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TECHNICAL FOLDER

ALICE TOF/PHOS/CPV/EMC COOLING PLANT - HYDRAULIC PART FCUL-00006

General description and functionalities

This document is the technical dossier of the ALICE TOF/PHOS/CPV/EMC water cooling plant. This cooling unit runs raw water in closed loop furnishing a maximum cooling power of 132.7 kW @ 15°C, corresponding to a total flow rate of 437 l/min. Its primary cold source is represented by CERN chilled water network. The nominal flow is split inside the plant to feed 16 cooling lines: 6 circuits serve the TOF Modules, 6 circuits are for TOF Crates, 1 circuit for PHOS, 1 for CPV transfer line and 2 circuits for ECM cooling.

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History of Changes			
Rev. No.	*Date*	*Pages*	*Description of Changes*
V1	2006-10-03	All	Original Document
V2	2012-12-01	27 to 29	Upgrade 2012: Installation of a circulator for PHOS on UPS

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1. GENERAL DESCRIPTION

This document is user-oriented and describes the main technical features and performances of the water cooling plant for the TOF (Time of Flight), PHOS (PHOton Spectrometer), CPV (Charged Particle Veto), and EMC (Electromagnetic Calorimeter) sub-detectors of the Alice (A Large Ion Collider Experiment) experiment.

This cooling plant will run as a cold media about 1000 liters of raw water in closed loop, with the scope of removing a total foreseen heat dissipation of 132.7 kW: 122.4 kW for the TOF system (by considering 1550 W of dissipation for each of the 72 crates and 120 W for each of the 90 modules), 4.3 kW for the electronics of the PHOS sub-detector (856 W in each of the 5 modules), 1 kW for the five modules of the CPV experiment (200 W each), and 5kW for the EMC detector.

Normal water will be used as the cooling medium, and supplied to the sub-detectors with the following total flow rates and temperatures: 293 l/min @ 15 °C to the TOF system, 100 l/min @ 15 °C to the PHOS, 15 l/min @ 15 °C to the CPV, and 29l/min to EMC.

This in order to remove the mentioned heat fluxes and limit the heating up of the coolant inside the detector lines to 6 °C for the TOF system, 0.7 °C for the PHOS, 1 °C for the CPV, and 2.5°C to EMC.

The maximum provided pressure drop inside the inner lines of the TOF sub-detector is 800 mbar, while 300 mbar is assumed as a maximum figure for each PHOS module. The pressure drop inside the cooling circuits of each CPV module has been evaluated to be about 200 mbar, and for the EMC 2 bar.

In the following Table 1.1 a summary of the main hydraulic parameters is reported.

Table 1.1. Hydraulic parameters.

Main Parameters	TOF	CPV	PHOS	EMC
Heat power dissipation	122.4 kW	1 kW	4.3 kW	5 kW
Total water flow	293 l / min	15 l / min	100 l / min	29 l/min
$T_{\text{INLET DETECTOR}}$	15 °C	15 °C	15 °C	15 °C
$\Delta T_{\text{INSIDE DETECTOR}}$	~ 6 °C	~ 1 °C	~ 0.7 °C	~2.5°C
$\Delta p_{\text{DETECTOR}}$	800 mbar	200 mbar	300 mbar	-
Number of transfer lines	12	1	5	2
Chilled water consumption	~21.1 m^3/h	~0.9 m^3/h		~0.9m3/h

2. HYDRAULIC DOSSIER

2.1 GENERAL SCHEME

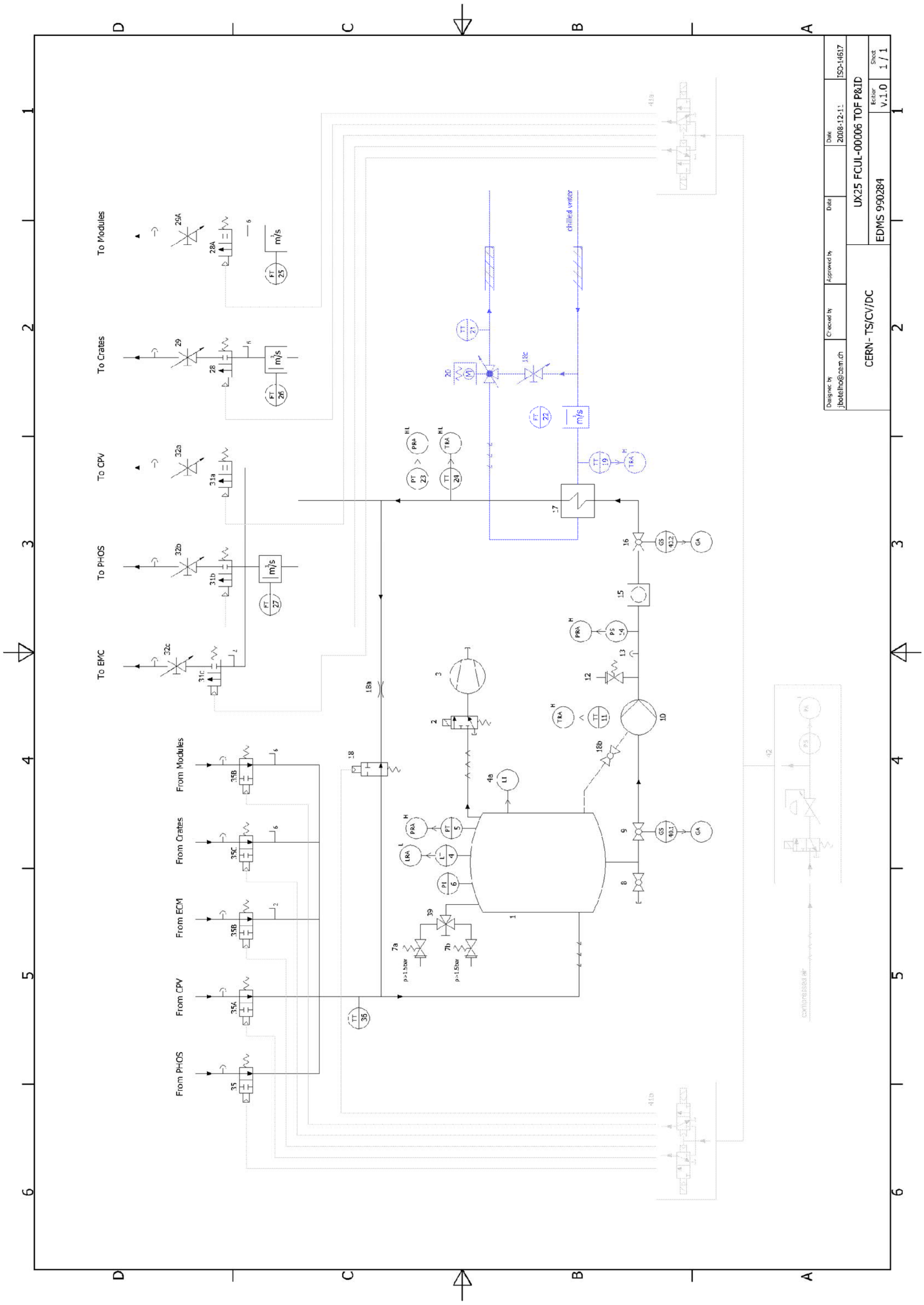


Figure 1.1. TOF/PHOS/CPV/EMC P&I diagram (https://edms.cern.ch/file/990284) according to ISO 14617.

