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CONSTRUCTION PROGRESS OF THE COOLING & VENTILATION IN THE LHC PROJECT

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Abstract

The Cooling and Ventilation Group has started the LHC construction work in September 1999 and will get into full activity when LEP will be stopped and dismantled: in total 12 major contracts for an amount of about 120 MCHF will be established to build the needed installations for the LHC. The author will report on the current works that are in progress on the different LEP Points distinguishing between the Ventilation and the Water Cooling installations. The Ventilation work, completed in the new surface buildings in Points 18, is currently held in Points 4 and 5. Point 1 will follow in the near future. The work for the Cooling plants comprehend the pumping stations, the cooling towers and the chilled water production stations in Points 1 and 5, the buried pipes in Points 1 and 4. For all of these activities, an updated report of the progress of the work, of the planning and of the expenses is given. Finally, a short overview of the future activities is presented.

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1 INTRODUCTION

Since September 1999 the Cooling and Ventilation group has started the most important activities related to the LHC Project; the peak of the work will be between 2001 and 2004, when the major installations and plants will be commissioned. During te time LEP was still in operation, no activity has been possible in the underground; since the LEP will be dismantled in 2001, the CV works will start in underground areas, as soon as the civil engineering structure will be finished.

In the following paragraphs the current activities that are in progress on the different LEP Points are reported, distinguishing between the Ventilation and the Hydraulic Cooling installations. The major contract for the ventilation system concerns the surface buildings, while for the cooling plants, several work has started in almost all the LEP Points.

The contracts established by ST/CV have been determined according to the typology of the work rather than to the surface point where the work has to be done, therefore all the Contractors are requested to make interventions on several areas.

For reason of simplicity, no mention is made to all the “minor” work, i.e. all the activities limited in duration, area and cost. The same happens for all what is not strictly related to the LHC machine and its experiments, i.e. the injection tunnels, CNGS etc.

The global amount for all the CV work is estimated to be around 120 MCHF, one third of them being already awarded and the remaining will be committed during the next 2 years.

2 HYDRAULIC WORK

The hydraulic work for LHC has started for the surface installation in Point 1, 18, 4 and 5, namely for the cooling pumping station, cooling towers, chilled water production plants and pipework.

Each of the following paragraphs is dedicated to one of these activities.

In March 2000, the piping work in Point 18 has already been completed, comprehending the following circuits: the raw water (for the cryogenic compressors), the hot water and the fire fighting supply for buildings SMA and SHM18, connecting them to the SPS cooling loop.

2.1 Cooling Towers at Point 1 and 5

Demineralised water will be used for the cooling of a large part of the LHC equipment, the cold source in the raw water primary circuit being the existing cooling towers. Some new cooling towers (SF buildings) are under construction in Point 1 and 5 for the ATLAS and CMS Experiments respectively. The make up water for the cooling towers will be provided from the LHC cooling loop via some pumps which are already existing in the tunnel and used for LEP. The raw water circuit will be operated by a new pumping station installed in the same building (see following paragraph 2.2).

The number of cells for each cooling tower is different in the two Points since the different thermal power is needed: 10 MW are requested for both of the Experiments however in Point 1 the same set of cells will be used for the SPS equipment located into the BA6 (bldg. 873); this represents some additional 14 MW power. In both cases a spare unit is foreseen.

The main parameters concerning the circuit of the cooling towers are listed in table 1. The overall dimensions of each cell are 11 by 11 meters per side with a height of 13 meters. The thermal capacity is 10 MW per cell.

The installation in Point 5 has started at the beginning of November 2000 and is due to end by February 2001. The work in Point 1 has started with some delay, on December 2000, upon delivery of the Civil Engineering construction. The end of the work is scheduled for March 2001. As mentioned, these cooling towers will be used both for ATLAS Experiment and for part of the SPS accelerator, the schedule is therefore mainly dictated by the SPS Shutdown rather than the LHC one.

