



Project acronym: GROUND-MED

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**Deliverable D5.4: Engineering design of Gezir demo system of Cultural Centre Benedikt in Slovenia**

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**Gezir d.o.o., Podjetje za poslovne storitve, Ljubljana**

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Dissemination level		
<b>PU</b>	Public	<b>X</b>
<b>PP</b>	Restricted to other programme participants (including the Commission Services)	
<b>RE</b>	Restricted to a group specified by the Consortium (including the Commission Services)	
<b>CO</b>	Confidential, only for members of the consortium (including the Commission Services)	

**GROUND-MED WP5 DELIVERABLE  
DEMO SITE ENGINEERING DESIGN**

**D5.4 GEJZIR**

# ENGINEERING DESIGN OF THE DEMO SITE

## Chapter I. Air Conditioned Spaces and Building Characteristics

### I.1 Building Location, Type and Use

The GSHP system is located in the Culture hall Benedikt, an institutional building at the Town of Benedikt, Slovenia.

Geographical location: City (Country)	Benedikt (Slovenia)
Latitude	46° 36´
Longitud	15° 54´
Altitude	254 m
Building use	auditorium
Building type	Offices, Conference rooms

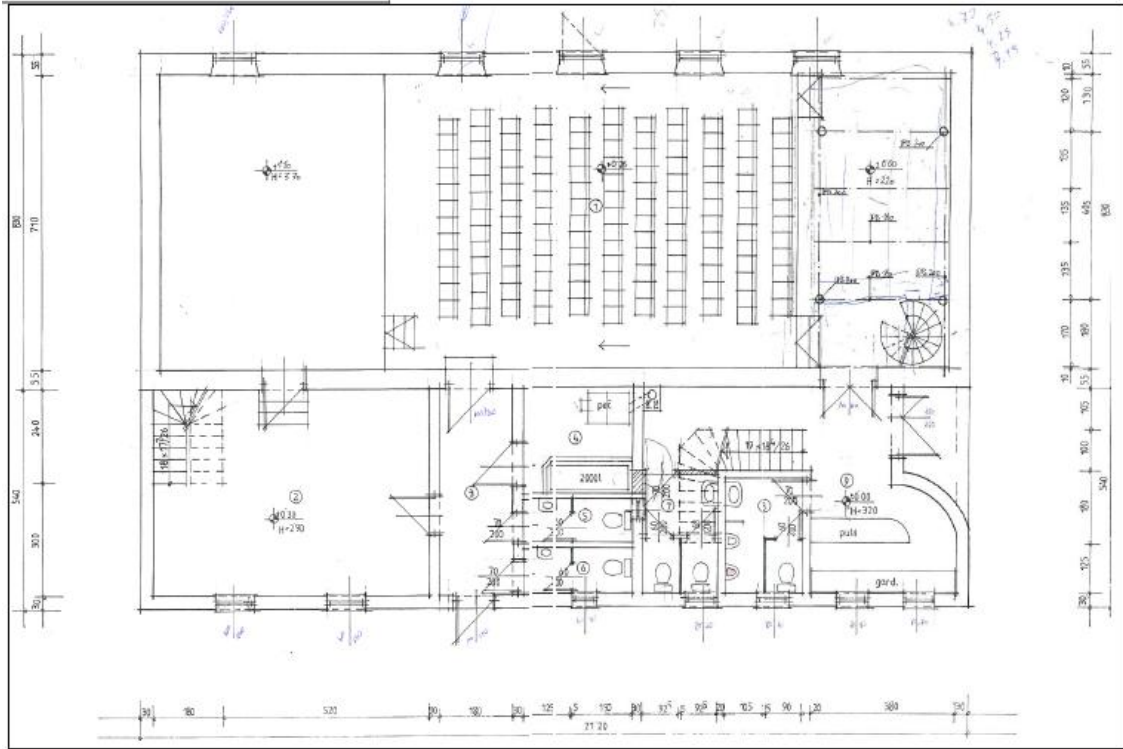
### I.2 Building Constructive Data



Total area of the building amounts to 290,44 m<sup>2</sup>, with ground plan dimensions of 13,70 x 21,20 m. Net area of all rooms and auditorium amounts to 328,44 m<sup>2</sup>.

