande PID d'ouverture de la vanne d'eau glacée VMA-S

Plage 01: Température de service +19.0 Cº, ajustable par l'utilisateur
(Gamme : 15.0 à 22.0 degrés C., à confirmer lors des essais de mise en service)

Précision: ± 1 degré.

Pulse mini.: Contrôle continu.

Protections: Protection software sur dépassement consigne.

3.11.5REG 05 :TEMPERATURE DE SORTIE ECHANGEUR SDD

Mesure: 1 mesure de température PT100, capteur TT-Da

Contrôle: PLC

Action : Commande PID d'ouverture de la vanne d'eau glacée VMA-D

Plage 01: Température de service +14.0 Cº, ajustable par l'utilisateur
(Gamme : 14.0 à 22.0 degrés C., à confirmer lors des essais de mise en service)

Précision: ± 1 degré.

Pulse mini.: Contrôle continu.

Protections: Protection software sur dépassement consigne.

3.11.6 REG 6 TO 21: TEMPERATURE DE SORTIE CIRCUITS SSD

Mesure: 1 mesure de température PT100, capteurs TT-S11 à TT-S18 et TT-S21 à TT-S28

Contrôle: PLC

Action : Commande PID sortie PWM des résistances chauffantes HTR-S11 à HTR-S18 et HTR-S21 à HTR-S28, via Triacs

Plage 01: Température de service +20.0 Cº, ajustable par l'utilisateur
(Gamme : 14.0 à 22.0 degrés C., à confirmer lors des essais de mise en service)

Précision: ± 0.5 degré.

Pulse mini.: Contrôle continu.

Protections: Protection software sur dépassement consigne.

3.11.7 REG 22 TO 53: TEMPERATURE DE SORTIE CIRCUITS SDD

Mesure: 1 mesure de température PT100, capteurs TT-D11 à TT-D18 et TT-D21 à TT-D28

Contrôle: PLC

Action : Commande PID sortie PWM des résistances chauffantes HTR-D11 à HTR-D18 et HTR-D21 à HTR-D28, via Triacs

Plage 01: Température de service +15.0 Cº, ajustable par l'utilisateur
(Gamme : 14.0 à 22.0 degrés C., à confirmer lors des essais de mise en service)

Précision: ± 0.5 degré.

Pulse mini.: Contrôle continu.

Protections: Protection software sur dépassement consigne.

4 ALARMES ET WARNINGS

Description	Origine du signal	Action	STA ND-BY	RUN
Défaut protections électrique Réseau Normale	disjoncteurs	Passe en STAND-BY	●	●
Défaut protections électrique Réseau Secouru	disjoncteurs	Passe en STOP	●	●
Panne de courant Réseau Normale		Passe en STAND-BY	●	●
Panne de courant Réseau Secouru		Passe en STOP	●	●
Pression air comprimé insuffisante (≤ 6bara)	PS-2	Passe en STAND-BY	●	●
Défaut commande pompe liquide	PP	Passe en STAND-BY		●
Pression réservoir trop haute (>0.6 bara)	PT-1	Passe en STAND-BY	●	●
Pression sortie pompe trop basse (<0.4 bara)	PT-2	Passe en STAND-BY		●
Pression sortie pompe trop haute (> 3.4 bara)	PT-2	Passe en STAND-BY		●
Pression sortie pompe trop trop haute (> 4 bara)	PS-1	Passe en STAND-BY		●
Température moteur pompe > 55Cº	TT-1	Passe en STAND-BY		●
Niveau liquide trop bas (≤ 100L)	LT	Passe en STAND-BY	●	●
Fuite d'eau (chute de niveau réservoir)	LT et PLC	Passe en STAND-BY	●	●
Défauts majeurs Automate	UC,com., I/O	Passe en STOP	●	●
Temps de pompage vide réservoir> 20 minutes	PLC	Passe en STAND-BY	●	●
Taux Oxygène trop haut (>2mg/L)	OT-1	Passe en STAND-BY		●
Résistivité trop basse (≤ 2MΩ.cm)	CT-1	*Passe en STAND-BY*		●
Insuffisance débit ˝SSD 5-ladder groups˝	DSS_out01	Visualisation		●
Insuffisance débit ˝SSD 4-ladder groups˝	DSS_out02	Visualisation		●
Insuffisance débit ˝SDD 2-ladder groups˝	DSS_out03	Visualisation		●
Insuffisance débit ˝SDD 2-endladder groups˝	DSS_out04	Visualisation		●
Insuffisance débit ˝SDD 4-ladder groups˝	DSS_out05	Visualisation		●
Insuffisance débit ˝SDD 4-endladder groups˝	DSS_out06	Visualisation		●
Niveau liquide instable	LT et PLC	Visualisation	●	●
Niveau liquide trop bas (≤ 200L)	LT	Visualisation	●	●
Pression sortie pompe trop haute (> 3.5 bara)	PT-2	Visualisation		●
T >40ºC dans coffret relais statiques	Thermostat	Visualisation		●
Débit de purification trop bas (≤10l/min)	FT-1	Visualisation		●
Débit de purification trop haut (>30l/min)	FT-1	Visualisation		●
Débit d'eau glacé = 0 l/min	*LW-1*	Visualisation		●
Pression N_2 insuffisante (≤ 4 bara)	*PS-3*	Visualisation		●
Taux Oxygène trop haut (>1mg/L)	OT-1	Visualisation		●
Résistivité trop basse (≤ 5 MΩ.cm)	CT-1	Visualisation		●
Pression membrane trop haute (>0.1 bara)	PT-3	Visualisation	●	●
Température moteur pompe > 45Cº	TT-1	Visualisation		●
Température sortie échangeur SSD ≤ 13Cº	TT-Sa	Visualisation		●
Température sortie échangeur SDD ≤ 13Cº	TT-Da	Visualisation		●
Eau glacée > 10Cº	TT-Win	Visualisation		●
Pression réservoir trop haute (>0.8 bara)	PT-1	Visualisation	●	●

4.1 ELECTRICAL SCHEMES

4.2 PROGRAMS

4.2.1 PLC

4.2.2 XBT

4.3 FREQUENCY DRIVE CONFIGURATION

5 USER MANUAL

5.1 INTRODUCTION

Most of the operation of the SDD/SSD cooling plant is done via a PLC interface panel (Magelis XBT) shown below:

