Project acronym: GROUND-MED

Project title: Advanced ground source heat pump systems for heating and cooling in Mediterranean climate

Start date of project: 1 January 2009

Duration: 60 months

Deliverable D5.1: Engineering design of CIAT demo system in Septemes les Vallons in France

Version: Final

Due date of deliverable: 31 October 2010

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Organisation name of lead contractor for this deliverable:

Compagnie Industrielle d'Applications Thermiques

Project co-funded by the European Commission within FP7 Programme		
Dissemination level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the Consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

GROUND-MED WP5 DELIVERABLE
DEMO SITE ENGINEERING DESIGN

D5.1 CIAT

ENGINEERING DESIGN OF THE DEMO SITE

Chapter I. Air Conditioned Spaces and Building Characteristics

I.1 Building Location, Type and Use

Geographical location: City (Country)	Septèmes les Vallons-(France)
Latitude	43°23'56''
Longitude	5°21'58''
Altitude	200m for the town hall
Building use	Office
Building type	Office part and Workshop part

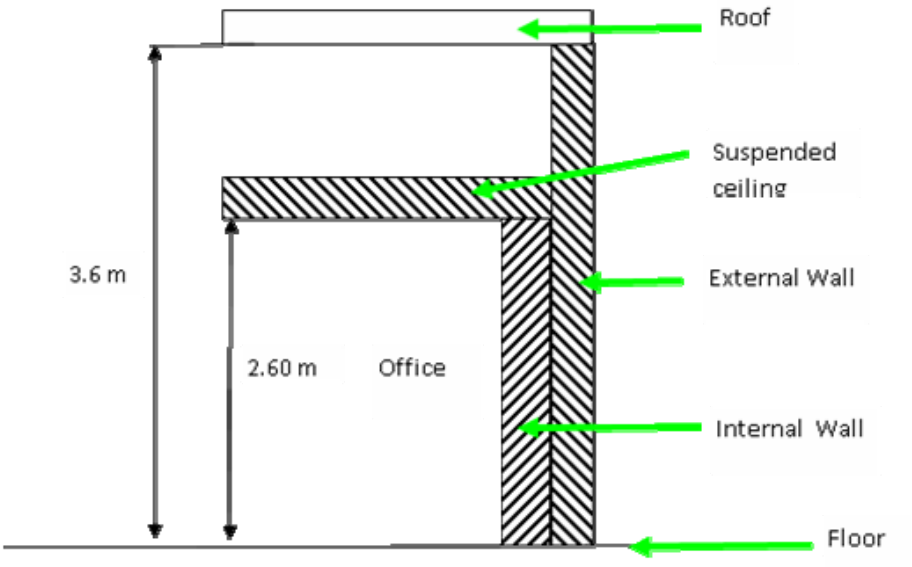
I.2 Building Constructive Data

I.3 Windows

External Windows

THERMAL CHARACTERISTICS		_____
U: overall heat transfer coefficient	4.55	W/m2·K
g: solar heat gain coefficient	0.81	_____

I.4 Walls



External Walls

layer material	Thickness (m)
aluminium	0.01
glass wool	0.1

Internal Walls

layer material	Thickness (m)
glass wool	0.045
pressed wood with PVC layer	0.012

Interior Walls

layer material	Thickness (m)
glass wool	0.045
pressed wood with PVC layer	0.012

Floor

layer material
concrete

Suspended ceiling Walls

Mineral panel AMSTRONG MINALOCK BOARD CORTEGA	
layer material	Thickness (m)
glass wool	0.1

Roof

layer material	Thickness (m)
glass wool	0.15

I.5 Use, Occupancy and Thermal loads calculations

I.5.1 Internal gains, ventilation, infiltration, air coupling

Thermal loads

Thermal gains (W/m2)		
People		**W**
According to ISO 7730		120
use:	Weekly schedule for office activity	
Computer		**W**
Type of computers		200
Artificial Lighting		
total heat gain: W/m2	?	
convective part:	?	
use:	Weekly schedule or other	

Air motion: ventilation, infiltration & Air coupling

Ventilation (renovation per hours)
outside air
1 vol/hr
Infiltration (renovation per hours)
outside air
in offices
in common rooms
Air coupling between zones (renovation per hours)
(between contiguous office rooms)
(between corridor and office rooms and/or common rooms)