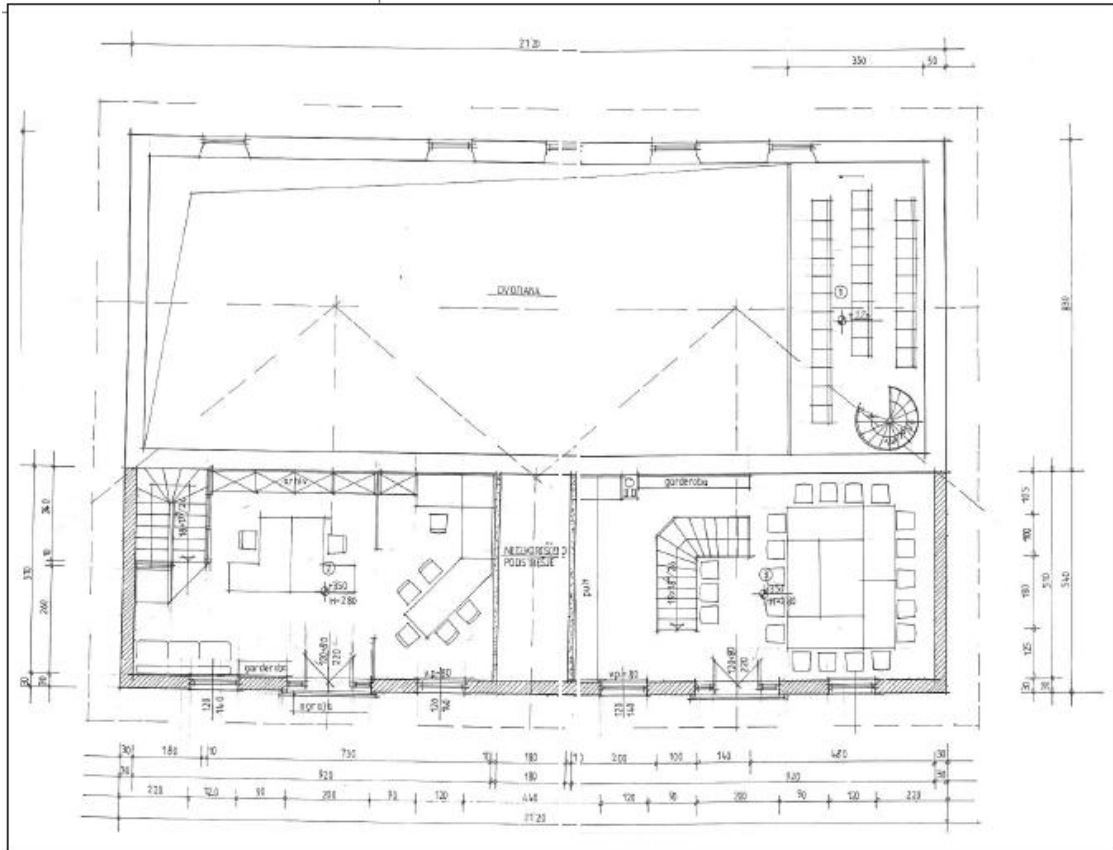
The whole building will be heated with the ground source heat pump (GSHP). Only the auditorium will be also cooled, mostly during Events. The geometrical characteristics of each conditioned area are detailed in the figure below.

YS



YN

YS



YN

BUILDING ZONES	CEILING(m2)	FLOOR(m2)	HEIGHT (m)
1 (Hall)	147,01	147,01	5,2
2	35,6	35,6	2,9
3	8,61	8,61	2,9
4	6,47	6,47	2,9
5	2,24	2,24	2,9
6	2,65	2,65	2,9
7	4,58	4,58	
8	4,58	4,58	2,9
9	28,24	28,24	2,9
II. Floor			
2	44,03	44,03	2,8
3	44,43	44,43	2,8

### I.3 Windows

#### *External Windows*



In the tables below the area of the windows and its thermal characteristics are presented for each latitude of the air conditioned spaces.

BUILDING ZONES	YN(m2)	YS (m2)	XE(m2)	XW(m2)
ZONE 1		11,7		
ZONE 2	2,400			
ZONE 3	2,300			
ZONE 4				
ZONE 5				
ZONE 6	0,500			
ZONE 7	0,600			
ZONE 8	0,600			
ZONE 9	1,280			8,4
floor 2	3,400			
floor 3	3,400			