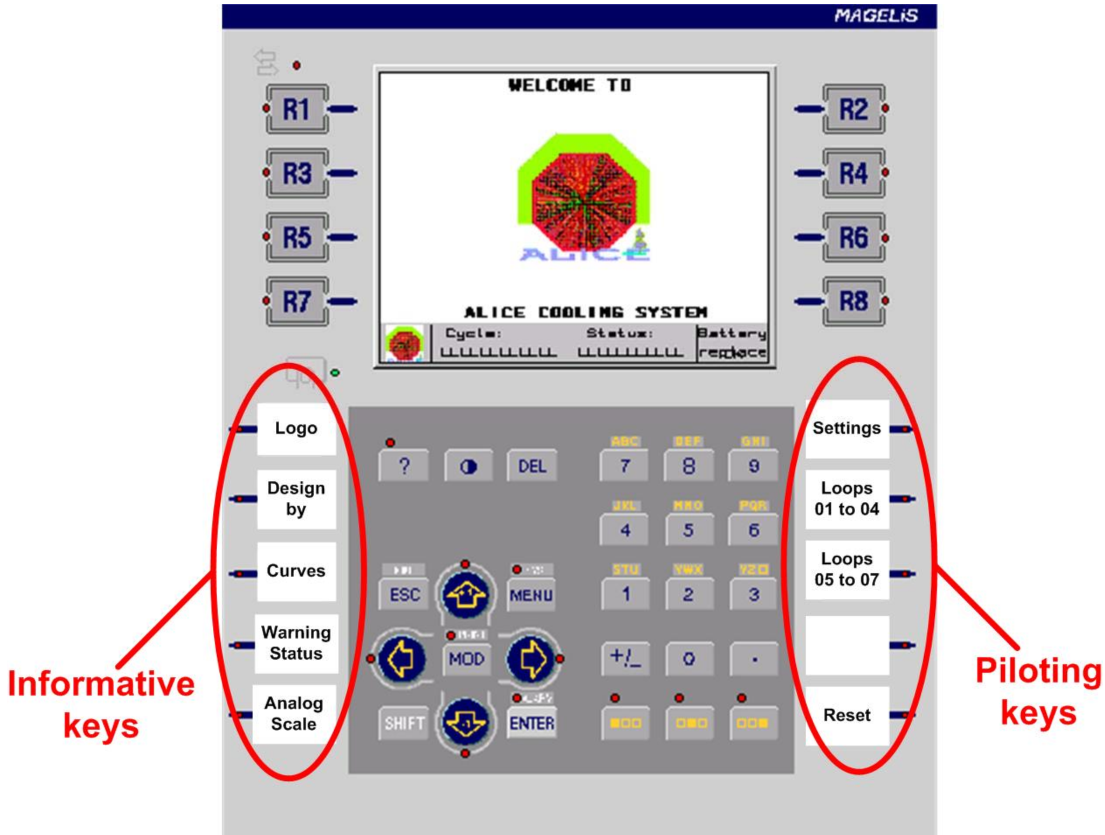


Figure. 5.1.0: XBT-Magelis Interface Panel

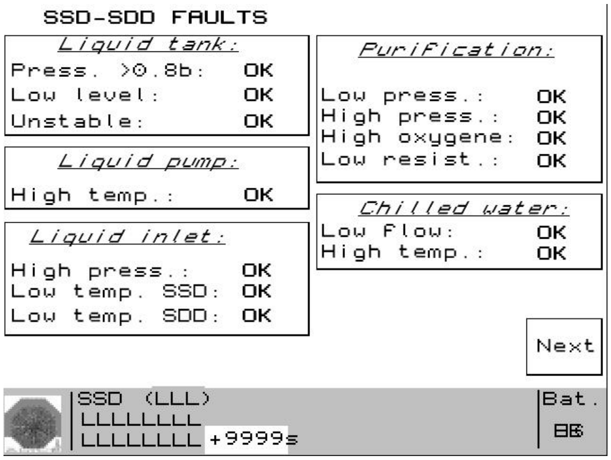
The buttons on the left of the panel (***Logo***, ***Design by***, ***Curves***, ***Warning Status*** and ***Analog Scale***) provide the user with varied information on cooling parameters, faults and alarms as well as handling of sensor outputs.

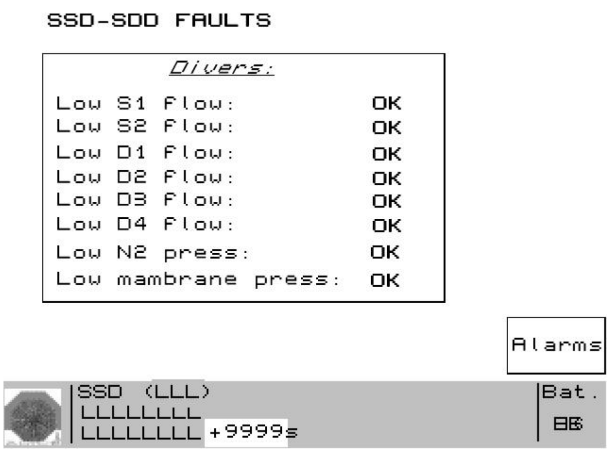
The buttons on the right of the panel (***Settings***, ***Loops 01…07*** and ***Reset***) allow the user to choose the flow rate and temperature, open and close valves and acknowledge alarms.

All pages displayed on the screen bear information on the ***Cycle*** and the ***Status***. The former can assume 4 different values: ***Stop***, ***Stand-by***, ***Run*** and ***Leak Search***. The latter can either display ***Warning*** or ***Alarm***.

The default ***Cycle*** when the plant is powered ON is **STOP.** In this cycle the circulator pump is idle; all circuits (supply and return valves) are closed; the reservoir is at atmospheric pressure; the mixed water valve is closed.

When the plant is powered ON, the ***Status*** is likely to be indicating **ALARM**. The exact list of alarms can be obtained by pressing ***Warning Status*** on the panel. Three pages appear (press ***Next*** and ***Return*** to move between pages). The first page lists all the ***faults***, the following two pages list the ***alarms***. Detailed explanation on these alarms and faults is given in §5.6.





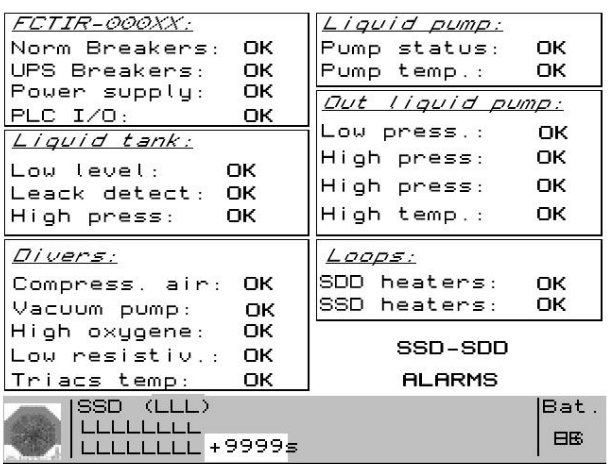


Figure. 5.1.1: Faults and Alarm list pages

In general, a ***FAULT*** occurs when a continuous variable (pressure, temperature, flow) goes beyond a defined threshold. If the variable attains a second threshold, then the ***FAULT*** turns into an ***ALARM***.

For some continuous variables however, only ***ALARM*** or ***FAULT*** thresholds were defined. Obviously, this is also the case for binary (boolean) variables (pressure switches, shut off valves, circuit breakers etc).

Once the origin of a ***FAULT*** has been corrected (i.e. the variable is back within its normal range or to its normal logical value) the indication ***OK*** appears by itself.

Once the origin of an ***ALARM*** has been corrected, the user must push the ***Reset*** button on the panel and only then the indication ***OK*** appears.

IMPORTANT:

- **An Alarm should only be reset after its cause has been fully understood (refer to §5.6 for an explanation of the alarm).**
- **If the Alarm persists after it has been reset, do not keep on pushing the Reset button repeatedly as this may damage the cooling plant.**

When all alarms have been cleared, the ***Status*** will indicate ***Warning*** (if at least one fault persists) or ***OK*** if all faults were resolved.

The PLC will only allow the ***Stand-by Cycle*** once the ***Status*** is ***Warning*** or ***OK***. As long as the ***Status*** is Alarm, the only possible ***Cycle*** is ***Stop***.

5.2 COOLING SETTINGS

Water flow rate and temperature are set when the plant is in ***Stand-by Cycle***.
To select the ***Stand-by Cycle***, use buttons on the panel as exemplified below:

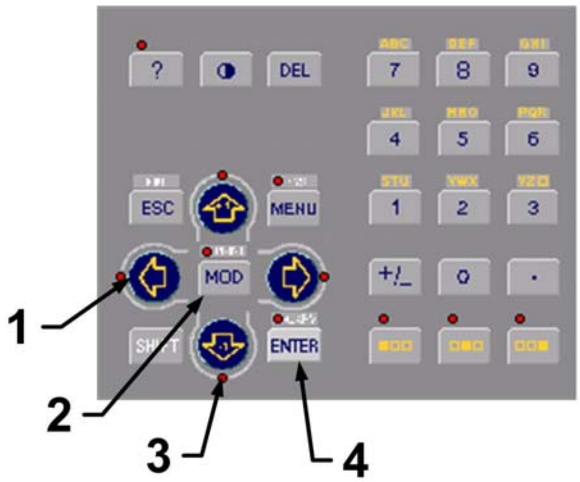


Figure. 5.2.1: Keyboard

1: Move the intermittent area using the arrows.

2: push the ***MOD*** button

3: scroll up or down until ***Stand-by*** appears.