Internal gains: people activity, computers, artificial lighting

ZONES	Num.People	Num.Computers	Zone A (m2)	People (W)	Computers (W)	Artificial Lighting (W)
ZONE A	1	1		120	200	#VALEUR!
ZONE B	1	1		120	200	#VALEUR!
ZONE C	1	1		120	200	#VALEUR!
ZONE D	1	1		120	200	#VALEUR!
ZONE E	1	1		120	200	#VALEUR!
ZONE F	1	1		120	200	#VALEUR!
ZONE G	1	1		120	200	#VALEUR!
ZONE H	1	1		120	200	#VALEUR!
ZONE I	1	1		120	200	#VALEUR!
ZONE J	1	1		120	200	#VALEUR!

I.5.2 Thermal loads results (Peak loads and monthly loads)

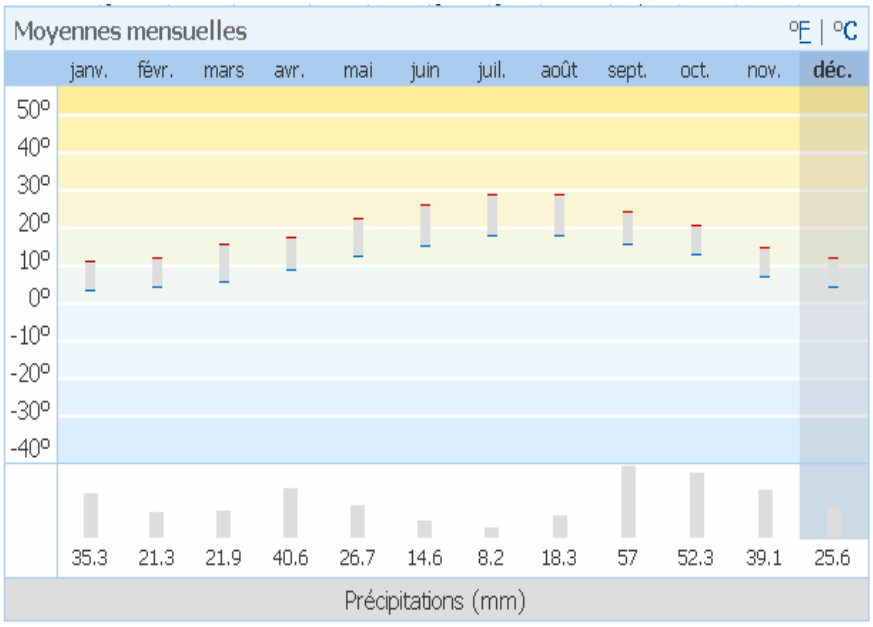
	Total Needs [kW·h]		Peak Loads [kW]	
	Heating	Cooling	Heating	Cooling
January	2836.815	0	24.601	0
February	2379.88	1.726	22.545	1.022
March	1311.759	3.922	21.908	0.551
April	586.621	42.501	17.606	2.86
May	191.703	141.461	12.84	4.105
June	2.862	445.711	2.071	8.649
July	0	1394.354	0	10.36
August	0	1185.503	0	11.586
September	29.183	299.773	12.141	6.27
October	291.738	28.779	13.102	2.578
November	1347.039	0	19.635	0
December	2062.311	0	21.932	0

Chapter II. Climate Description and Geology

II.1 Demo site Climate Description (template data)

II.1.2 Temperature

Weather data	Latitude	43°23'56''
	Longitude	5°21'58''
	Altitude	200m for the townhall
	Average annual air temperature (ºC)	15,3°C
	Average annual air Relative Humidity (%)	69%



II.2 Soil and Geology

II.2.1 General Geology

	Soil Parameters	
Location type (rural, build up, field or paved)	field	
General soil profile	limestone	
Estimate of Conductivity		W/m*K
Estimate of Volumetric Heat Capacity		kJ/K*m3
Ground water flow (qualitative: no, high, low)	no	
phreatic groundwater level	-	m

II.2.2 Geological Profile (if available)

depth (m)	formation	lithology	stratigraphy	altitude (m)
3.65	bottom (top soil)	top soil with debris of limestone	holocene	260.35
7.5	limestone and marly limestone	limestone with few marl, grey beige, compact	bajocian to bathonian	256.5
28.4		grey blue limestone, hard with calcite vein, lightly marly		235.6
29		blue limestone, more marly		235
46.2		grey blue limestone, calcite vein, lightly marly		217.8
46.5		marly vein		217.5
49.2		grey blue limestone, calcite vein, more marly		214.8
49.5		marly vein		214.5
59.2		grey black limestone, calcite vein, lightly marly		204.8
59.5		marly vein		204.5
60.2		grey blue limestone, calcite vein, lightly marly		203.8
60.5		marly vein		203.5
80		grey black limestone, calcite vein, lightly marly		184