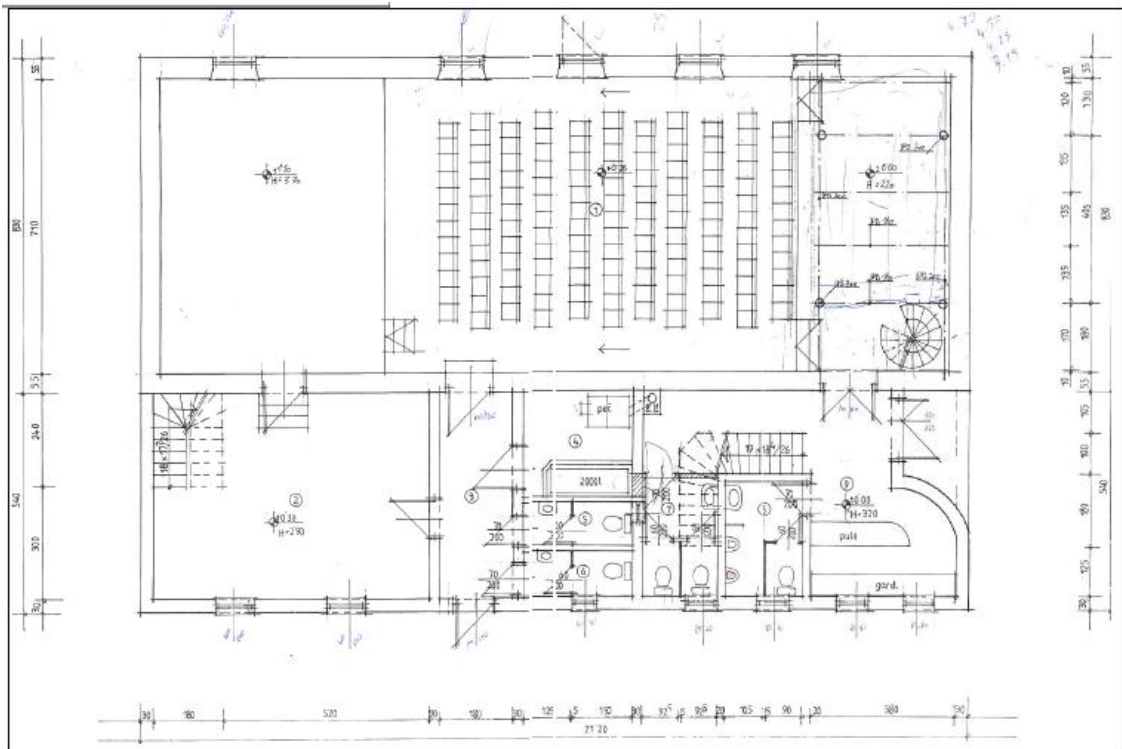
THERMAL CHARACTERISTICS			
U(WINDOW)	1,3	W/m <sup>2</sup> ·K	
g(WINDOW)			
U(DOR)	1,3	W/m <sup>2</sup> ·K	
A (m <sup>2</sup> )	EXTERNAL BLIND	INTERNAL BLIND	FRAME FRACTION %
	NO	NO	
	NO	NO	
	NO	NO	