4: validate your choice by hitting ***Enter***

Once the ***Stand-by Cycle*** has been selected, hit the ***Setting*** button on the panel. This will open the page shown below:

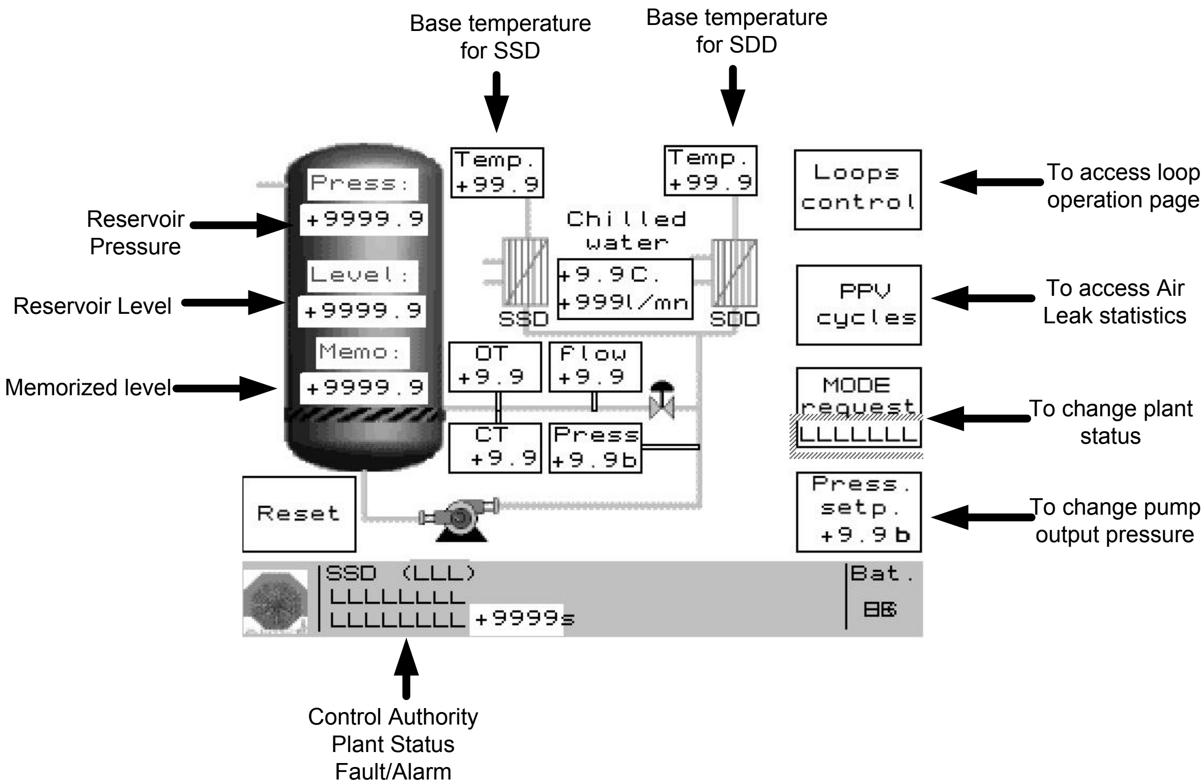
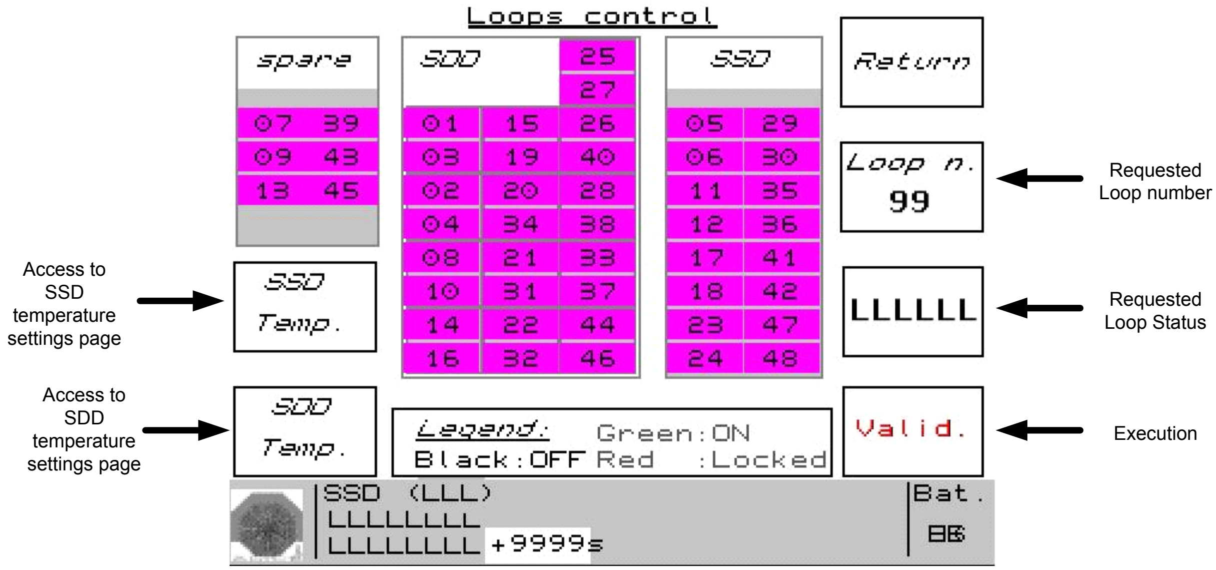


Figure. 5.2.2: Settings page

In this page the user has the possibility to choose the pressure set points. Later on, when the system will be in ***RUN CYCLE***, this page will also provide information on the actual values of these two variables.

Given the correlation between flow rate and pressure (loosely $\Delta P \sim FlowRate^2$), the user should adjust the pressure set point while minding the flow rate reading. While the plant is in ***Stand-by***, the circulator pump is idle so no reading is available yet. It is prudent to start out with a low pressure set point and increase it gradually once the plant is in ***Run***.

After temperature and pressure set-points have been selected, the user should turn his attention to the exact cooling circuits he plans to flow water through. This is done by hitting the ***Loops Control*** keys on the panel.



Any given cooling circuit can display one of three states:

- **Locked**: supply and return valves are closed. This is the state you should select for un-used outlets.
- **Open or ON**: supply and return valves are open, hence the right configuration for water to flow through this circuit.
- **Closed or OFF**: supply valve is closed but return valve is open. Select this state if the plant is in ***Stand-by*** and you intend to **open** the circuit once the plant is in ***Run*** (the reason for this is explained in §5.3). This is also the state in which a circuit should remain if it is piped to the detector and contains water left inside. By letting the return valve open, the whole circuit will be kept below atmospheric pressure and thereby prevent any water spill out through possible leaks in the detector.

When a cooling circuit changes from locked to open, there is a 6 sec time delay between the opening of the return and the supply valve. Similarly, when a open circuit is to be locked, the return valve is shut 6 sec after the supply valve.

Note that when the cooling plant is in ***Stand-by***, the pressure in the reservoir is kept sub-atmospheric by a vacuum pump. This pressure is controlled by switching ON the vacuum pump when the pressure surges 20mbar and OFF when it is back at its set point. Therefore, when the volume of a cooling circuit is for the first time put in contact with the reservoir volume, (example: **locked** → **closed** or **locked** → **open**), the vacuum pump will have to remove that additional air from the reservoir.

In case of a major air infiltration causing the pressure to rise above 0.9bar, the ***Pressure Fault*** will appear in the ***Warnings*** page and the circulator pump stops (if the plant happens to be in ***Run*** at that moment). When the pressure drops below 0.9bar the circulator pumps restarts.

However, after 20 minutes of continuous pumping, the ***Vacuum pump timing ALARM*** will make the system go to ***Stand-by*** (thus bringing the circulator pump to a definitive halt). Nevertheless, as implied by the ***Stand-by Cycle***, the reservoir pressure regulation stays active so the vacuum pump carries on working to bring the pressure down to the set point.

5.3 STARTING COOLING

Upon selecting the ***RUN Cycle***, the circulator pump starts working and the mixed water valve begins cooling the heat exchanger. Both of these processes are piloted by a PID control algorithm in which the controlled variables are respectively the pressure and the temperature at the supply manifold. The set points for these closed-loop controls are selected on the ***Settings*** page, as explained in §5.2.

> Before flowing water through a newly connected circuit, the user should run the ***Leak Search*** procedure (see chapter 5.5)

If all the cooling circuits are closed or locked when the circulator pump starts working (i.e. when the ***RUN Cycle*** is selected), then the by-pass valve (17a) shall divert the flow from the supply manifold to the return manifold and the ***Loops Status*** displays ***Fault*** in the warnings page. However, starting pumping through the by-pass before opening any circuit is in fact the safest way to proceed, as it will prevent any initial pressure or temperature spike to propagate to the detector.

Once at least one cooling circuit is open, the by-pass valve will close.

5.4 THE "LEAKLESS" PROTECTION

When the cooling plant is in ***Stand-by***, the whole system (plant + piping + detector) is below atmospheric pressure whereas in ***Run***, only the return pipes and eventually part or the detector is in negative pressure. Therefore, should a leak occur, it may either lead to water spillage or air infiltration, depending on its location.

5.4.1 WATER LEAKAGE

Leakage of water can be detected and stopped early in time. This is done by continuously measuring the water level in the reservoir and stopping the circulator pump when a significant drop is detected. As soon as the pump stops, the by-pass valve opens and the sub-atmospheric pressure prevails throughout the whole system (system = cooling plant + piping + detector), thereby stopping the water spillage.