2.2 PART LIST & D7I NAMING

SYSTEM	P&I	Ref. Component	D7I
TOF	1	Tank	FCEE-00037
TOF	2	Electrovalve 3 voies	FCV-00584
TOF	3	Vacuum pump	FCP-00054
TOF	4	Level transmitter	FCLT-00012
TOF	4a	Level indicator	FCLG-00003
TOF	5	Pressure transmitter	FCPT-00109
TOF	6	Manometer	FCPG-00127
TOF	7a	Safety valve	FCKE-00232
TOF	7b	Safety valve	FCKE-00233
TOF	8	Ball valve	FCV-02921
TOF	9	Ball valve	FCV-02922
TOF	10	Pump	FCP-00055
TOF	11	Temperature transmitter	FCTT-00135
TOF	12	Safety valve	FCKE-00234
TOF	13	Schraeder valve	
TOF	14	Pressure switch	FCPS-00033
TOF	15	Strainer/Filter	FCF-00115
TOF	16	Ball valve	FCF-00039
TOF	17	Heat exchanger	FCE-00065
TOF	18	Pneumatic valve	FCV-00585
TOF	18a	Restrictor	
TOF	18b	Ball valve	FCV-02923
TOF	18c	Piston valve	FCV-02924
TOF	19	Temperature transmitter	FCTT-00136
TOF	20	Control valve	FCV-00586
TOF	20.1	Actuator	FCV-02925
TOF	21	Temperature transmitter	FCTT-00137
TOF	22	Flowmeter	FCFT-00006
TOF	22	Flowmeter	FCFT-00152
TOF	23	Pressure transmitter	FCPT-00110
TOF	24	Temperature transmitter	FCTT-00138
TOF	25	Flowmeter	FCFIC-00042
TOF	25	Flowmeter	FCFT-00154
TOF	26	Flowmeter	FCFT-00007
TOF	26	Flowmeter	FCFT-00153
TOF	27	Flowmeter	FCFIC-00043
TOF	27	Flowmeter	FCFT-00155
TOF	28.1	Pneumatic valve	FCV-00587
TOF	28.2	Pneumatic valve	FCV-02926
TOF	28.3	Pneumatic valve	FCV-02927

TOF	28.4	Pneumatic valve	FCV-02928
TOF	28.5	Pneumatic valve	FCV-02929
TOF	28.6	Pneumatic valve	FCV-02930
TOF	28A.1	Pneumatic valve	FCV-00588
TOF	28A.2	Pneumatic valve	FCV-02931
TOF	28A.3	Pneumatic valve	FCV-02932
TOF	28A.4	Pneumatic valve	FCV-02933
TOF	28A.5	Pneumatic valve	FCV-02934
TOF	28A.6	Pneumatic valve	FCV-02935
TOF	29.1	Piston valve	FCV-02936
TOF	29.2	Piston valve	FCV-02937
TOF	29.3	Piston valve	FCV-02938
TOF	29.4	Piston valve	FCV-02939
TOF	29.5	Piston valve	FCV-02940
TOF	29.6	Piston valve	FCV-02941
TOF	29A.1	Piston valve	FCV-02942
TOF	29A.2	Piston valve	FCV-02943
TOF	29A.3	Piston valve	FCV-02944
TOF	29A.4	Piston valve	FCV-02945
TOF	29A.5	Piston valve	FCV-02946
TOF	29A.6	Piston valve	FCV-02947
TOF	30	Schraeder valve	
TOF	31a	Pneumatic valve	FCV-00589
TOF	31b	Pneumatic valve	FCV-00590
TOF	31c.1	Pneumatic valve	FCV-02948
TOF	31c.2	Pneumatic valve	FCV-02949
TOF	32a	Piston valve	FCV-02950
TOF	32b	Piston valve	FCV-02951
TOF	32c.1	Piston valve	FCV-02952
TOF	32c.2	Piston valve	FCV-02953
TOF	33	Schraeder valve	
TOF	34	Schraeder valve	
TOF	35	Pneumatic valve	FCV-00591
TOF	35A	Pneumatic valve	FCV-00592
TOF	35B.1	Pneumatic valve	FCV-00593
TOF	35B.2	Pneumatic valve	FCV-02954
TOF	35C.1	Pneumatic valve	FCV-00594
TOF	35C.2	Pneumatic valve	FCV-00592
TOF	35C.3	Pneumatic valve	FCV-02955
TOF	35C.4	Pneumatic valve	FCV-02956
TOF	35C.5	Pneumatic valve	FCV-02960
TOF	35C.6	Pneumatic valve	FCV-02961
TOF	36	Temperature transmitter	FCTT-00139
TOF	39	3-way valve	FCV-02962

TOF	40.1	Contact switch	FCEZE-00002
TOF	40.2	Contact switch	FCEZE-00003

2.3 CIVIL ENGINEERING INTEGRATION

The services required by this cooling plant are:

- 35m^3/h at dp=2bar of mixed water
- 4kVA, 400V from the TS-CV standard power distribution
- 1000W, 220V from TS-CV UPS power distribution
- Compressed air at 6bar (consumption is negligible).
- TCP/IP connection

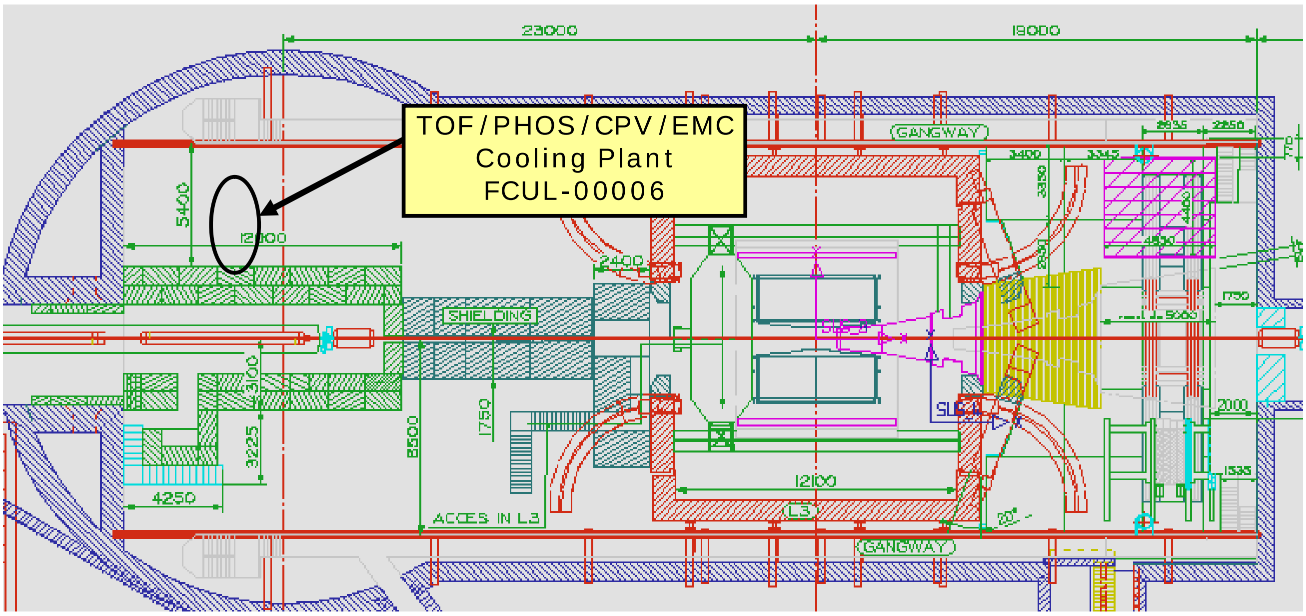


Figure 2.1. HMPID Cooling Plant location on UX25.