### *Indoor Windows*

There are no internal windows considered

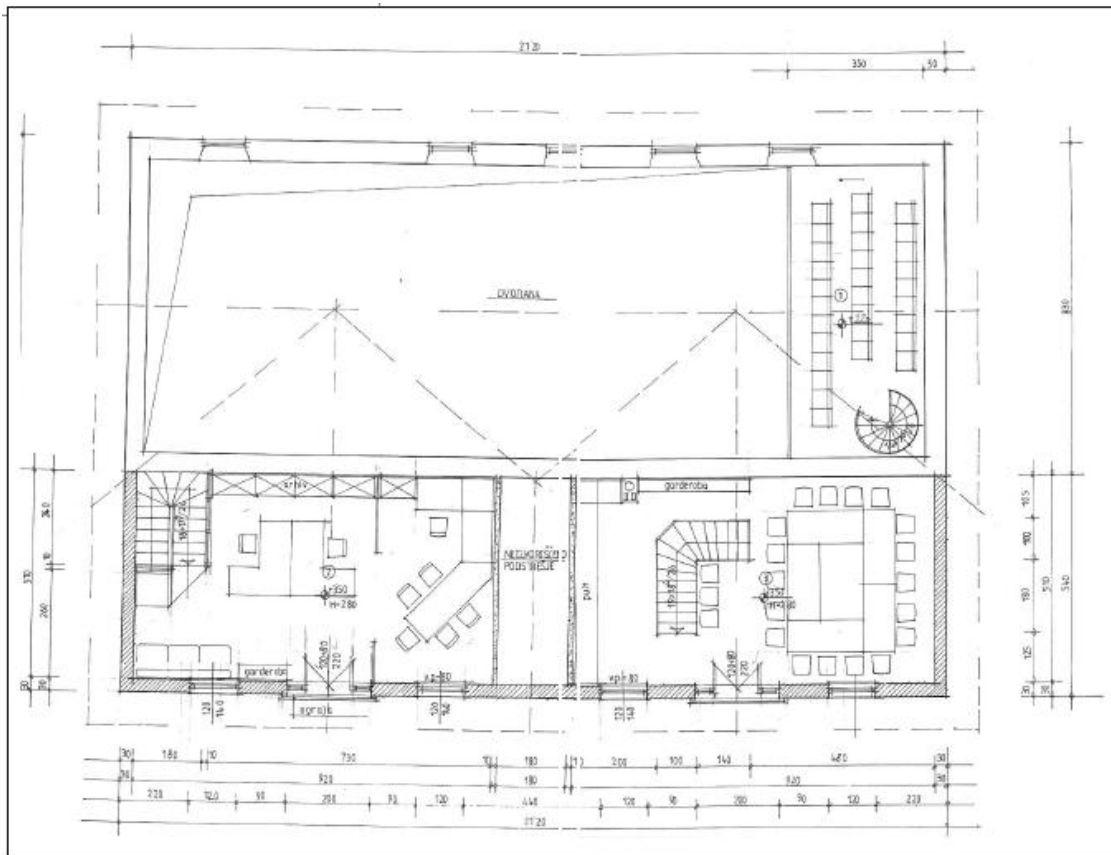
### I.4 Walls

**YS**



**YN**

YS



YN

There are two different kinds of façade, an old one corresponding to the original structure and a new one corresponding to expansion works in the building.

### Outdoor Walls

External walls area versus orientation:

ZONES	YN (m2)	YS (m2)	XE(m2)	XW(m2)
ZONE	152,64	110,24	82,56	82,56

Building wall type 1					
layer material	Thickness (m)	Conductivity (kJ/hmK)	Density (kg/m3)	Specific heat (kJ/kgK)	Resistance (hm2K/kJ)
thermoiz. fasade	0,05 (?)	0,011	20	1,26	0,144
brick (wall 1)	0,55	0,219	1700	0,88	0,468

Building wall type 2					
layer material	Thickness (m)	Conductivity (kJ/hmK)	Density (kg/m3)	Specific heat (kJ/kgK)	Resistance (hm2K/kJ)
thermoiz. fasade	0,05 (?)	0,011	20	1,26	0,144
brick (wall 2)	0,3	0,219	1700	0,88	0,468

### Indoor Walls

Interior walls: air conditioned spaces and adjacent areas (only zone 1 will be air conditioned space)

ZONES	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6	ZONE 7	ZONE 8	ZONE 9	ZONE F1	ZONE F2
ZONE 1	X	20,3	6,09	8,99					24,21	10,3	10,3

Building wall type (interior and boundary walls)					
layer material	Thickness (m)	Conductivity (kJ/hmK)	Density (kg/m3)	Specific heat (kJ/kgK)	Resistance (hm2K/kJ)
YTONG	0,1	0,058	900	0,84	0,144
brick	0,3	0,219	1700	0,88	0,468

### *Boundary Condition Walls*

Boundary walls to a conditioned area:

<b>ZONES</b>	<b>A (m2)</b>
ZONE 1	94,47
ZONE 2	35,96
ZONE 3	36,54
ZONE 4	30,16
ZONE 5	24,94
ZONE 6	16,82
ZONE 7	22,78
ZONE 8	22,78
ZONE 9	71,69
ZONE F1	41,76
ZONE F2	41,76

### *Ceiling and Ground*

<b>Floor wall type</b>					
layer material	Thickness (m)	Conductivity (kJ/hmK)	Density (kg/m3)	Specific heat (kJ/kgK)	Resistance (hm2K/kJ)
monta	0,2	0,292	1900	0,86	0,468