Chapter III. System Description

III.1 Heat Pump Description

III.1.1 Water temperature conditions considered for the design

For heating mode, water temperatures considered are:

- Condenser temperature inlet/outlet: 35-40 (°C)

For cooling mode, water temperatures considered are:

- Evaporator temperature inlet/outlet: 15-10 (°C)

III.1.2 Heat Pump Capacity for cooling and heating mode

For heating mode, capacity is 26 kW and for cooling mode it is 26.6 kW.

III.1.3 Nominal flow rate

For heating mode, nominal flow rate is:

- indoor loop 4.5m^3/h
- outdoor loop 3.7m^3/h

For cooling mode, nominal flow rate is:

- indoor loop 4.6m^3/h
- outdoor loop 5.2m^3/h.

III. 2 Indoor Loop Description

III.2.1 Hydraulic Loop Description

Indoor loop is composed of two networks: primary network warmed or chilled by the heat pump and secondary network to feed the fan coils units and air handling unit.

Separation between two, is made thanks to a decoupling tank and allow separating request and supply. There is also a buffer tank, to increase thermal inertia of the primary network. This additional volume, decreases the on/off heat pump cycles.

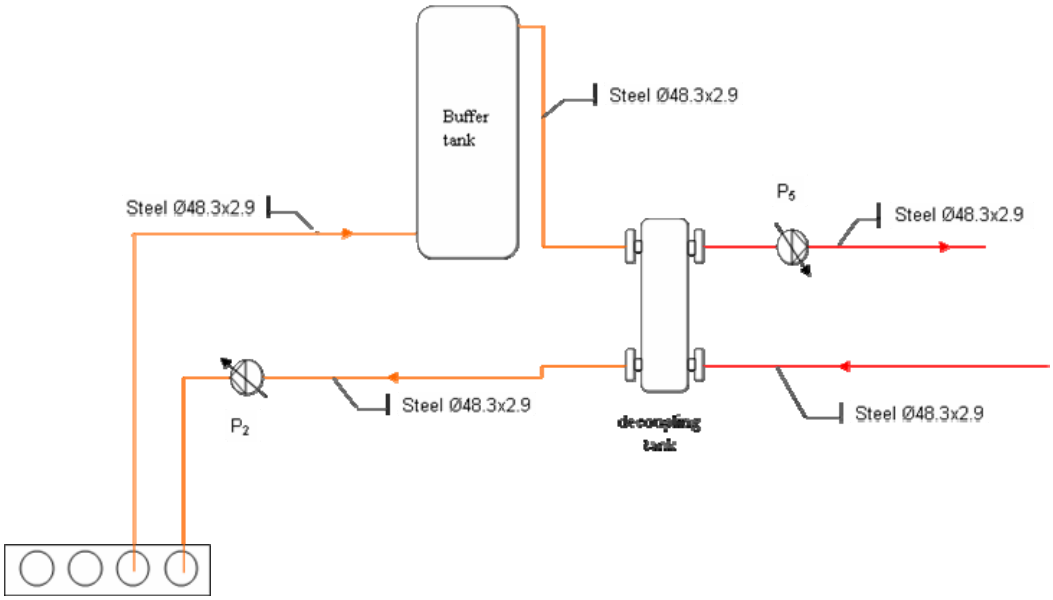
III.2.2 Internal Tank: volume and position

Buffer tank (400 liters) and decoupling tank (4.8 liters) are located in the technical premise surrounding the heat pump.

III.2.3 Location of the control temperature sensor for the heat pump

On the condenser inlet, for heating mode and on the evaporator inlet, for cooling mode.

III.2.4 Hydraulic pipes distribution system: schema of the distribution specifying external and internal diameter and flow rate.