3. USER MANUAL

Most of the operation of the TOF cooling plant is done via a PLC interface panel (Magelis XBT) shown in Figure 3.1 below:

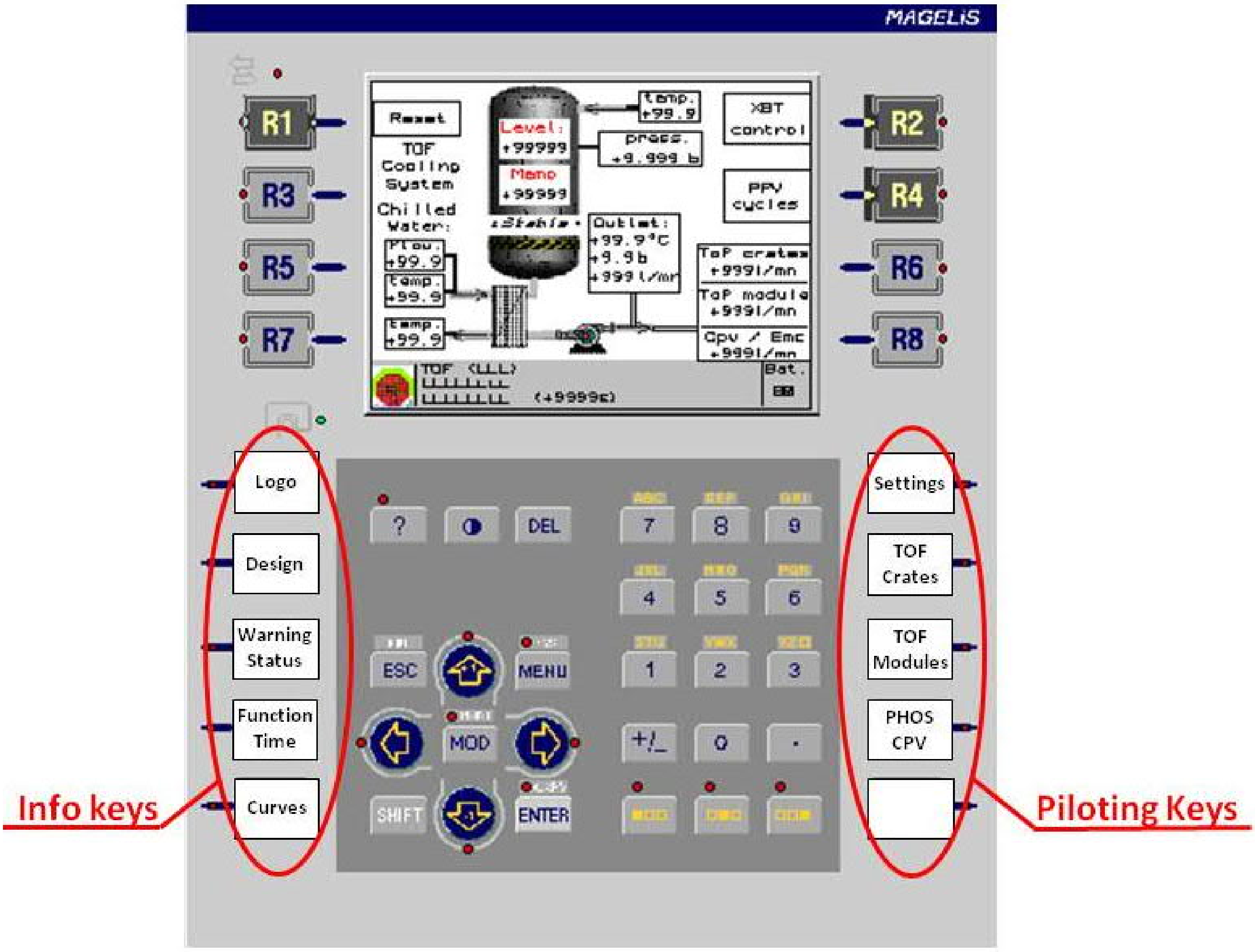


Figure 3.1. Interface panel (Magelis XBT).

The buttons on the left of the panel (*Logo*, *Design by*, *Curves*, *Function Time* and *Curves*) 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*, *TOF Crates, TOF Modules, PHOS/CPV/EMC*) allow the user to open and close valves.

The button “R2” on the top right of the panel allows the user to choose the cooling plant cycle (STOP, STAN-BY, and RUN), as well as to choose the flow rate and temperature (as it is shown in next Figure 3.2).

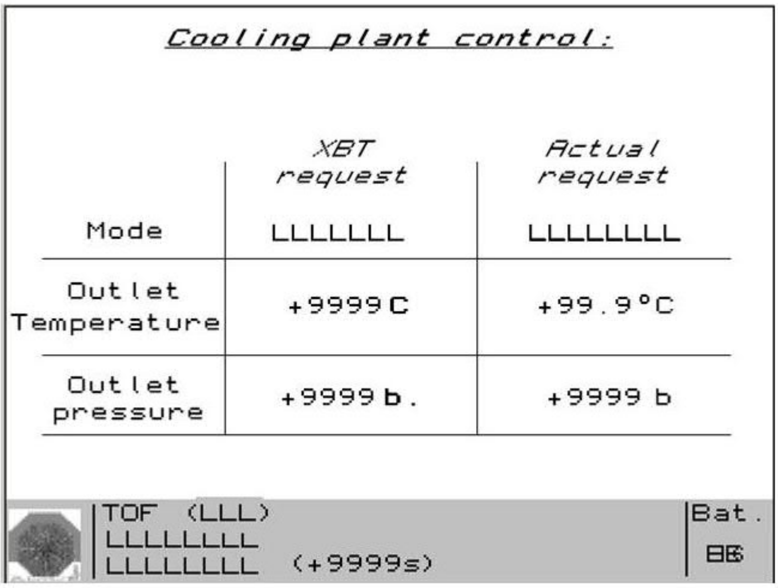


Figure 3.2. XBT Control page.

All pages displayed on the screen bear information on the *Cycle* and the *Status*. The former can assume 3 different values: *Stop*, *Stand-by*, and *Run*. The letter 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 (see next Figure 3.3)*.

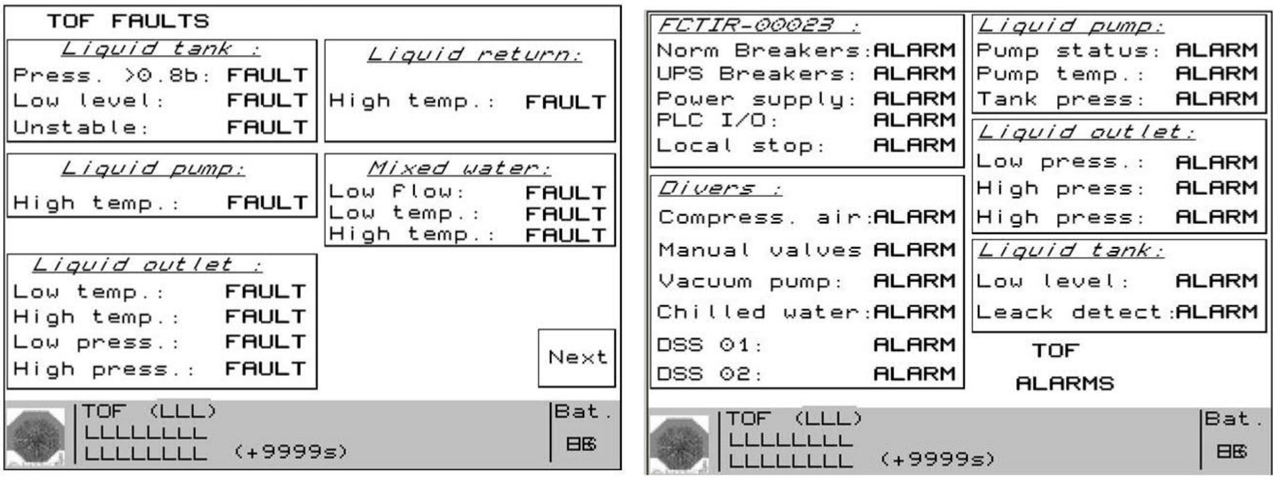


Figure 3.3. Faults and Alarms page.