## I.5 Use, Occupancy and Thermal loads calculations

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

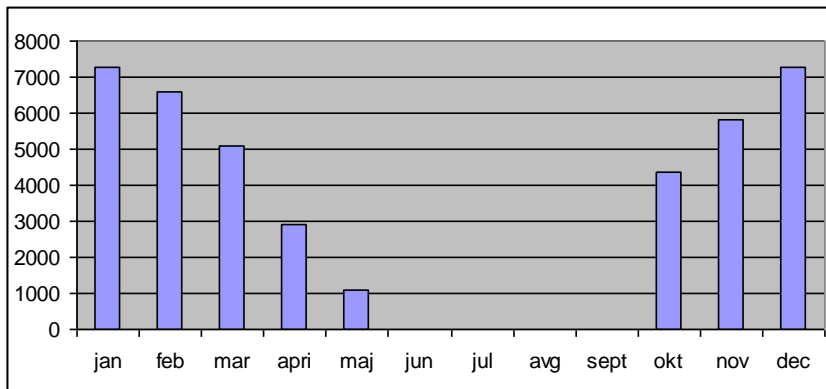
<b>ZONES</b>	<b>Num.People</b>	<b>Num.Computers</b>	<b>Zone A (m2)</b>	<b>People (W)</b>	<b>Computers (W)</b>	<b>Artificial Lighting (W)</b>
ZONE 1	80	0	147	2400	0	2400
ZONE				0	0	0
II. Floor				0	0	0
ZONE 2	5	1	46,4	465	80	40
ZONE 3	10	1	46,4	930	80	40

<b>Ventilation (renovation per hours)</b>
<b>outside air</b>
3600 m <sup>3</sup> /h
<b>Infiltration (renovation per hours)</b>
<b>outside air</b>
in auditorium

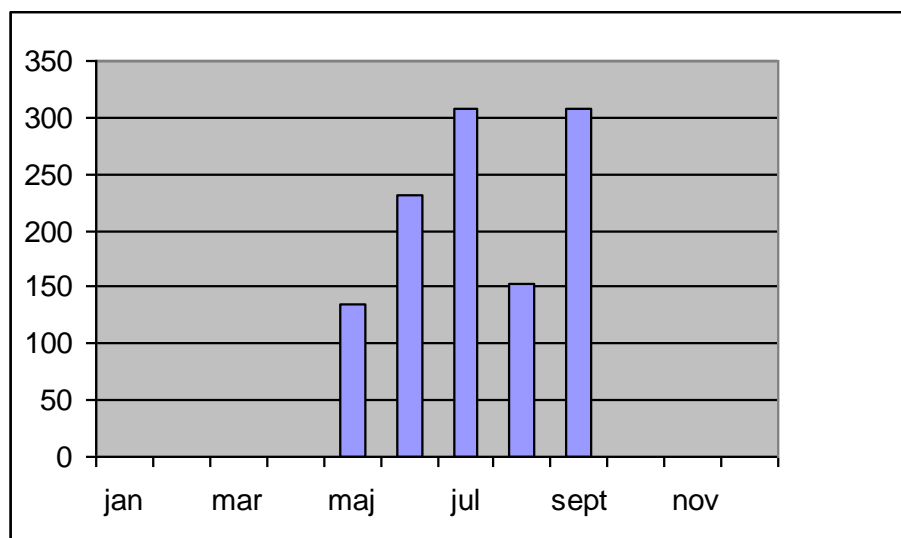
*1.5.2 Thermal loads results (Peak loads and monthly loads)*

	<b>PEAK LOAD</b>	<b>PEAK DAY</b>
<b>SUMMER PEAK LOAD (kW)</b>	19,2	19,2
<b>WINTER PEAK LOAD (kW)</b>	20,3	20,3

**HEATING**



**COOLING**



	Total Loads [kW·h]		Peak Loads [kW]	
	Heating	Cooling	Heating	Cooling
January	7.285		9,8	
February	6.580		9	
March	5.099		7	
April	2.914		4	
May	1.093	134,4	1	19,4
June		230,4		19,4
July		307,2		19,4
August		153,6		19,4
September		307,2		19,4
October	4.371		6	
November	5.828		8	
December	7.285		10	