2.2 Pumping Stations at Point 1 and 5

The pumping stations for the primary circuit are located in the same building as the cooling towers, in the underground floor. The stations are intended to cool the cryogenic compressors, the chilled water production plants and some electronic equipment.

The main parameters are shown in table 1; the nominal pressure is 10 bar.

Table 1
Main parameters for the cooling circuit

Point	Temperature range °C	Flow rate l/s	Number of circuits	Number of pumps
Point 1	24-34	750	2	4
Point 5	24-34	335	3	6

In order to respect the tight schedule the work has started in both the Points in October 2000 and will finish in May 2001. As for the cooling tower in Point 1 the main constraint for the schedule is represented by the restart of the SPS accelerator in June 2001.

2.3 Chilled Water Production Plants, Point 1 and 5

The needs for ATLAS and CMS are produced in the two SUX buildings by a set of chillers that can provide chilled (5 °C) or mixed (12 °C) water. The chilled water is produced for electronic equipment in the underground areas (USA, USC caverns) and for the air handling units, both for the underground areas (SUX) and some surface buildings (SH, SXC, SGX, SX). The chilled water production is linked to a heat recovery system that provides water to pre-heat the air for the underground areas in the air handling unit located in the same buildings.

The parameters for the chilled water circuits are listed in table 2.

Table 2
Breakdown of the main parameters of the chilled water circuits

Point	Circuit/ building	Flow rate l/s	Power MW	Pressure Mpa
Point 1	SUX	67.5	2.10	0.30
	USA	57.2	0.80	0.30
	SH/SGX/SXC	41.6	0.48	0.25
	SU	71.6	1.00	0.30
	Total Point 1	237.9	4.38	
Point 5	SUX/SX	95.8	1.70	0.40
	SH/SGX/SXC	37.2	0.51	0.40
	USC	20	0.50	0.30
	Total Point 5	153	2.71	

The mixed water is produced for equipment in the underground caverns (USA, USC or UX) and for the racks in the surface buildings SDX and SCX; the parameters for these circuits are reported in table 3.

Table 3
Breakdown of the main parameters of the mixed water circuits

Point	Circuit/ building	Flow rate l/s	Power MW	Pressure Mpa
Point 1	USA /SDX	166.6	4.2	0.30
Point 5	SCX	14.7	0.4	0.30
	USC/UX	151.9	3.7	0.30
	Total Point 5	166.6	4.1	

The installation is composed by 2 chillers per Point, with a cooling power of 2.5 MW each; the cooling of the condenser of the chiller is made by raw water coming from the new cooling towers mentioned in paragraph 1.1. The cooling of the demineralised water is assured by plate heat exchangers.

The contract was awarded in the end of 1999, while the installation phase will start in March 2001 for Point 1 while the start in Point 5 is foreseen by August 2001, according to the delivery by the Civil Engineering Group. The commissioning is scheduled by January 2002 for Point 1 and October 2002 for Point 5

2.4 Pipework

Several contracts for the pipe works in the different LHC Points have been established, the most important is the pipes on Point 1 and 5 (galleries and shafts) and the buried pipes on Point 1 and 4; these pipe networks link the cooling towers, the chilled water production stations and the equipment to be cooled.

The main parameters of these networks are listed in the following table.

Table 4
Main characteristics of the pipes in galleries, shafts as well as buried pipes.

Galleries and shafts in Point 1 and 5					
Type	**Concerned buildings**	**Diameter (mm)**	**Material**	**Pressure (bar)**	**Operating temperatures (°C)**
Raw water	SF/SH/SDX/ SUX/PX/ USA	200 - 500	Carbon steel	8	24 – 34
Chilled water	SUX/PX/SU SDX/USA/ SGX	65 - 300	Carbon steel with lagging	6	6 – 12
Mixed water	SUX/PX	300	Stainless steel	6	13 – 19
Fire fighting	SXC/SDX/ SH	100-150	Cast iron	15	Ambient
Compr. air	SUX/SDX	50	Galvanised carbon steel	10	Ambient
Discharge water	PX/SDX	150	Stainless steel	16	Ambient
Demin. water	PX/USA	200	Stainless steel	16	27 - 37