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.
- 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 *Run Cycle* once the *Status* is *Warning* or *OK*. As long as the *Status* is Alarm, the only possible *Cycles* are *Stand-by* and *Stop*.

3.1 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 (while in the page shown on Figure 3.2):

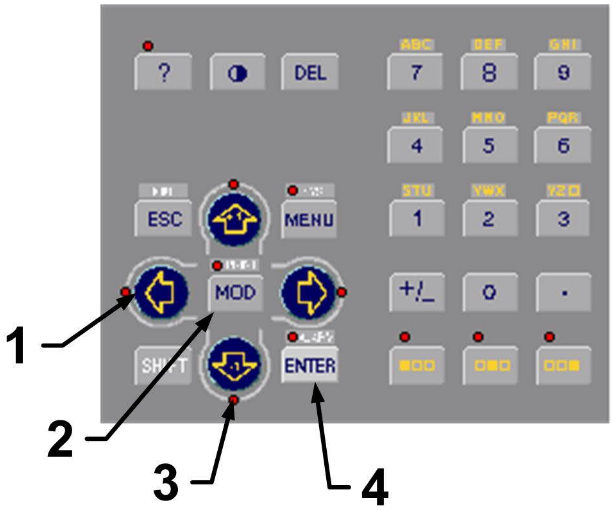


Figure. 3.4. Keyboard.

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*

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 *Piloting keys* on the panel (TOF Crates, TOF Modules, and PHOS/CPV/EMC):

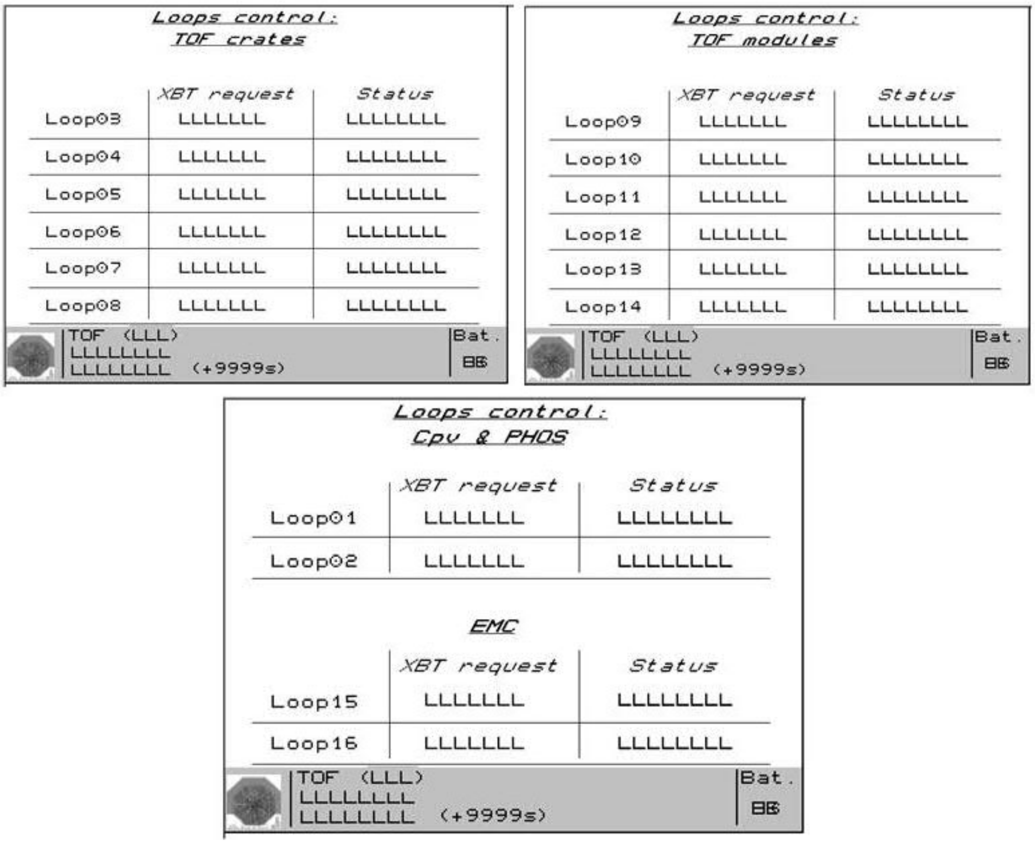


Figure 3.5. Loops Control.

Any given cooling circuit (loop) can display one of three states:

- Locked: supply and return valves are closed. This is the state you should select for un-used outlets. This state is available in *STAND-BY* and *RUN CYCLES*.
- Open: supply and return valves are open, hence the right configuration for water to flow through this circuit. This state is only available in *RUN CYCLE*. When the cooling plant goes to *STAND-BY* or *STOP CYCLE* the state goes automatically to *closed*.
- Closed: supply valve is closed but return valve is open. 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.

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 50mbar 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.

3.2 STARTING PROCEDURE

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.

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 shall divert the flow from the supply manifold to the return manifold. 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.

3.3 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 the detector is below atmospheric pressure. Therefore, should a leak occur, it may either lead to water spillage or air infiltration, depending on its location.

3.3.1 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:

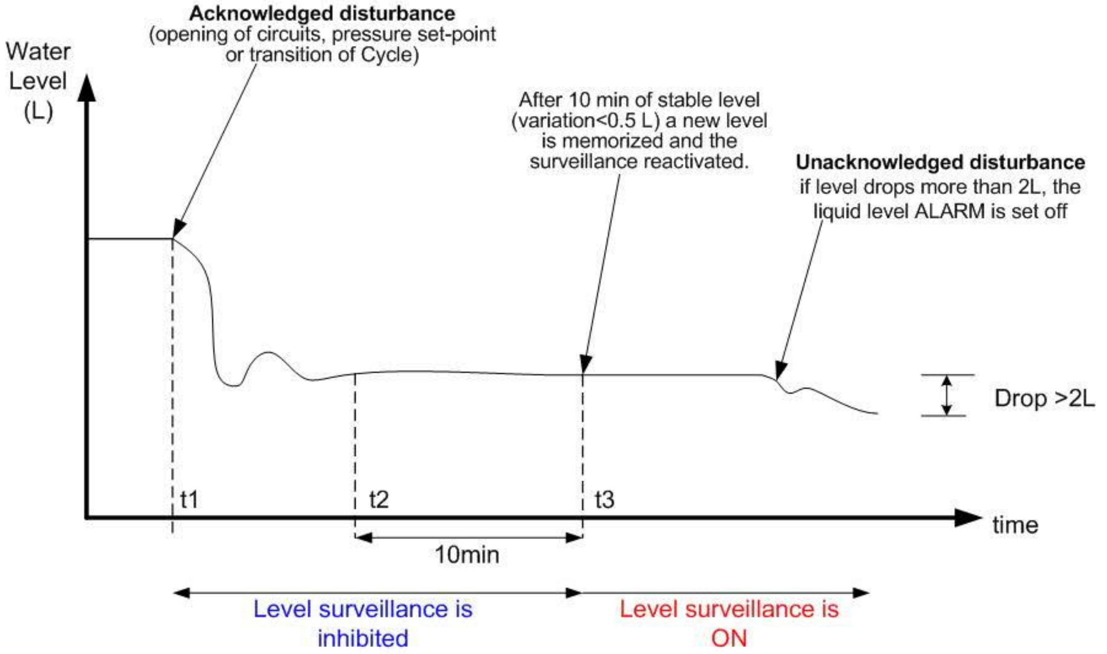


Figure. 3.6. Normal and abnormal variations of the water level in the reservoir

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.