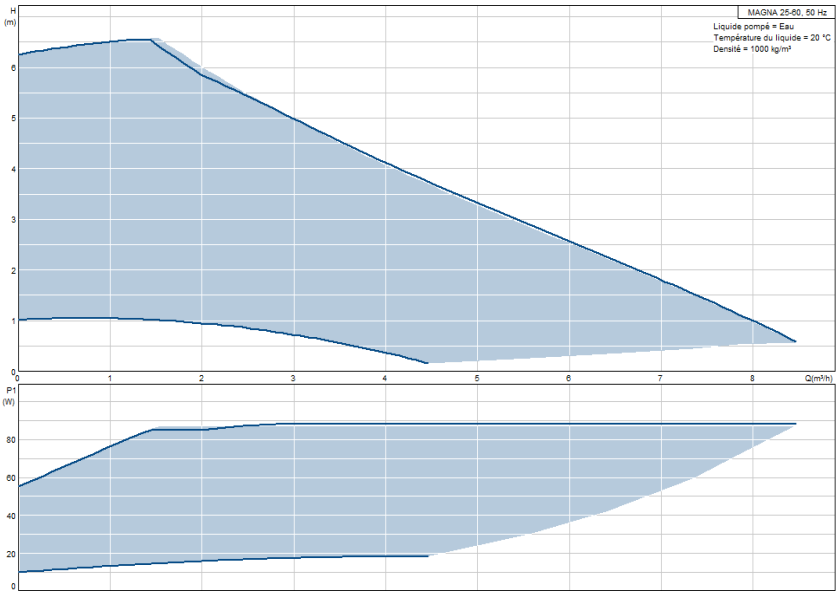


II.2.5 Circulation pump selected:

Specify the total pressure drop and water flow rate that must be provided by the circulation pump.

P_5: - water flow 4.6 m^3/h
- total pressure 3.5 m

P_5: MAGNA 25-60 variable velocity manufactured by GRUNDFOS.



P_2: - water flow 4.6 m^3/h
- total pressure 5.5 mH2O

Manufacturer, model, type (fixed velocity or variable velocity) and catalogue data (performance curves)

P_2: variable velocity pump manufactured by GRUNDFOS.
Model to finalize.

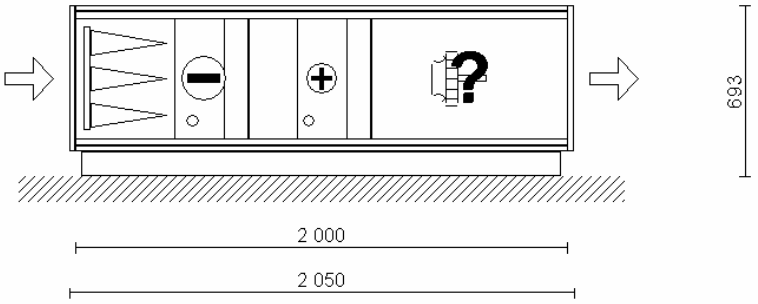
III.2.6 AHU Technical Description

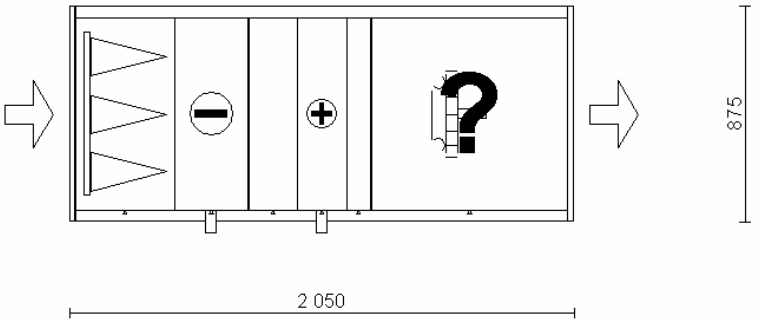
The Air handling unit provides fresh air preheated or precooled , depending on the season.
This fresh air is directed to the fresh air intake located in the fan coil units.
The AHU is located in the machinery room.

Manufacturer & Model selected

The selected AHU is a Climaciat Airtech 25, manufactured by CIAT.

It includes a filter, a cooling coil, a heating coil and a fan.





Performance data

Air flow rate

600 m3/h

Cooling capacity

3.93 kW with water temperature inlet/outlet: 0/5°C

Heating capacity

5.25 kW with water temperature inlet/outlet: 40/35°C

III.2.7 Fan Coil Technical Description

Manufacturer & Model selected

The selected fan coil is: Coadis 2, model 235/33, 2 tubes, manufactured by CIAT.