Nonetheless, the water level in the reservoir may drop without necessarily meaning that water is being spilled out somewhere. This the case when the plant goes from ***Stand-by*** to ***Run*** and/or when cooling(s) circuits are put into service (more water leaves the reservoir to fill-up new volumes outside the plant) or when the pumped flow varies (altering the pressure set point). It is quite often the case that air trapped inside the detector piping itself takes time to be flushed down to the reservoir, so new volumes of water are still being filled outside the plant, long after the pumping has started. These three water level disturbances (opening circuits, pump start/stop and change of flow throughput) are acknowledged by the PLC and do not set off the ***Fast liquid level change ALARM***. However, after one of these disturbances has occurred, the PLC needs to rememorize a new stable level. Level is considered suitable to be memorized if it remains within a +- 0.5L margin of a given level for the 10 minutes following the reading of that level. Once a new level is memorized, the surveillance is reactivated and any level drop of more than 2L will give rise to the ***Fast liquid level change ALARM*** and take the system to ***Stand-by***.

The evolution of water level during all these events is shown below:

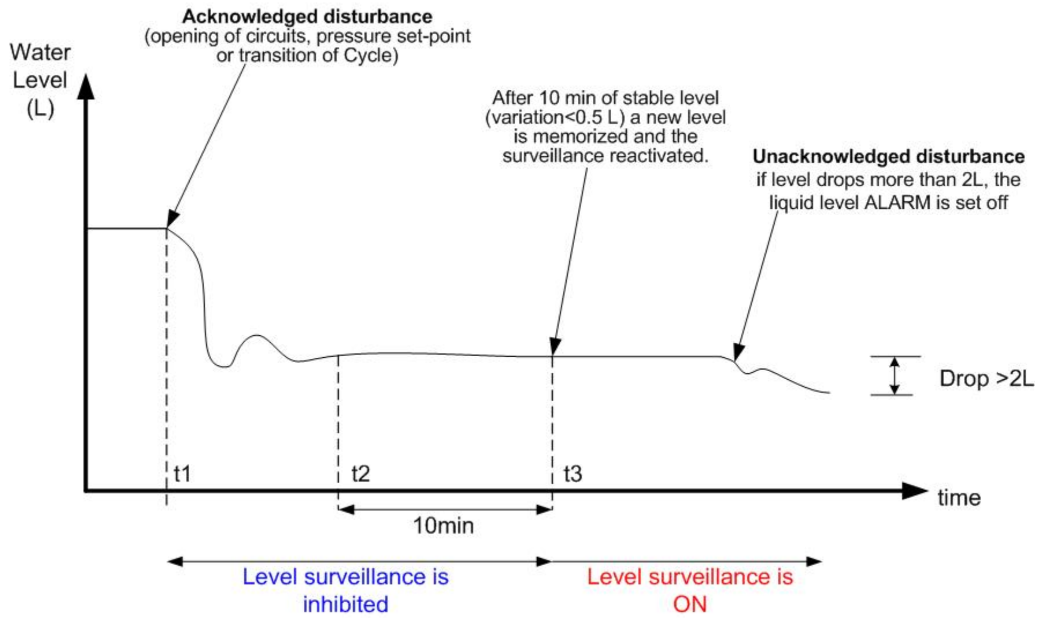


Figure. 5.4.1: Normal and abnormal variations of the water level in the reservoir

During the surveillance inhibition period, the ***Level stability Fault*** will appear (Faults & Warnings page). Once the Level surveillance is back on, this fault will disappear.

> Make sure you repair the leak before reseting the ***Fast liquid level change ALARM***. Failure to do so may lead to substancial leakage of water as the alarm is inhibited waiting for the level to stabilize again.

The HMPID cooling plant features a ***Leak Search*** automatic procedure, explained in §5.5.

5.4.2 AIR INFILTRATION

Air infiltration is not a problem *per se* but may become one if it is big enough. It may equalize the pressure to atmospheric and thereby allow water to spill out.

In case of a major air infiltration causing the air pressure to rise above 0.9bar, the ***Pressure Fault*** will appear in the Warnings page and the circulator pump stops (if the plant happens to be in ***Run*** at that moment). When the pressure drops below 0.9bar the circulator pumps restarts.

However, after 20 minutes of continuous vacuum pump working, the ***Vacuum pump timing ALARM*** will make the system go to ***Stand-by*** (thus bringing the circulator pump to a definitive halt). Note however that in ***Stand-by*** the reservoir pressure regulation is still ON, so the vacuum pump carries on working to bring the pressure down to the set point.

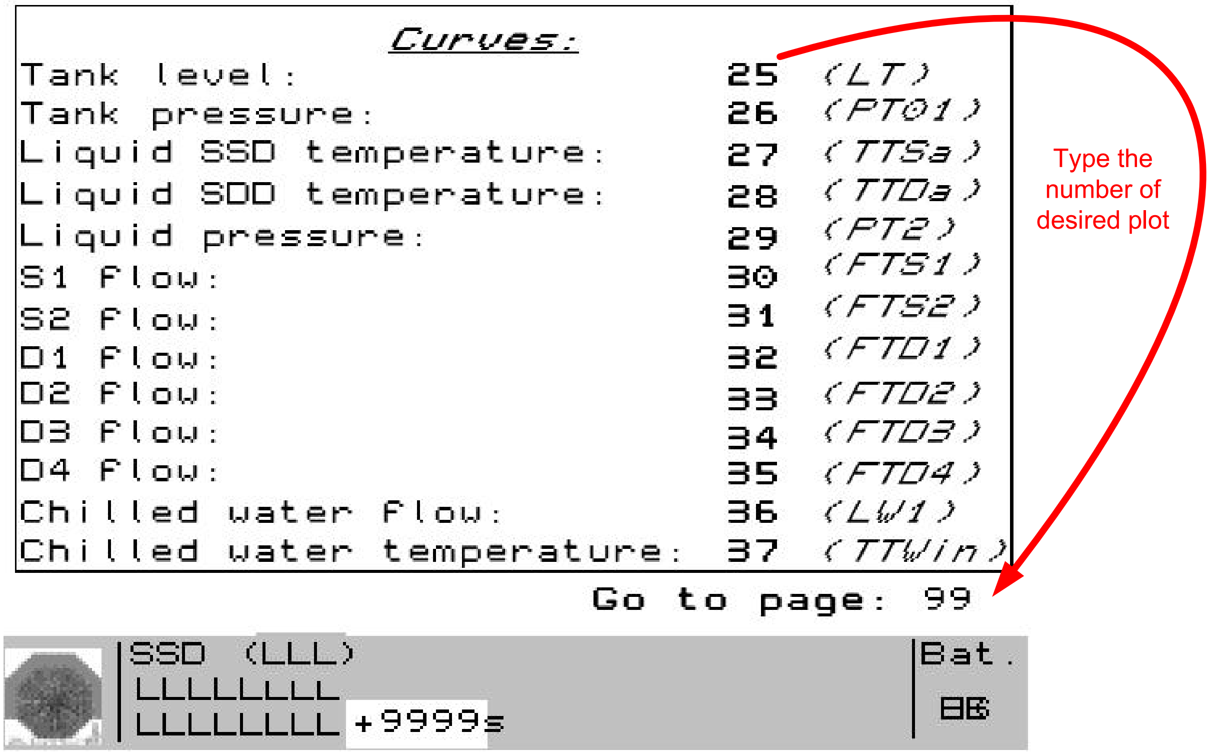
5.5 FAULTS AND ALARMS

Fault	Cause	Outcome	Stand-by	Run
Liquid Pump: Eng.temp > 45ºC	The motor temperature is higher than 45ºC. If the temperature rises above 50ºC, this fault converts into an alarm (see alarm list below).	none	•	•
Liquid outlet: Temp. < 16ºC	The temperature of the water at the supply manifold is below 16ºC	none		•
Liquid outlet: Temp. > 20ºC	The temperature of the water at the supply manifold is above 20ºC	none		•
Liquid outlet: Low press.	The pressure at the supply manifold is below 1bar(a). If it falls below 0.8bar this fault converts into an alarm (see alarm list below)	none		•
Liquid outlet: High press.	The pressure at the supply manifold is above 5.5bar(a). If it surges above 6bar this fault converts into an alarm (see alarm list below)	Halts circulator pump		•
Liquid outlet: Low Flow	The cooling water flow is lower than 1L/min	none		•
Loops status	All cooling circuits are either closed or locked	Opens by-pass valve.		•
Mixed water: temp<8ºC	The mixed water temperature is lower than 8ºC.	none		•
Mixed water: temp>16ºC	The mixed water temperature is higher than 16ºC.	none		•
Mixed water: Flow<5L/h	The mixed water flow is lower than 5L/h.	none		•
Liquid Tank: Pressure	Air pressure in the reservoir is above 0.9bar	Halts circulator pump (if in Run)	•	•
Liquid Tank: Level<20L	The volume of water in the reservoir is less than 20L. If it drops below 10L this fault converts into an alarm (see alarm list below)	none	•	•
Liquid Tank: Level stability	Following an acknowledged disturbance, the level surveillance is inhibited while a new stable level is being memorized.	none	•	•