3.3.2 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.

3.4 FAULTS AND ALARMS

Fault	Cause	Outcome	Cycles in which it is active	
			Stand-by	Run
Liquid Pump: Eng.temp > 40ºC	The motor temperature is higher than 40ºC. If the temperature rises above 50ºC, this fault converts into an alarm (see alarm list below).	none	●	●
Liquid outlet: Temp. < 13.5ºC	The temperature of the water at the supply manifold is below 13.5ºC	none		●
Liquid outlet: Temp. > 24ºC	The temperature of the water at the supply manifold is above 24ºC	none		●
Liquid outlet: Low press. <0.9bar	The pressure at the supply manifold is below 0.8bar(a). If it falls below 0.9bar this fault converts into an alarm (see alarm list below)	none		●
Liquid outlet: High press. >5.5bar	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		●
Return Temperature >26 °C	The temperature of the water at the return manifold is above 26ºC	none		●
Chilled water: temp<4ºC	The mixed water temperature is lower than 4ºC.	none		●
Chilled water: temp>12ºC	The mixed water temperature is higher than 12ºC.	none		●
Chilled water: Flow<20L/h	The mixed water flow is lower than 20L/h.	none		●
Liquid Tank: Pressure	Air pressure in the reservoir is above 0.8bar	Halts circulator pump (if in Run)	●	●
Liquid Tank: Level<100L	The volume of water in the reservoir is less than 100L. If it drops below 50L 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	Cycles in which it is active	
			Stand-by	Run
Compress air < 6bar(g)	The pneumatic supply pressure is below 6bar(g).	Goes to Stand-by		●
UPS fault	The circuit breakers of the Emergency Power Supply tripped	Goes to Stop	●	●
Breakers fault	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 Valves closed	The reservoir containment valve is closed	Goes to Stand-by		●
Low outlet Pressure	Following the fault threshold at 0.9bar, the pressure has now dropped below 0.8bar	Goes to Stand-by		●
Liquid outlet temperature out of range (>25°C or <12°C)	*Liquid outlet temperature is higher than 25°C or lower than 12°C*	Goes to Stand-by		●
Liquid Tank: Pressure	Air pressure in the reservoir is above 0.9bar	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 100L, the level has further dropped below 50L.	Goes to Stand-by		●
Fast Liquid level change	Following an unacknowledged disturbance, the level drops more than 50L	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		●	●

3.5 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.

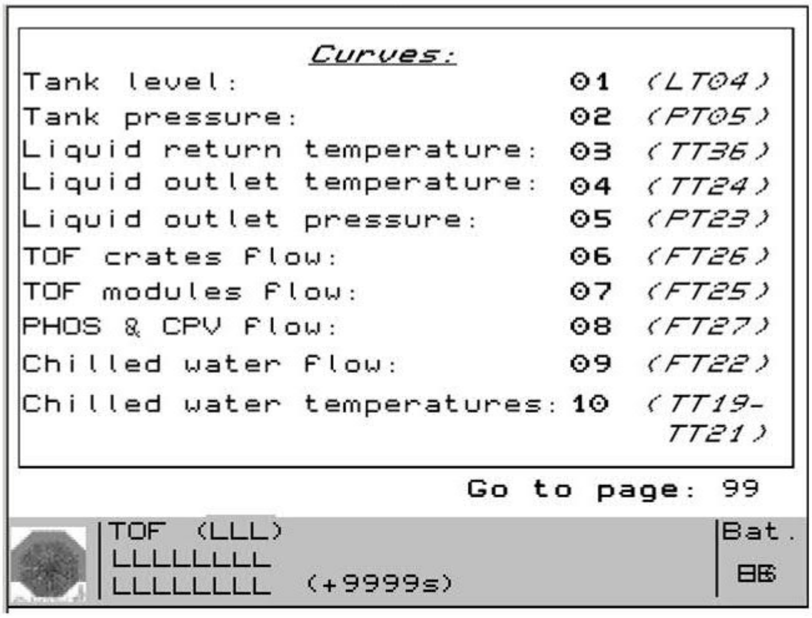


Figure 3.7. Real time information of several parameters.

3.6 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.

4. REGULATION PARAMETERS

Parameters signalled with * require access to the PLC source code file and therefore can only be modified by EN/CV/DC.

4.1 REGULATION OF PRESSURE IN RESERVOIR

Type: ON/OFF
Set-point=0.8bar*
Regulation band = 50mbar*
Maximum pumping time = 20min*

4.2 REGULATION OF TEMPERATURE

Type: PID
Set point=15~20ºC
P=see source PL7 code
I= see source PL7 code
D= see source PL7 code

4.3 REGULATION OF WATER PRESSURE

Type: PID
Set point=1.2~5.0 bar
P= see source PL7 code
I= see source PL7 code
D= see source PL7 code

5. MAINTENANCE

This chapter describes, where applicable, the maintenance procedures to be foreseen to operate the installation.

There are two types of maintenance to be applied on the cooling plant: Corrective maintenance and preventive maintenance.

As for the corrective maintenance, a spare part list (Maintenance Agreement signed between TS department and the Experiments) is to be maintained case malfunctions on the equipment are observed. This list can be found at the EDMS portal: https://edms.cern.ch/document/848184/1.

As for the Preventive Maintenance, the two categories: Programed and Condicioned are applied. The Conditioned Preventive Maintenance activity is based on the observation/monitoring of the cooling plant (EN/CV/DC SCADA system) used to predict malfunctions on the equipment so that an action can be taken (to replace the vaccum pump membranes case the pumping efficiency decrease as an example). The Programed Preventive Maintenance action plan is the following:

Equipment	Title	Instruction List	Every 6 months	Every Year
FCE-00065	Heat exchanger	CONTROLES ENCRASSEMENT PAR ΔT ET ΔP, ETANCHEITE		X
FCEE-00037	Tank with 1200 liters capacity	CONTRÔLE ETAT GENERAL, BON FONCTIONNEMENT (PRESSION, NIVEAU), ETANCHEITE		X
FCF-00115	Strainer	ISOLATION HYDRAULIQUE, VIDANGE, OUVERTURE FILTRE, DEMONTAGE ELEMENT FILTRANT ET EVACUATION, REMONTAGE NOUVEL ELEMENT FILTRANT, REMPLISSAGE, PURGER FILTRE, MISE EN SERVICE		X
FCF-00039	Hand valve (after pump)			X
FCKE-00232	Tank pressure safety valve	ISOLATION HYDRAULIQUE, DEMONTAGE, CONTROLE BATTANT (RESSORT OU MEMBRANE)- REMPLACEMENT SI NECESSAIRE, REMPLACEMENT DES JOINT (FILASSES), MISE EN EAU, ESSAI ET MISE EN SERVICE		X
FCKE-00233	Tank pressure safety valve	ISOLATION HYDRAULIQUE, DEMONTAGE, CONTROLE BATTANT (RESSORT OU MEMBRANE)- REMPLACEMENT SI NECESSAIRE, REMPLACEMENT DES JOINT (FILASSES), MISE EN EAU, ESSAI ET MISE EN SERVICE		X