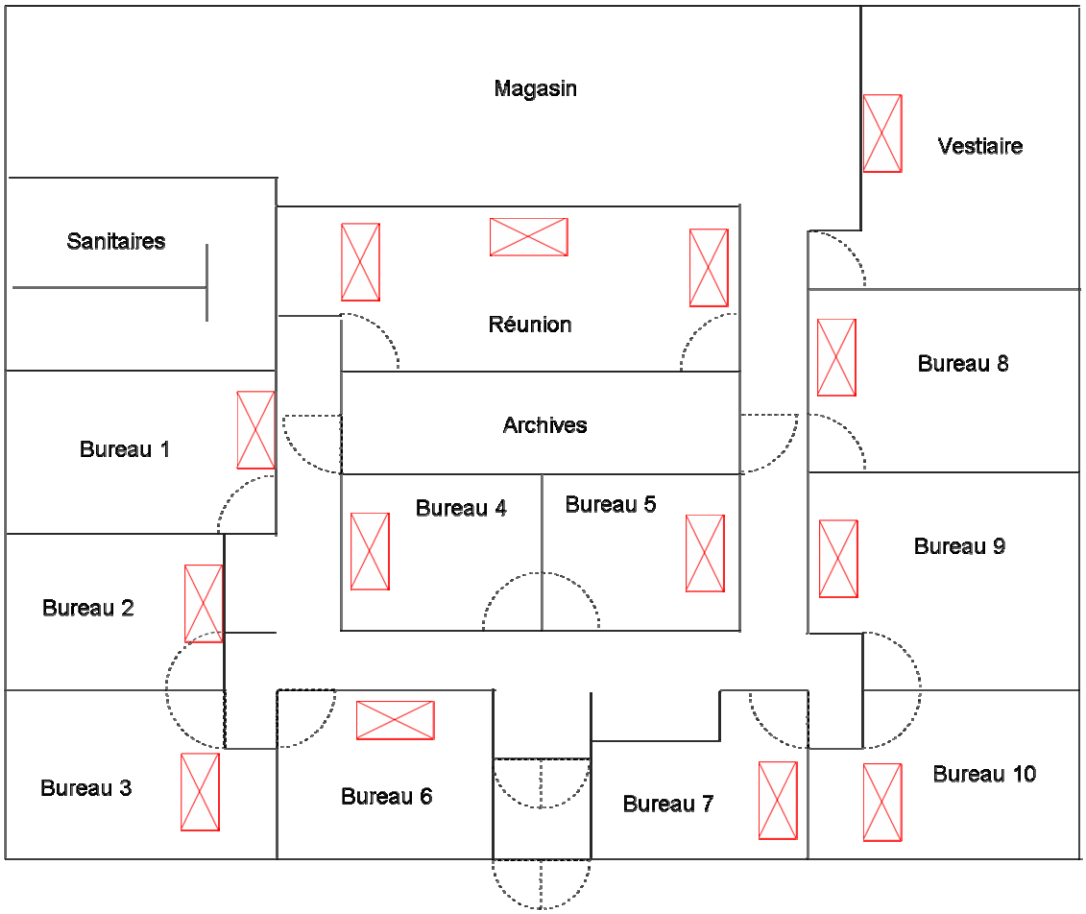
The centrifugal fan uses a high-efficiency impeller to draw in air through a perforated return air register. The air is filtered then warmed or cooled as it passes through a high-efficiency heat exchanger containing hot or chilled water. Air is then pulsed horizontally into the room by **COANDA** effect through several directional diffusion nozzles with a high induction rate. Coadis are Eurovent certified.

Performance data

REGIMES	***BATTERIE FROIDE***	***BATTERIE CHAUDE***
Fluid	*Eau*	*Eau*
Inlet Fluid Temperature	*10 °C*	*40 °C*
Outlet Fluid Temperature	*15 °C*	
Inlet Recycled Air Temperature	*24 °C*	*20 °C*
Inlet Recycled Air Humidity	*50 %(HR)*	*50 %(HR)*