Alarm	Cause	Outcome	Stand-by	Run
Compress air < 6bar(g)	The pneumatic supply pressure is below 6bar(g).	Goes to Stand-by		•
Breakers fault 1-3	The circuit breakers of the Emergency Power Supply tripped	Goes to Stop	•	•
Breakers fault 4-6	The main circuit breakers tripped	Goes to Stand-by		•
Liquid Pump Failure	The frequency inverter detected a surge in the current (caused for instance by mechanical obstruction of the pump axis)	Goes to Stand-by		•
Manual Valve 10 closed	The reservoir containment valve is closed	Goes to Stand-by		•
Low outlet Pressure	Following the fault threshold at 1bar, the pressure has now dropped below 0.8bar	Goes to Stand-by		•
High outlet Pressure	Following the fault threshold at 5.5bar, the pressure has now surged above 6bar	Goes to Stand-by		•
Liquid pump overheat	Following the fault threshold at 45ºC, the temperature has now risen above 50ºC.	Goes to Stand-by		•
Tank liquid level	Following the fault threshold at 20L, the level has further dropped below 10L.	Goes to Stand-by		•
Fast Liquid level change	Following an unacknowledged disturbance, the level drops more than 2L	Goes to Stand-by		•
Mixed water temperature > 15C	If the mixed water supply is at a temperature higher than 15ºC for more than 20min	Goes to Stand-by		•
PLC I/O failure	Communication or out of range input signal	Goes to Stop	•	•
Vacuum pump timing	Vacuum pump works continuously for more than 20min	Goes to Stand-by		•
Power failure	Power outage from normal network	Goes to Stand-by (on EPS power)		•
Main power switch OFF	The user switched off the power		•	•

5.6 MONITORING OF PARAMETERS

Real time information on several parameters is available from the ***Curves*** key on the left of the panel. Type the page number using the panel keyboard to obtain 1h and 48h plots.



5.7 STOP PROCEDURE

The user can select ***Stop*** from any of the other cycles. When doing so, the circulator stops, the mixed water, the supply and the by-pass valves shut and the return valves open. The negative pressure in the reservoir is no longer maintained.

The cooling plant can remain safely in ***Stand-by*** or ***Stop*** and it should not be powered off unless it is to remain unused for a long period.

COMPONENT DOCUMENTATION

5.8 LIST OF COMPONENTS

P&I reference	Description
Boitier Orange	Unite traitement air ONE 8bar
	Pneumatic distribution bloc for supply manifold
	Pneumatic distribution bloc for supply manifold
	Pneumatic distribution bloc for return manifold
	Pneumatic distribution bloc for return manifold
CT-1	Conductivity meter, CT-1
SDD Exchanger	Heat Exchanger SDD
SSD Exchanger	Heat Exchanger SSD
RWA	Reservoir 600L, RWA
DM	Mixed bed de-ionizer Ministil, DM
FOA-1	Strainer Stainless steel - custom made mesh: 0.1mm, FOA-1
V-Db1	Sight glass SSD return, V-Db1
V-Db1	Sight glass SSD return, V-Db2
V-Sb1	Sight glass SSD return, V-Sb1
V-Sb2	Sight glass SSD return, V-Sb2
FT-1	Flowmeter water treatment, FT-1
FT-D1	Flowmeter SDD 4-ladder groups, FT-D1
FT-D2	Flowmeter SDD 2-ladder groups, FT-D2
FT-D3	Flowmeter SDD 4-end ladder groups, FT-D3
FT-D4	Flowmeter SDD 2-end ladder groups, FT-D4
FT-S1	Flowmeter SSD 4-ladder groups, FT-S1
FT-S2	Flowmeter SSD 5-ladder groups, FT-S2
LW-1	Flowmeter chilled water, LW-1
DG	Membrane Desox, DG
HTR-D11	Heater 500WLoop 1, HTR-D11
HTR-D12	Heater 500WLoop 7, HTR-D12
HTR-D13	Heater 500WLoop 13, HTR-D13
HTR-D14	Heater 500WLoop 19, HTR-D14
HTR-D15	Heater 500WLoop 25, HTR-D15
HTR-D16	Heater 500WLoop 31, HTR-D16
HTR-D17	Heater 500WLoop 37, HTR-D17
HTR-D18	Heater 500WLoop 43, HTR-D18
HTR-D21	Heater 250WLoop 2, HTR-D21
HTR-D22	Heater 250WLoop 8, HTR-D22
HTR-D23	Heater 250WLoop 14, HTR-D23
HTR-D24	Heater 250WLoop 20, HTR-D24
HTR-D25	Heater 250WLoop 26, HTR-D25
HTR-D26	Heater 250WLoop 32, HTR-D26
HTR-D27	Heater 250WLoop 38, HTR-D27
HTR-D28	Heater 250WLoop 44, HTR-D28
HTR-D31	Heater 1000WLoop 3, HTR-D31
HTR-D32	Heater 1000WLoop 9, HTR-D32

HTR-D33	Heater 1000WLoop 15, HTR-D33
HTR-D34	Heater 1000WLoop 21, HTR-D34
HTR-D35	Heater 1000WLoop 27, HTR-D35
HTR-D36	Heater 1000WLoop 33, HTR-D36
HTR-D37	Heater 1000WLoop 39, HTR-D37
HTR-D38	Heater 1000WLoop 45, HTR-D38
HTR-D41	Heater 500WLoop 4, HTR-D41
HTR-D42	Heater 500WLoop 10, HTR-D42
HTR-D43	Heater 500WLoop 16, HTR-D43
HTR-D44	Heater 500WLoop 22, HTR-D44
HTR-D45	Heater 500WLoop 28, HTR-D45
HTR-D46	Heater 500WLoop 34, HTR-D46
HTR-D47	Heater 500WLoop 40, HTR-D47
HTR-D48	Heater 500WLoop 46, HTR-D48
HTR-S11	Heater 500WLoop 5, HTR-S11
HTR-S12	Heater 500WLoop 11, HTR-S12
HTR-S13	Heater 500WLoop 17, HTR-S13
HTR-S14	Heater 500WLoop 23, HTR-S14
HTR-S15	Heater 500WLoop 29, HTR-S15
HTR-S16	Heater 500WLoop 35, HTR-S16
HTR-S17	Heater 500WLoop 41, HTR-S17
HTR-S18	Heater 500WLoop 47, HTR-S18
HTR-S21	Heater 500WLoop 6, HTR-S21
HTR-S22	Heater 500WLoop 12, HTR-S22
HTR-S23	Heater 500WLoop 18, HTR-S23
HTR-S24	Heater 500WLoop 24, HTR-S24
HTR-S25	Heater 500WLoop 30, HTR-S25
HTR-S26	Heater 500WLoop 36, HTR-S26
HTR-S27	Heater 500WLoop 42, HTR-S27
HTR-S28	Heater 500WLoop 48, HTR-S28
VR-1	Relief valve on reservoir, VR-1
LT	Reservoir Level Sensor, LT
PP	Circulation pump, PP
PPV-1	Vacuum pump reservoir, PPV-1
PPV-2	Vacuum pump reservoir, PPV-2
PPV-3	Liquid ring vacuum pump Desox membrane, PPV-3
PI-1	Manometer reservoir, PI-1
PI-2	Manometer pump outlet, PI-2
PI-3	Manometer Desox membrane, PI-3
PS-1	Pressure switch pump outlet, PS-1
PS-3	Pressure switch N2 supply, PS-2
PT-1	Pressure transmitter reservoir, PT-1
PT-2	Pressure transmitter pump outlet, PT-2
PT-3	Pressure transmitter Desox membrane, PT-3
QP-3	Pressure regulator tap water to PPV-3, QP-1
UV	UV Lamp water sterilizer, UV
TT-Da	Temperature Sensor Pt100 SDD exchanger outlet, TT-Da
TT-Sa	Temperature Sensor Pt100 SSD exchanger outlet, TT-Sa
TT-Win	Temperature Sensor Pt100 supply chilled water, TT-Win