FCKE-00234	Safety valve (after pump)	ISOLATION HYDRAULIQUE, DEMONTAGE, CONTROLE BATTANT (RESSORT OU MEMBRANE)- REMPLACEMENT SI NECESSAIRE, REMPLACEMENT DES JOINT (FILASSES), MISE EN EAU, ESSAI ET MISE EN SERVICE		X
FCP-00054	Vacuum pump	Service contract with KNF		
FCP-00055	Circulation Pump	CONTROLES : ETAT GENERAL, ROULEMENTS PAR ROTATION MANUELLE, VIBRATIONS AVEC ENREGISTREMENTS, ACCOUPLEMENT, PRESSE-ETOUPE AVEC RAJOUT DE TRESSE EVENTUELLE, CHANGEMENT HUILE/ GRAISSE		X
		CONTRôLE TEMPERATURE ET BRUITS ANORMAUX, MESURE ISOLEMENT BOBINAGE ET RESISTANCE DE SURCHAUFFE, GAISSAGE DES ROULEMENTS SI POSSIBLE		X
FCV-00584	Vacuum pump electro valve (normaly closed)	CONTROLES: POSITIONNEUR, FIN DE COURSE, LIMITEUR EFFORT, ETANCHEITE. GRAISSAGE DE AXES, MANŒUVRE VANNE		X
FCV-00586	Chilled water control valve			X
FCV-02925	Control valve actuator			X
FCV-00587	Pneumatic valve for TOF Crates supply			X
FCV-02926	Pneumatic valve for TOF Crates supply			X
FCV-02927	Pneumatic valve for TOF Crates supply			X
FCV-02928	Pneumatic valve for TOF Crates supply			X
FCV-02929	Pneumatic valve for TOF Crates supply			X
FCV-02930	Pneumatic valve for TOF Crates			X

	supply			
FCV-00588	Pneumatic valve for TOF Modules supply			X
FCV-02931	Pneumatic valve for TOF Modules supply			X
FCV-02932	Pneumatic valve for TOF Modules supply			X
FCV-02933	Pneumatic valve for TOF Modules supply			X
FCV-02934	Pneumatic valve for TOF Modules supply			X
FCV-02935	Pneumatic valve for TOF Modules supply			X
FCV-00589	Pneumatic valve to CPV supply			X
FCV-00590	Pneumatic valve to PHOS supply			X
FCV-02948	Pneumatic valve to EMC supply			X
FCV-02949	Pneumatic valve to EMC supply			X
FCV-00591	Pneumatic valve for PHOS return			X
FCV-00592	Pneumatic valve for CPV return			X
FCV-00593	Pneumatic valve for EMC return			X
FCV-02954	Pneumatic valve for EMC return			X
FCV-00594	Pneumatic valve for Crates return			X
FCV-00592	Pneumatic valve for Crates return			X
FCV-02955	Pneumatic valve for Crates return			X
FCV-02956	Pneumatic valve for Crates return			X
FCV-02960	Pneumatic valve for Crates return			X
FCV-02961	Pneumatic valve for Crates return			X

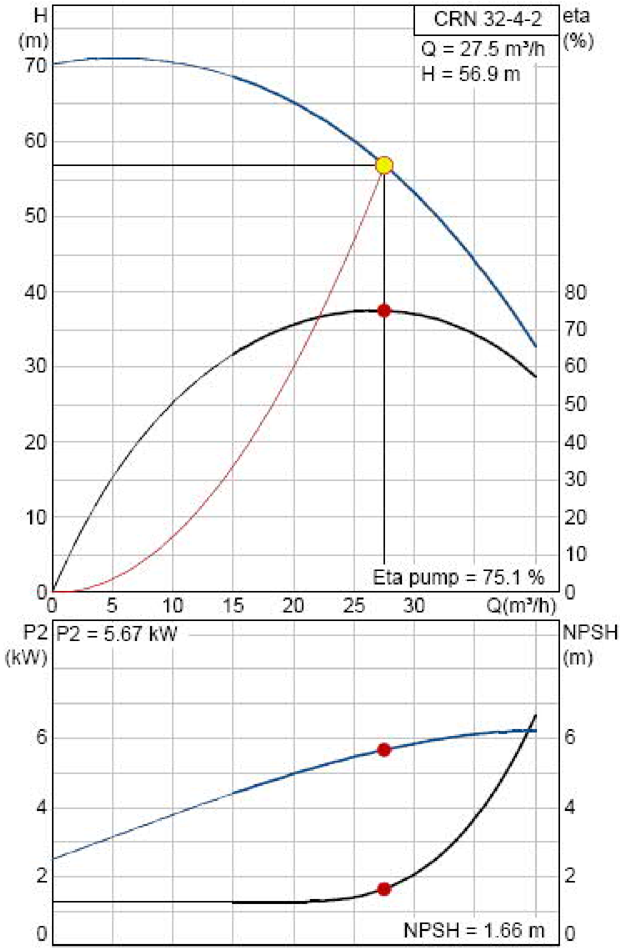
FCTIR-00023	Cabinet	VERIFICATION DES CONNECTIONS,BORNIERS, CONTACTEUR, CONTRÔLE DES PROTECTIONS ET DES VOYANTS	X	
		THERMOGRAPHIE DES CONNECTIONS		
FCIC-00018	Power supply	Reference module: TSX PSY xxx	X	
FCIC-00019	Power supply (no pile)	Reference pile de rechange: TSX PLP 01	X	
		Frequence de remplacement: chaque annee.		
		Procedure:		
		Enlever la pile usagee		
		Mettre une pile neuve		
		Mettre une etiquette avec la date du remplacement.	X	
FCUC-00013	Processor	Reference module: TSX Pxxx (processor) Reference pile de rechange: TSX BAT M02 + TSX BAT M03 Frequence de remplacement: chaque annee. Procedure: Connecter la console de programmation directement au PLC (prise TER). Verifier et sauvegarder si necessaire la version de programme embarque. Sauvegarder les variables courantes a l'aide de la commande : AP\Transferer donnees\Automate vers fichier Enregistrer le fichier sous le nom: Backup_"system"_"mois"_"annee".dat (ex: Backup_HMPID_10_2008.dat) Passer PL7 en mode "Local". Arreter les systemes de cooling depuis XBT. Couper l'alimentation des racks PLCs (Disjoncteur) Enlever la carte memoire du processeur. Remplacer la pile principale "TSX BAT M02" Remplacer la pile auxilliaire "TSX BAT M03" Remettre la carte memoire en place. Remettre le PLC sous tension (disjoncteur) Reconnecter la console de programmation et verifier la version de programme. Recharger les variables courante dans le PLC a l'aide de la commande: AP\Transferer donnees\Fichier vers Automate. Controler l'absence de defaut "Piles PLC" Redemarrer les systemes de cooling. Sauvegarder le fichier de variables courantes sur Detcool. Note: -Toujours remplacer les piles l'une apres l'autre pour conserver le programme en memoire. -L'ensemble de ces operation prend environs 10 minutes	X	
FCUC-00014	Processor (no pile)			

		dont 5 avec arret du refroidissement		
FCSC-00013	Speed Controller	VERIFICATION SIGNAL ENTREE, SIGNAL SORTIE, DE LA CONFIGURATION, DES PROTECTIONS, TEST + NETTOYAGE ET CONTROLE VENTILATEUR		X