			BATTERIE FROIDE					**BATTERIE CHAUDE**				**Lp**
SERIE **Taille**	**R#**	**Qa** m3/h	**Pt** W	**Ps** W	**Ts** °C	**Qe** l/h	**dP** kPa	**P** W	**Ts** °C	**Qe** l/h	**dP** kPa	*ISO ou NR*
	R1	855	2 560	2 560	15.3	440	18.6	3 220	31.6	444	16.8	43
235	**R2**	**725**	**2 270**	**2 270**	**14.9**	**390**	**15.0**	**2 860**	**32.2**	**393**	**13.5**	**38**
	R3	**600**	**1 970**	**1 970**	**14.5**	**337**	**11.5**	**2 490**	**32.7**	**341**	**10.5**	**35**
	R4	480	1 650	1 590	14.4	283	8.26	2 090	33.3	285	7.63	29
	R5	390	1 390	1 330	14.1	238	6.02	1 760	33.9	240	5.62	23
33	**R6**	**305**	**1 120**	**1 070**	**13.8**	**191**	**4.04**	**1 430**	**34.5**	**193**	**3.86**	**16**
	R7	205	782	747	13.5	134	2.11	991	35.3	135	2.09	<15

Location in the building (Schematic Distribution)



Control system

Each fan coil is regulated by a control terminal V3000 KNX. Global regulation is made by the easy CIAT Control module.

III.2.8 PCM product Description

Manufacturer & type selected

PCM products will be used to store cold energy at night then used during daytime to perform dehumidification.
PCM will be provided by Cristopia. The type selected is AC 00.

A very small heat pump (few kilowatts of cooling capacity), operating with brine as the storage temperature is around 0°C, will be dedicated only to energy storage.

The volume of the tank storage will be 500 litres.

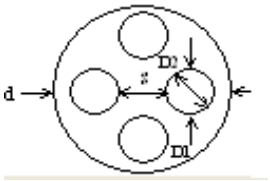
III.3 Outdoor Loop Description

III.3.1 Ground Source Heat Exchanger Description

Type of configuration (rectangular, line....etc)

Single U or Double U (specifying diameters with drawings)