TT-D11	Temperature Sensor Pt100 Loop 1, TT-D11
TT-D12	Temperature Sensor Pt100 Loop 7, TT-D12
TT-D13	Temperature Sensor Pt100 Loop 13, TT-D13
TT-D14	Temperature Sensor Pt100 Loop 19, TT-D14
TT-D15	Temperature Sensor Pt100 Loop 25, TT-D15
TT-D16	Temperature Sensor Pt100 Loop 31, TT-D16
TT-D17	Temperature Sensor Pt100 Loop 37, TT-D17
TT-D18	Temperature Sensor Pt100 Loop 43, TT-D18
TT-D21	Temperature Sensor Pt100 Loop 2, TT-D21
TT-D22	Temperature Sensor Pt100 Loop 8, TT-D22
TT-D23	Temperature Sensor Pt100 Loop 14, TT-D23
TT-D24	Temperature Sensor Pt100 Loop 20, TT-D24
TT-D25	Temperature Sensor Pt100 Loop 26, TT-D25
TT-D26	Temperature Sensor Pt100 Loop 32, TT-D26
TT-D27	Temperature Sensor Pt100 Loop 38, TT-D27
TT-D28	Temperature Sensor Pt100 Loop 44, TT-D28
TT-D31	Temperature Sensor Pt100 Loop 3, TT-D31
TT-D32	Temperature Sensor Pt100 Loop 9, TT-D32
TT-D33	Temperature Sensor Pt100 Loop 15, TT-D33
TT-D34	Temperature Sensor Pt100 Loop 21, TT-D34
TT-D35	Temperature Sensor Pt100 Loop 27, TT-D35
TT-D36	Temperature Sensor Pt100 Loop 33, TT-D36
TT-D37	Temperature Sensor Pt100 Loop 39, TT-D37
TT-D38	Temperature Sensor Pt100 Loop 45, TT-D38
TT-D41	Temperature Sensor Pt100 Loop 4, TT-D41
TT-D42	Temperature Sensor Pt100 Loop 10, TT-D42
TT-D43	Temperature Sensor Pt100 Loop 16, TT-D43
TT-D44	Temperature Sensor Pt100 Loop 22, TT-D44
TT-D45	Temperature Sensor Pt100 Loop 28, TT-D45
TT-D46	Temperature Sensor Pt100 Loop 34, TT-D46
TT-D47	Temperature Sensor Pt100 Loop 40, TT-D47
TT-D48	Temperature Sensor Pt100 Loop 46, TT-D48
TT-S11	Temperature Sensor Pt100 Loop 5, TT-S11
TT-S12	Temperature Sensor Pt100 Loop 11, TT-S12
TT-S13	Temperature Sensor Pt100 Loop 17, TT-S13
TT-S14	Temperature Sensor Pt100 Loop 23, TT-S14
TT-S15	Temperature Sensor Pt100 Loop 29, TT-S15
TT-S16	Temperature Sensor Pt100 Loop 35, TT-S16
TT-S17	Temperature Sensor Pt100 Loop 41, TT-S17
TT-S18	Temperature Sensor Pt100 Loop 47, TT-S18
TT-S21	Temperature Sensor Pt100 Loop 6, TT-S21
TT-S22	Temperature Sensor Pt100 Loop 12, TT-S22
TT-S23	Temperature Sensor Pt100 Loop 18, TT-S23
TT-S24	Temperature Sensor Pt100 Loop 24, TT-S24
TT-S25	Temperature Sensor Pt100 Loop 30, TT-S25
TT-S26	Temperature Sensor Pt100 Loop 36, TT-S26
TT-S27	Temperature Sensor Pt100 Loop 42, TT-S27
TT-S28	Temperature Sensor Pt100 Loop 48, TT-S28
VEA-2	Electrovalve 3-way for vacuum pump start-up, VEA-2

VEA-3	Electrovalve 3-way for vacuum pump start-up, VEA-3
VEA-4	Electrovalve 3-way for N2 supply membrane, VEA-4
VEA-5	Electrovalve 3-way for N2 supply reservoir, VEA-5
QR-1	Hand valve for draining, QR-1
QR-2	Reservoir containment hand valve, QR-2
VMA-S	Chilled water regulation 2-way valve for SSD, VMA-S
VMA-D	Chilled water regulation 2-way valve for SDD, VMA-D
VP-1	Pneumatic valve into water treatment, VP-1
VP-2	Pneumatic valve supply tap water to Liquid ring pump, VP-2
VP-3	Pneumatic valve vacuum Desox membrane, VP-3
VTA-1	Balancing valve water treatment, VTA-1
VTA-D1	Balancing valve SDD 4-ladder groups, VTA-D1
VTA-D2	Balancing valve SDD 2-ladder groups, VTA-D2
VTA-D3	Balancing valve SDD 4-end ladder groups, VTA-D3
VTA-D4	Balancing valve SDD 2-end ladder groups, VTA-D4
VTA-S1	Balancing valve SSD 4-ladder groups, VTA-S1
VTA-S2	Balancing valve SSD 5-ladder groups, VTA-S2
VP-D11a	Pneumatic bellow shut-off valve SL 1, VP-D11a
VP-D12a	Pneumatic bellow shut-off valve SL 7, VP-D12a
VP-D13a	Pneumatic bellow shut-off valve SL 13, VP-D13a
VP-D14a	Pneumatic bellow shut-off valve SL 19, VPD14a
VP-D15a	Pneumatic bellow shut-off valve SL 25, VP-D15a
VP-D16a	Pneumatic bellow shut-off valve SL 31, VP-D16a
VP-D17a	Pneumatic bellow shut-off valve SL 37, VP-D17a
VP-D18a	Pneumatic bellow shut-off valve SL 43, VP-D18a
VP-D21a	Pneumatic bellow shut-off valve SL 2, VP-D21a
VP-D22a	Pneumatic bellow shut-off valve SL 8, VP-D22a
VP-D23a	Pneumatic bellow shut-off valve SL 14, VP-D23a
VP-D24a	Pneumatic bellow shut-off valve SL 20, VP-D24a
VP-D25a	Pneumatic bellow shut-off valve SL 26, VP-D25a
VP-D26a	Pneumatic bellow shut-off valve SL 32, VP-D26a
VP-D27a	Pneumatic bellow shut-off valve SL 38, VP-D27a
VP-D28a	Pneumatic bellow shut-off valve SL 44, VP-D28a
VP-D31a	Pneumatic bellow shut-off valve SL 3, VP-D31a
VP-D32a	Pneumatic bellow shut-off valve SL 9, VP-D32a
VP-D33a	Pneumatic bellow shut-off valve SL 15, VP-D33a
VP-D34a	Pneumatic bellow shut-off valve SL 21, VP-D34a
VP-D35a	Pneumatic bellow shut-off valve SL 27, VP-D35a
VP-D36a	Pneumatic bellow shut-off valve SL 33, VP-D36a
VP-D37a	Pneumatic bellow shut-off valve SL 39, VP-D37a
VP-D38a	Pneumatic bellow shut-off valve SL 45, VP-D38a
VP-D41a	Pneumatic bellow shut-off valve SL 4, VP-D41a
VP-D42a	Pneumatic bellow shut-off valve SL 10, VP-D42a
VP-D43a	Pneumatic bellow shut-off valve SL 16, VP-D43a
VP-D44a	Pneumatic bellow shut-off valve SL 22, VP-D44a
VP-D45a	Pneumatic bellow shut-off valve SL 28, VP-D45a
VP-D46a	Pneumatic bellow shut-off valve SL 34, VP-D46a
VP-D47a	Pneumatic bellow shut-off valve SL 40, VP-D47a
VP-D48a	Pneumatic bellow shut-off valve SL 46, VP-D48a