6. COMPONENT SELECTION

6.1 CIRCULATOR PUMP

Description	Value
Product name:	CRN 32-4-2
Product No:	96122356
EAN number:	5700396684000
Technical:	
Speed for pump data:	2919 rpm
Rated flow:	30 m³/h
Rated head:	50.8 m
Impellers:	4
Impeller reduc.:	2
Type of shaft seal:	HQQE
Curve tolerance:	ISO 9906 Annex A
Stages:	4
Pump version:	A
Model:	A
Materials:	
Material, pump housing:	Stainless steel
	1.4408 DIN W.-Nr.
	316 LN AISI
Material, impeller:	Stainless steel
	1.4401 DIN W.-Nr.
	316 AISI
Material code:	G
Code for rubber:	E
Installation:	
Maximum ambient temperature:	40 °C
Max pressure at stated temp:	16 / 120 bar / °C
Standard, pipe connection:	DIN
Connect code:	F
Size, pipe connection:	DN 65
Pressure stage, pipe connec.:	PN 16 / PN 25 / PN 40
Flange size for motor:	FF265
Liquid:	
Liquid temperature range:	-30 .. 120 °C
Electrical data:	
Motor type:	132SC
Efficiency class:	2
Number of poles:	2
P2:	7.5 kW
Mains frequency:	50 Hz
Rated voltage:	3 x 380-415 D V
Rated current:	15.2 A
Starting current:	910-990 %
Cos phi - power factor:	0,87-0,81
Rated speed:	2890-2910 rpm
Enclosure class (IEC 34-5):	IP55
Insulation class (IEC 85):	F
Motor protec:	PTC
Motor No:	85817422
Others:	
Net weight:	115 kg
Gross weight:	175 kg
Shipping volume:	0.3 m³



6.2 TANK

Tank volume calculation:

	Pipe Diameter [mm]	L RB24 [m]	L RB26 [m]	V [m3]
TOF Crates Supply	32	35x3	65x3	0.24
TOF Modules Supply	16	35x3	65x3	0.06
PHOS Supply	40	35	-	0.04
CPV Supply	20	35	-	0.01
EMCAL Supply	16	35	65	0.02
TOF Crates Return	32	35x3	65x3	0.24
TOF Modules Return	16	35x3	65x3	0.06
PHOS Return	50	35		0.07
CPV Return	25	35		0.02
EMCAL Return	16	35	65	0.02
			Line Volume	0.78
			Detector Volume	0.17
			TOTAL VOLUME	1.2

6.3 HEAT EXCHANGER

HEAT EXCHANGER: B60x70H/1P

SINGLE PHASE - Dimensionamento

Customer: Date: 20/12/2005
Reference: Our Ref.:

DUTY REQUIREMENTS			**SIDE 1**	**SIDE 2**
Fluid Side 1	Water			
Fluid Side 2	Water			
Inlet temperature	°C	:	22.00	6.00
Outlet temperature	°C	:	14.00	12.00
Flow rate	l/min/kg/s	:	435.0	9.625
Max. pressure drop	kPa	:	50.0	50.0
Thermal length	NTU	:	0.893	0.669
PHYSICAL PROPERTIES				
Reference temperature	°C	:	18.00	9.00
Dynamic viscosity	cP	:	1.05	1.35
Dynamic viscosity - wall	cP	:	1.16	1.18
Density	kg/m³	:	998.5	999.8
Specific heat capacity	kJ/kg, °C	:	4.184	4.195
Thermal conductivity	W/m, °C	:	0.5948	0.5781
PLATE HEAT EXCHANGER				
Heat load	kW	:	242.3	
Total heat transfer area	m²	:	8.70	
Heat flux	kW/m²	:	27.85	
Log mean temperature difference	K	:	8.96	
Overall H.T.C. (available/required)	W/m², °C	:	3690/3110	
Pressure drops - total	kPa	:	46.7	12.9
- in ports	kPa	:	4.43	3.02
Port diameter	mm	:	55.0	70.0
Number of channels		:	34H	35L
Number of plates		:	70	
Oversurfacing	%	:	19	
Fouling factor	m², °C/kW	:	0.050	

6.4 CONTROL VALVE

ΔP available in the cavern is 2bar.

Head loss on heat exchanger	Nominal Flow	Head loss with nominal flow	Kv for the nominal flow	% of openning for the nominal flow (linear and Kv=100)
50kPa	$23m^3/h$	5.3kPa	19	19

7. UPGRADE 2012

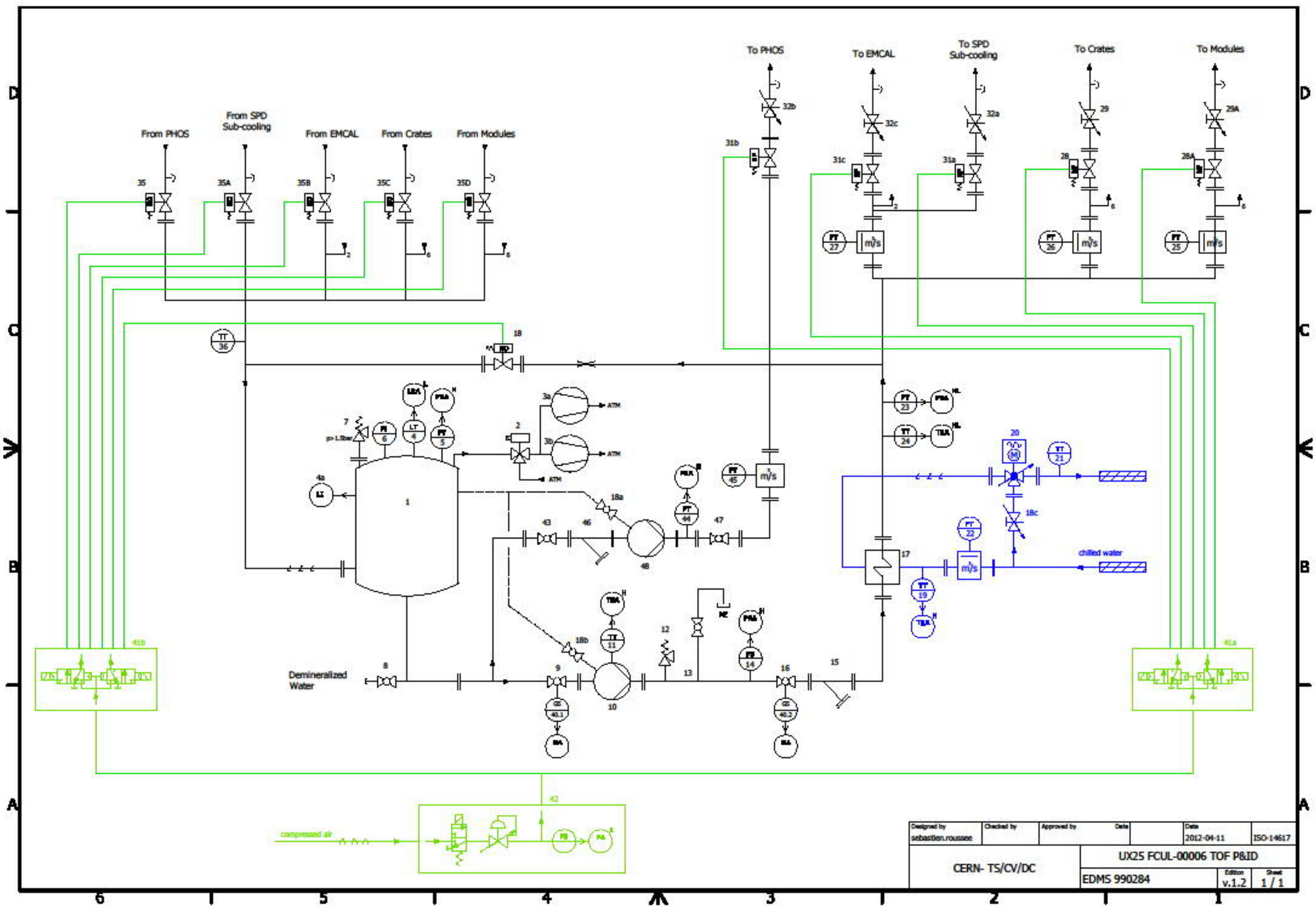
The cooling circuit of PHOS is used to thermalize the PHOS's components, area where the temperature could decrease to -25°C with extreme conditions.