DOUBLE U TUBE

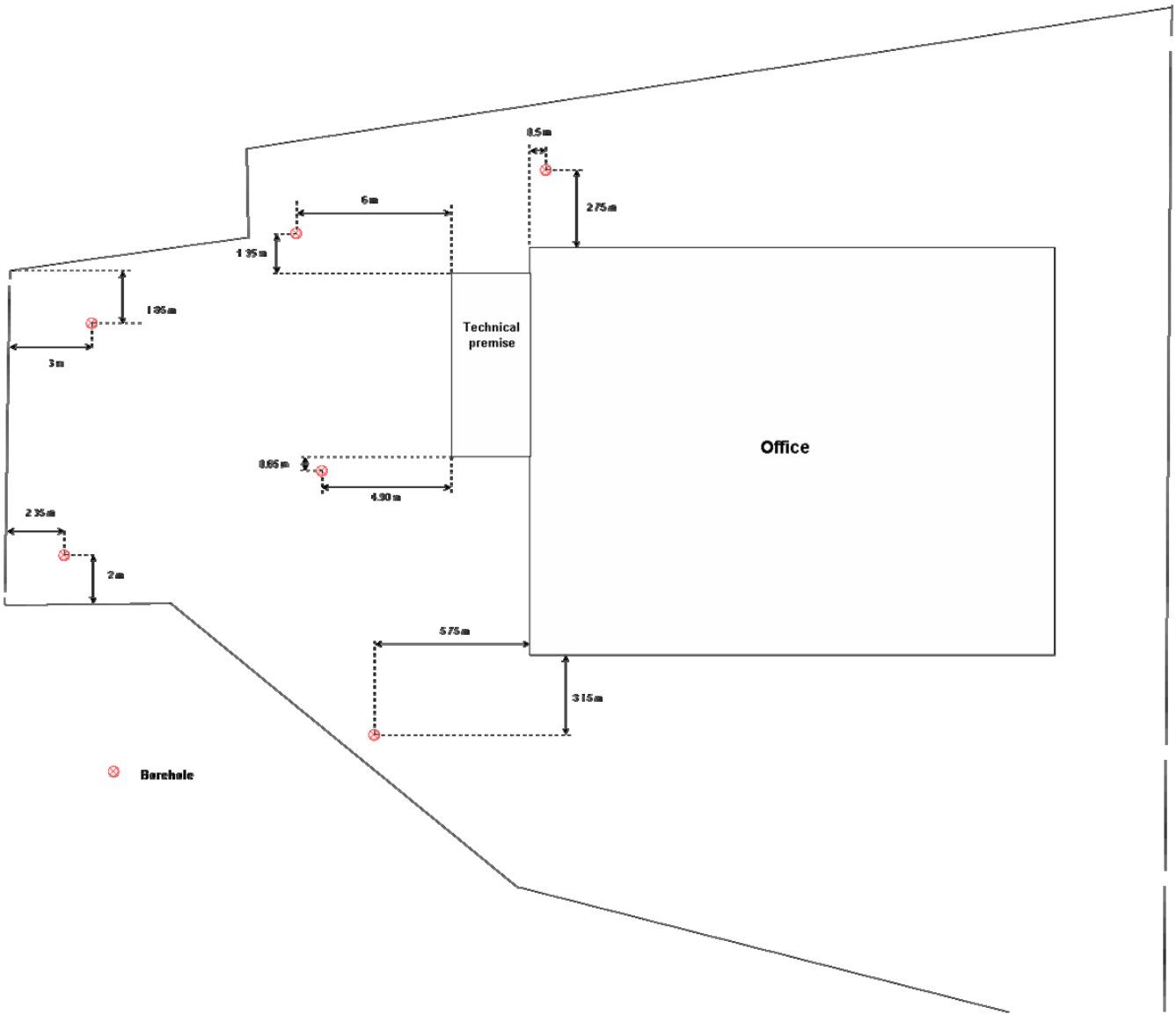


Borehole diameter (d)	133	mm
Pipe internal diameter (D2)	26.2	mm
Pipe external diameter (D1)	32	mm
Shank spacing (s)	-	mm

Borehole depth

100m

Borehole spacing



Grout material and conductivity

Bentonite

Depth below surface

1 m

Pipe material

Polyethylene PE-100

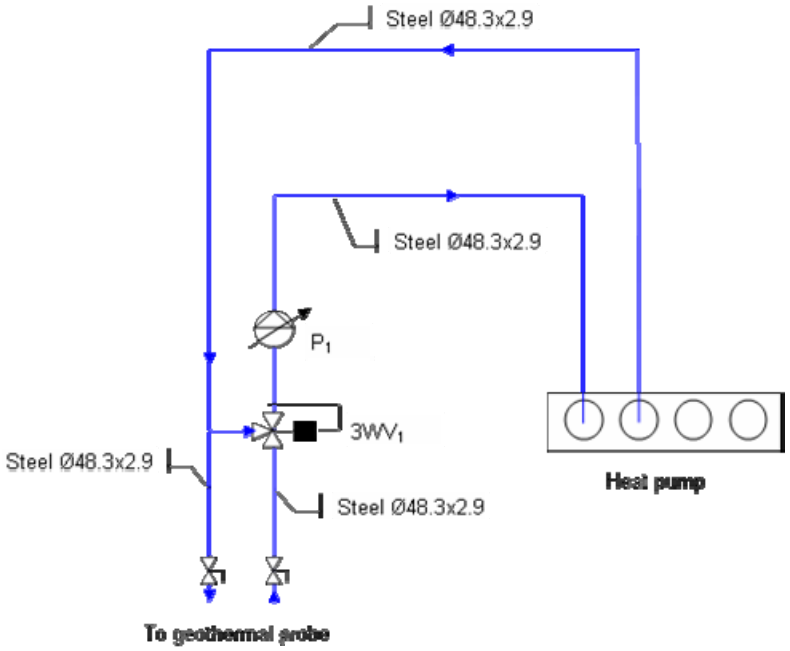
Working fluid

Pure water

III.3.2 Hydraulic Loop Description

Outdoor loop is composed of six boreholes, connected to a collector. This collector is joining to a steel pipe network, where a three way valve is located. The 3WV only has a role during the geo-cooling use, controlling the water temperature sent to the FCU.
Role off outdoor loop is to extract heat soil for heating mode and reject building heat in soil for cooling mode.

III.3.3 Hydraulic pipes distribution system: schema of the distribution specifying external and internal diameter and flow rate.



III.3.4 Circulation pump selected:

Specify the total pressure drop and water flow rate that must be provided by the circulation pump.

P_1: - water flow 5.2 m^3/h
- total pressure 11 mH2O

Manufacturer, model, type (fixed velocity or variable velocity) and catalogue data (performance curves)

P_1: variable velocity pump manufactured by GRUNDFOS.
Model to finalize.

Chapter IV. OPEN ISSUES (design or construction decisions not solved yet)

None