VP-S11a	Pneumatic bellow shut-off valve SL 5, VP-S11a
VP-S12a	Pneumatic bellow shut-off valve SL 11, VP-S12a
VP-S13a	Pneumatic bellow shut-off valve SL 17, VP-S13a
VP-S14a	Pneumatic bellow shut-off valve SL 23, VP-S14a
VP-S15a	Pneumatic bellow shut-off valve SL 29, VP-S15a
VP-S16a	Pneumatic bellow shut-off valve SL 35, VP-S16a
VP-S17a	Pneumatic bellow shut-off valve SL 41, VP-S17a
VP-S18a	Pneumatic bellow shut-off valve SL 47, VP-S18a
VP-S21a	Pneumatic bellow shut-off valve SL 6, VP-S21a
VP-S22a	Pneumatic bellow shut-off valve SL 12, VP-S22a
VP-S23a	Pneumatic bellow shut-off valve SL 18, VP-S23a
VP-S24a	Pneumatic bellow shut-off valve SL 24, VP-S24a
VP-S25a	Pneumatic bellow shut-off valve SL 30, VP-S25a
VP-S26a	Pneumatic bellow shut-off valve SL 36, VP-S26a
VP-S27a	Pneumatic bellow shut-off valve SL 42, VP-S27a
VP-S28a	Pneumatic bellow shut-off valve SL 48, VP-S28a
VP-D1121b	Pneumatic bellow shut-off valve RL 1+2, VP-D1121b
VP-D1222b	Pneumatic bellow shut-off valve RL 7+8, VP-D1222b
VP-D1323b	Pneumatic bellow shut-off valve RL 13+14, VP-D1323b
VP-D1424b	Pneumatic bellow shut-off valve RL 19+20, VP-D1424b
VP-D1525b	Pneumatic bellow shut-off valve RL 19+20, VP-D1424b
VP-D1626b	Pneumatic bellow shut-off valve RL 25+26, VP-D1525b
VP-D1727b	Pneumatic bellow shut-off valve RL 31+32, VP-D1626b
VP-D1828b	Pneumatic bellow shut-off valve RL 37+38, VP-D1727b
VP-D3141b	Pneumatic bellow shut-off valve RL 43+44, VP-D1828b
VP-D3242b	Pneumatic bellow shut-off valve RL 3+4, VP-D3141b
VP-D3343b	Pneumatic bellow shut-off valve RL 9+10, VP-D3242b
VP-D3444b	Pneumatic bellow shut-off valve RL 15+16, VP-D3343b
VP-D3545b	Pneumatic bellow shut-off valve RL 21+22, VP-D3444b
VP-D3646b	Pneumatic bellow shut-off valve RL 27+28, VP-D3545b
VP-D3747b	Pneumatic bellow shut-off valve RL 33+34, VP-D3646b
VP-D3848b	Pneumatic bellow shut-off valve RL 39+40, VP-D3747b
VP-S11b	Pneumatic bellow shut-off valve RL 45+46, VP-D3848b
VP-S12b	Pneumatic bellow shut-off valve RL 5, VP-S11b
VP-S13b	Pneumatic bellow shut-off valve RL 11, VP-S12b
VP-S14b	Pneumatic bellow shut-off valve RL 17, VP-S13b
VP-S15b	Pneumatic bellow shut-off valve RL 23, VP-S14b
VP-S16b	Pneumatic bellow shut-off valve RL 29, VP-S15b
VP-S17b	Pneumatic bellow shut-off valve RL 35, VP-S16b
VP-S18b	Pneumatic bellow shut-off valve RL 41, VP-S17b
VP-S21b	Pneumatic bellow shut-off valve RL 47, VP-S18b
VP-S22b	Pneumatic bellow shut-off valve RL 6, VP-S21b
VP-S23b	Pneumatic bellow shut-off valve RL 12, VP-S22b
VP-S24b	Pneumatic bellow shut-off valve RL 18, VP-S23b
VP-S25b	Pneumatic bellow shut-off valve RL 24, VP-S24b
VP-S26b	Pneumatic bellow shut-off valve RL 30, VP-S25b
VP-S27b	Pneumatic bellow shut-off valve RL 36, VP-S26b
VP-S28b	Pneumatic bellow shut-off valve RL 42, VP-S27b
QR-3	Pneumatic bellow shut-off valve RL 48, VP-S28b

QR-4	Hand valve return to reservoir from water treatment, QR-3
QR-5	Hand valve into deionizer water treatment, QR-4
	Hand valve out UV water treatment, QR-5

5.9 PHOTO GALLERY

Fig. 6.2.1 – Pump and containement valve

Fig. 6.2.2 –Heat Exchanger, regulation valve and flowmeter

Fig. 6.2.3 – 100micron Filter

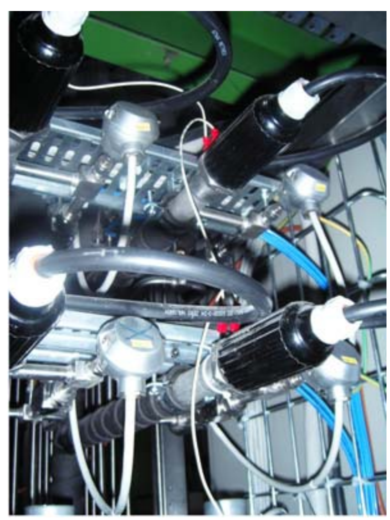


Fig. 6.2.3 – Detail of Heaters

Fig. 6.2.3 – Pressure Dials

Fig. 6.2.4 – Vacuum Pumps

Fig. 6.2.5 – Corrosion Monitoring

Fig. 6.2.6 – Global view

Fig. 6.2.9 – Pneumatic supply box

Fig. 6.2.9 – Return manifold

Fig. 6.2.9 – Global View

5.10 CIRCULATOR PUMP

5.10.1 CALCULATION OF PRESSURE DROP IN THE CIRCUIT

The location of the cooling plant inside the experimental cavern is shown in Figure AI-1.

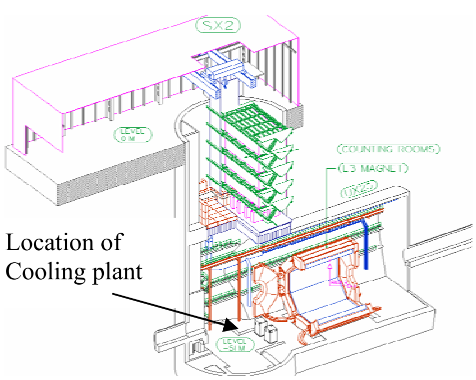
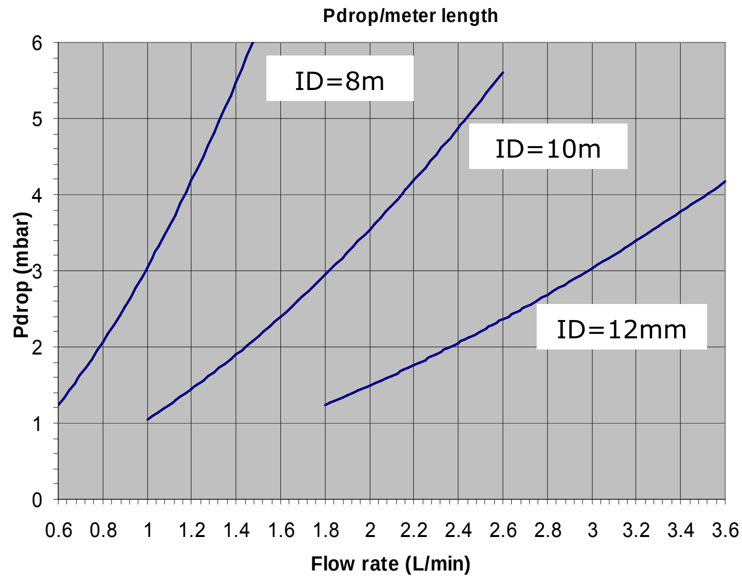


Fig.AI-1- Location of SSD+SDD cooling plant in the experimental cavern

The approximate pipe length between cooling plant and the ITS is 70m for the RB24 access side and 90m for RB26.

Figure AI-2 shows the pressure drop per meter length for pipes of various diameters. If sub-atmospheric operation is to be enabled, pressure drop on the return lines should be minimized.



The number of elbows is approximately 40 and 20 for the pipes accessing the RB26 and RB24 side respectively. All these elbows are of long radius type (curvature=5×Ø) and therefore introduce a pressure drop equivalent to an additional length of 30×inner diameter. The table below shows the resulting total equivalent friction lengths.

ID	RB24	RB26
8MM	70M+(20ELBOWS×30×0.008M) = 74.8M	90M+(40ELBOWS×30×0.008M) = 99.6M
10MM	70M+(20ELBOWS×30×0.010M) = 76M	90M+(40ELBOWS×30×0.010M) = 102M
12MM	70M+(20ELBOWS×30×0.012M) = 77.2M	90M+(40ELBOWS×30×0.012M) = 104.4M

The following table shows the pressure drop for 3 different standard pipe diameters and the range of flow needed by the SSD and SDD detector.