In Case of stopped of the flow in this loop, the risk of freezing is existing inside the piping, could give a lot of damage.

A circulation with a flow of water of 100 L/min with an ambiance temperature is enough to keep the temperature of this circuit above to 0°C.

To minimize the stopping of this circulation, it was decided to put a new circulator only on this loop, and connect it on the UPS.

7.1 P&I AND PART LIST



SYSTEM	P&I	Ref. Component	D7I
TOF	18a	Ball valve to purge pump PHOS	**FCV-03158**
TOF	43	Hand valve Inlet PHOS pump	**FCV-03156**
TOF	44	Pressure transmeter outlet PHOS pump	**FCPT-00311**
TOF	45	Flowmeter PHOS	**FCFIC-00070**
TOF	46	Mecanic Filter inlet POHS pump	**FCF-00147**
TOF	47	Hand valve outlet PHOS pump	**FCV-03157**
TOF	48	Circulation PHOS pump	**FCP-00144**

7.2 FONCTIONNALITY

This new pump is controlled by a frequency inverter, the outlet pressure is is tuned at 1.5 bar(a) (PT44).

A ramp pressure allow to join the set point when it restarts (ramp= 2sec.)

Start & Stop of the pump:

- The pump starts automatically when the status of the PHOS loop is “ON”.
- The pump stops automatically when the status of the PHOS is “OFF” or Locked”.

Finally, the useful of this loop is not affected to the different mode of the TOF plant.

To optimize the disponibility, some specifics alarms from TOF circuit and the “Stand-by” mode, don’t stop the PHOS circulation.

Only the “Stop” mode immediately stops the both systems.

Tab of the interaction between TOF/PHOS : (in red: New alarms)

Exploitation normale				
TOF plant		Phos loop		
Alarmes	*Mode*	*Alarmes*	*Mode*	*Pump*
none	RUN	none	Loop ON	ON
none	Stand-by	none		
none	Stop	none	Loop OFF	OFF

Defauts TOF only				
TOF plant		Phos loop		
Alarmes	*Mode*	*Alarmes*	*Mode*	*Pump*
Def. disjoncteurs normal	stand-by			
Def. pressence secteur	stand-by			
Liquid pump status	stand-by			
Def. temperature 12<T>25	stand-by			
Def. tank pressure >0.9	stand-by			
Outlet pressure < 0.9b	stand-by	none	Loop ON	ON
Outlet pressure > 4b	stand-by			
Outlet pressure > 6b	stand-by			
Niveau liquide < 50l	stand-by			
Position vannes manuelles	Stand-by			
Temp. pompe > 50 C.	Stand-by			

Defauts Commun				
TOF plant		Phos loop		
Alarmes	*Mode*	*Alarmes*	*Mode*	*Pump*
Vacuum pump > 20mn	Stand-by	Vacuum pump > 20mn		
Niveau liquide < 30l	stand-by	Niveau liquide < 30l		
DSS Interlock	Stop	DSS Interlock		
Detection de fuites	stand-by	Detection de fuites		
Defaut PLC	Stop	Defaut PLC	Loop OFF	OFF
Def. disjoncteurs UPS	Stop	Def. disjoncteurs UPS		
Air comprime	stop	Air comprime		
DSS Interlock	Stand-by	DSS Interlock		

Defauts Phos only				
TOF plant		Phos loop		
Alarmes	*Mode*	*Alarmes*	*Mode*	*Pump*
		Pump pressure < 1.0b		
Visualisation Only	no change	Pump pressure > 2.0b	loop OFF	OFF
		def. pompe		

7.3 DIVERS:

During this upgrade of this cooling plant, some points were optimized:

- Added a new flowmeter on the PHOS Loop (183/07.FT45).
- Added a second vacuum pump (183/07.PPV02).
- Modification of the UPS power source.

8. PHOTO GALLERY

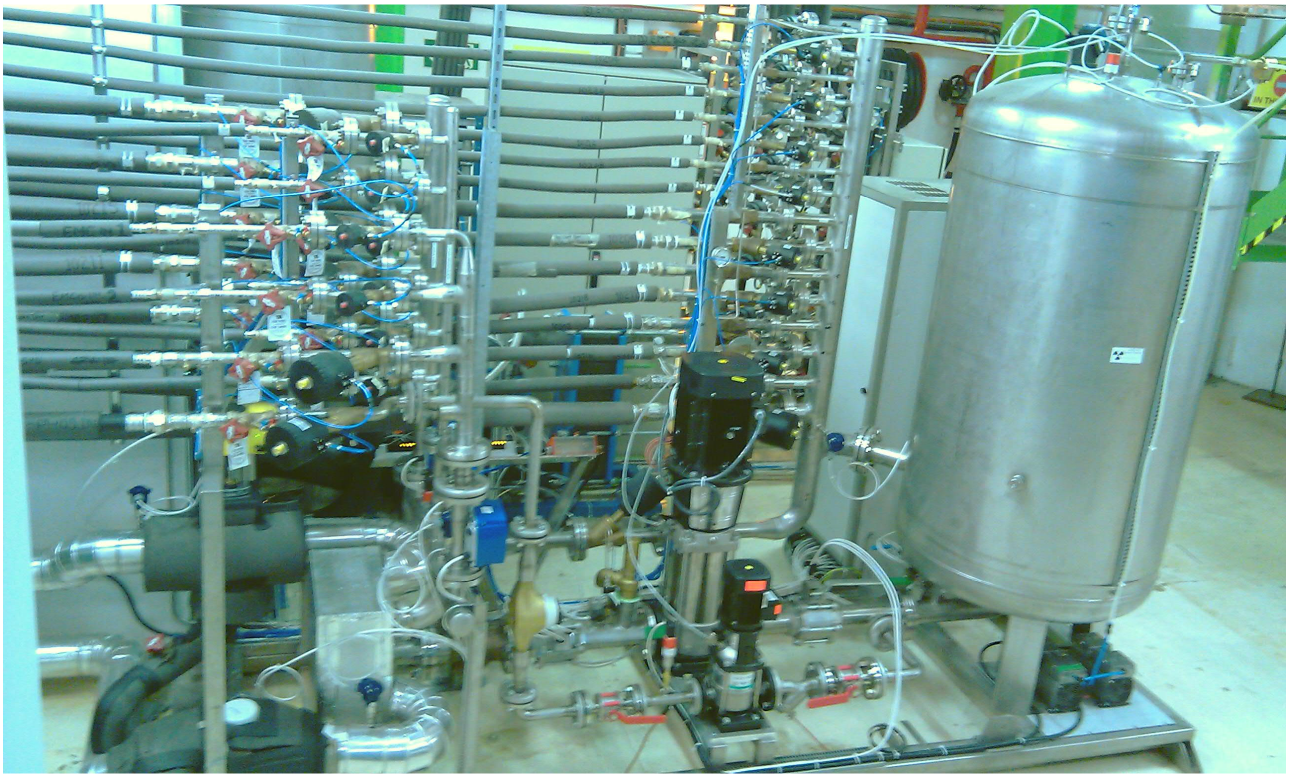


Figure 8.1. General overview.

Figure 8.2. PLC/Electrical rack and tank.

ANNEXES