Helium piping	SH/SD	250	Stainless steel	20	Ambient
Buried pipes in Point 1 and 4					
Primary water	SH1/BA6/ SHM4	300 - 500	Cast iron	10	24 - 34
Waste water	SF1	150	Cast iron	4	12 – 34
Raw water	SF1/SHM4	150	Cast iron	10	12 – 22
Compr. air	SHM4	100	Galvanised	15	12 - 20

For the pipes in the galleries and in the shafts the work was started in July 2000 in Point 1 (SUX, SD, SH buildings) and will continue until 2004 following the completion of the civil engineering construction. For the buried pipes, the work has started in October 2000 and will be finished in March 2001.

3 VENTILATION WORK

The ventilation work at presents concerns only the ventilation plants for the new surface building. One single contract has been established for that, while the ventilation of the experimental areas and the modification to the existing LEP installation will be object of two coming tenders (see last paragraph)

3.1 Ventilation in the Surface Buildings

This contract has been awarded at the beginning of 1999 and concerns the buildings on almost all the LHC Points. In the following table a list of buildings per Point is given as well as the milestones.

Table 5
List of surface buildings with a new ventilation plant per Point.

Point	Building	Start of Work	End of Work
Point 1	SGX1, SH1,	February 2002	July 2002
	SX1	October 2002	January 2003
Point 18	SD18, SHM18, SMA18	October 1999	August 2000
Point 2	SMI/SDI2, SUH/SH2	February 2002	September 2002
Point 4	SDH4, SHM4	September 2000	January 2001
	SH4	June 2002	January 2003
Point 5	SH5, SX5	January 2000	July 2001
	SGX5, SX5	July 2003	June 2004
Point 6	SA6, SHM6	August 2001	November 2001
	SH6	October 2002	May 2003
Point 8	SDH8, SHM8	February 2001	July 2001
	SH8	April 2002	November 2002

The purposes of the units to be installed are mainly the supply and the extraction of the air; some of them will be used in case of smoke removal. The flow rate range is between 750 and 75000

m^3/h for the supply, between 300 and 8600 m^3/h for the extraction and between 15000 and 22000 m^3/h for the smoke removal, according to the needs in the different buildings. The most important units (75000 m^3/h air flow rate) have two air channels.

The work was started in October 1999 in Point 18 with the SHM building and the schedule is respected, even though some minor delays with no interference with the overall LHC schedule. Point 18 buildings have been completed, work is at present going on in Points 4, 5 and 6.

4 IN THE FUTURE?

In addition to all the work mentioned in this report, other important contracts will be established in the next future to complete the preparation of CV installation for the commissioning of LHC.

In table 6 an overview of these activities is given with the foreseen schedule; the dates are indicative since for several projects a detailed list of the needs and of the final configuration are still under study.

Table 6
List of future activities to be done in the CV Group for LHC Project

Description	Market Survey	Call for tender	Work phase
Hydraulic plants			
Modification of the cooling station at Point 2,4,6,8	7/2000	6/2001	2001-2002
Stainless steel pipes for demineralised water	9/2000	4/2001	2002-2003
Cooling stations for the ATLAS and CMS experiments	5/2000	2002	2003
Clear, drain and waste water systems	8/2000	6/2001	2002-2004
Ventilation plants			
Ventilation plants for ATLAS and CMS experimental areas	3/2000	9/2000	2001
Ventilation plants for LHC tunnel, LHCb and ALICE	10/2001	9/2002	2004

5 CONCLUSIONS

Globally all the work has started respecting the schedule and no major delay is foreseen: the site activities have been well monitored with a remarkable effort from all the CV staff involved and this has let a correct advancement of the work. The final cost is also within the estimations, with no particular exceed to the contractual amount at the adjudication of the contract. An even bigger effort will be demanded in the next two years as the work charge will increase.