Flow L/min	ID=8mm		ID=10mm		ID=12mm	
	RB24	RB26	RB24	RB26	RB24	RB26
0.6	74.8m×1.24mbar/m = **93 mbar**	99.6m×1.24mbar/m = **124 mbar**	76m×0.42mbar/m = **32 mbar**	102m×0.42mbar/m = **43 mbar**		
0.96	74.8m×2.78mbar/m = **208 mbar**	99.6m×2.78mbar/m = **277 mbar**	76m×0.98mbar/m = **74 mbar**	102m×0.98mbar/m = **100 mbar**		
1.2	74.8m×4.18mbar/m = **313 mbar**	99.6m×4.18mbar/m = **416 mbar**	76m×1.45mbar/m = **110 mbar**	102m×1.45mbar/m = **148 mbar**		
1.8			76m×2.95mbar/m = **224 mbar**	102m×2.95mbar/m = **301 mbar**	77.2m×1.24mbar/m = **96 mbar**	104.4m×1.24mbar/m = **129 mbar**
2.4			76m×4.88mbar/m = **371 mbar**	102m×4.88mbar/m = **498 mbar**	77.2m×2.05mbar/m = **158 mbar**	104.4m×2.05mbar/m = **214 mbar**
3.6					77.2m×4.17mbar/m = **322 mbar**	104.4m×4.17mbar/m = **435 mbar**

The suggested pipe diameters are as follows:

SDD supply:
26 pipes of ID=10mm with a **3mm thick-insulation** to the **RB24** side +
26 pipes of ID=10mm with a **3mm thick-insulation** to the **RB26** side
SDD return:
13 pipes of ID=12mm from the **RB26** side +
13 pipes of ID=12mm from the **RB24** side

SSD supply:
16 pipes of ID=8mm with a **3mm thick-insulation** to the **RB24** side +
16 pipes of ID=8mm with a **3mm thick-insulation** to the **RB26** side
SSD return:
16 pipes of ID=10mm from the **RB26** side +
16 pipes of ID=10mm from the **RB26** side

The pressure drop between the pump outlet and the supply manifold can be estimated at:

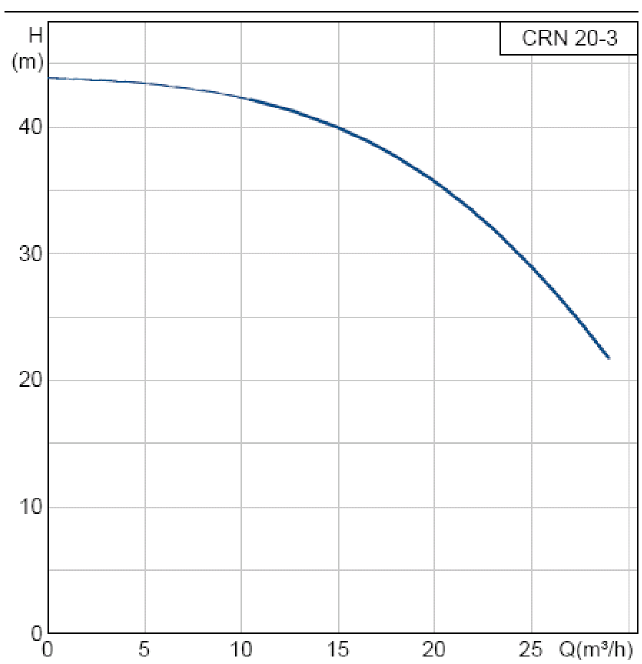
300 mbar (Heat exchanger) + 100mbar (filter) + 150 mbar (flowmeter) + 100mbar (valve) + 50mbar (piping) ≈ **700mbar**

5.10.2CALCULATION OF REQUIRED PUMP HEAD

Total Pressure drop for 1 loop (from pump outlet to reservoir):

700mbar + 500mbar (worst case supply pipe) + 600mbar (detector)+ 500mbar (worst case return pipe) = 2300 mbar

Hence the pump must supply at least **2.3bar** for a flow rate of **7.2m³/h**.



5.10.3 CALCULATION OF REQUIRED NPSH

For non occurrence of cavitation, the minimum head required at the pump inlet or Net positive suction head NPSH, must be

$$\frac{P\tan k}{\rho g} - hf + \Delta y - \frac{Psatvap(Tamb)}{\rho g} > NPSH$$

assuming the friction in the pipe to be cancelled by the difference in level, i.e.

$$-hf + \Delta y = 0$$

and $\frac{Psatvap(25^{o}C)}{\rho g} \approx 0.3m$ with and Ptank=400mbar, it must then be:

$NPSH \leq 4m - 0.3m = 3.7m$ The chosen pump verifies this condition.

5.11 RESERVOIR

Total volume of water in installation:

supply pipes: ID=10mm
return pipes: ID=12mm
length of pipe ~70+90 m per loop

Total volume of water in supply + return pipes = 90m×48loops ×π/4 × $(0.010^2+0.12^2)$ ≈ 132L

Supply and return manifolds + heat exchanger + pump inner volume ≈ 10L

Volume in the detector ≈ 5 L

Thus, the total volume of water moving through the installation at anytime is ≈147L

With a 180L reservoir, the maximum amount of water stocked inside during operation will be 180-147=33L, which will bring the water level to about 1/5 of the total reservoir height – enough to obtain a stable level surface.

5.12 HEAT EXCHANGERS

SSD

SPÉCIFICATIONS		CÔTÉ 1		CÔTÉ 2
Fluide Côté 1	Water			
Fluide Côté 2	Water			
Température entrée	°C	: 22.0		6.0
Température sortie	°C	: 15.0		11.7
Débit	m³/h	: 2.10		2.55

ÉCHANGEUR A PLAQUES				
Puissance	kW	:	17.05	
Surface d'échange	m²	:	0.320	
Écart logarithmique	°C	:	9.6	
Coefficient de transfert	W/m²,°C	:	5539	
Pertes de charge calculées	kPa / kPa	: 29		31
Canaux		: 5		6
Nombre de plaques		:	12	

SDD

ECHANGEUR DE CHALEUR: GC-12x20
MONO-PHASIQUE - Type
Client: CERN Genève - M. dos Santos — Date: 11/2/2004
Référence: Echangeurs — N/réf.: 0411023Dca

SPÉCIFICATIONS		CÔTÉ 1		CÔTÉ 2
Fluide Côté 1	Water			
Fluide Côté 2	Water			
Température entrée	°C	: 22.0		6.0
Température sortie	°C	: 15.0		12.2
Débit	m³/h	: 3.90		4.37

ÉCHANGEUR A PLAQUES				
Puissance	kW	:	31.67	
Surface d'échange	m²	:	0.576	
Écart logarithmique	°C	:	9.4	
Coefficient de transfert	W/m²,°C	:	5860	
Pertes de charge calculées	kPa / kPa	: 31		33
Canaux		: 9		10
Nombre de plaques		:	20	

The heat exchanged is much greater than the detector dissipation (~6kW). The plant can cope with heat picked up from the environment along supply and return pipes.

5.13 MIXED WATER VALVE

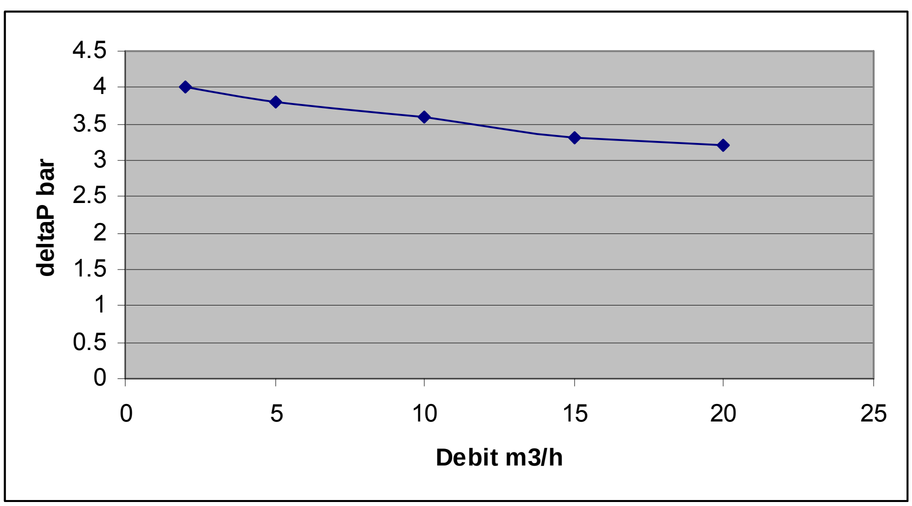
ΔP available in the cavern is **2bar** (information source: B. Pirollet)

1) Kv calculé par $Kv = 0.01 \times \frac{debit(L/h)}{\sqrt{\Delta P(kPa)}}$

5.14 COOLING PERFORMANCE

The heat exchanger can remove up to 30kW when supplied with mixed water at nominal temperature and pressure (see §6.5). It was not possible to test this limit in our lab.

5.15 MEASURED HYDRAULIC PERFORMANCE AT 50HZ



6 PREVENTIVE MAINTENANCE

- periodic replacement of mixed-bed de-ionizer
- periodic cleaning of strainer

7 ANNEXES

7.1 CONTACT PERSONS

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