## Chapter II. Climate Description and Geology

### II.1 Demo site Climate Description ( template data)

#### II.1.2 Temperature

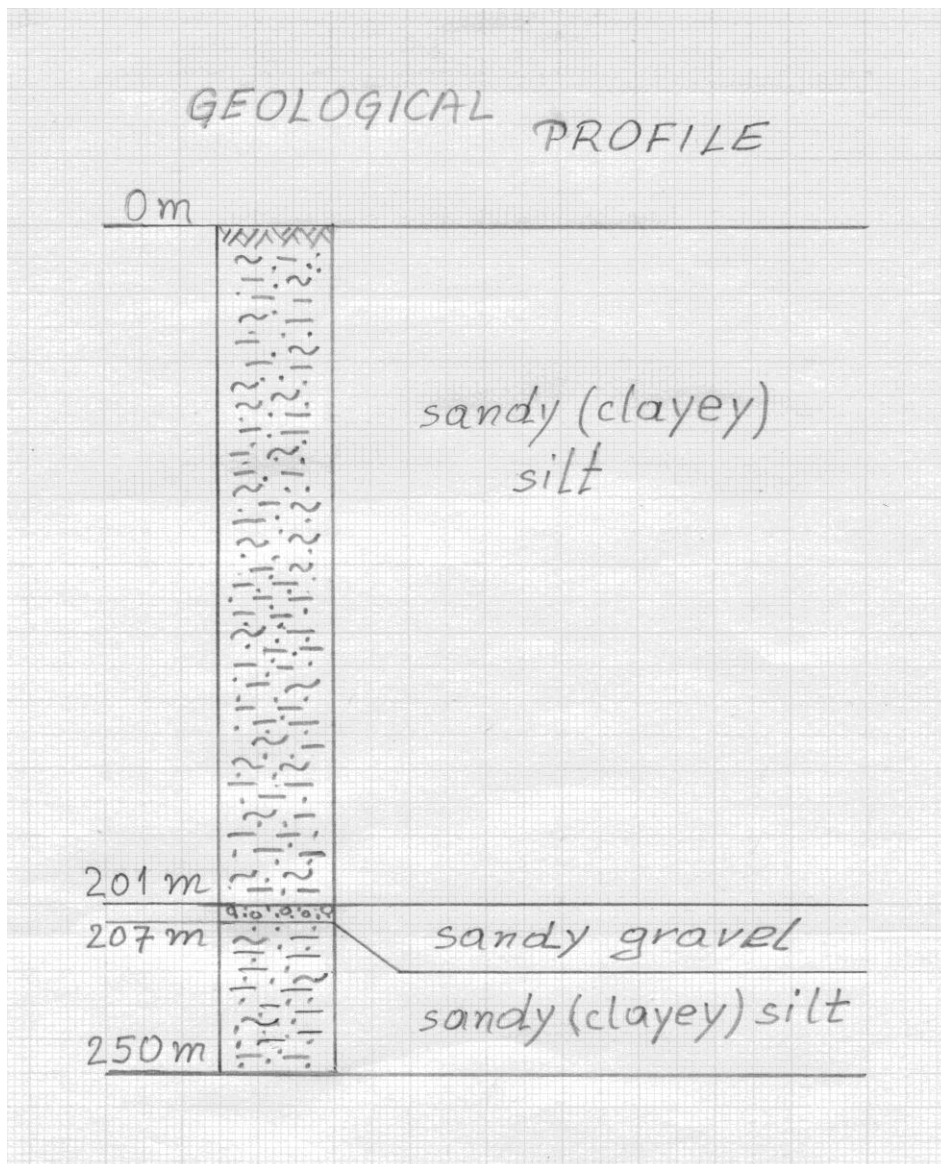
Weather data	Latitude	46° 36´
	Longitud	15° 54´
	Altitude	254 m
	Average annual air temperature (°C) Maribor	10,7 (1991 - 2000);
	Average annual air Relative Humidity (%)	78 (2006, M. Sobota)

## II.2 Soil and Geology

### II.2.1 General Geology

	Soil Parameters	
Location type (rural, build up, field or paved)	build up	
General soil profile	sandy (clayey) silt	
Estimate of Conductivity	2	W/m*K
Estimate of Volumetric Heat	2,600	kJ/K*m3
Ground water flow (qualitative: no, high,low)	low	
Freatic groundwater level	2	m

### II.2.2 Geological Profile



## Chapter III. System Description

### III.1 Heat Pump Description

#### *III.1.1 Water temperature conditions considered for the design*

User Side Water Temperatures (Chiller) IN/OUT	[°C]	18 / 14
User Side Water Temperatures (Heat Pump) IN/OUT	[°C]	35 / 45
Source Side Water Temperatures (Chiller)	[°C]	20 / 32
% of eth. glycol	[%]	0%
Source Side Water Temperatures (Heat Pump)	[°C]	12 / 7
% of eth. glycol	[%]	0%

#### *III.1.2 Heat Pump Capacity and nominal flow rate for cooling and heating mode*

#### **GMWW 23 HK plus ❄️ 55°C 65°C**

<b>Performance Data normal mode</b>	<b>GMWW23p</b>	
Heating Capacity	W10/W35	22,6 kW
Cooling Capacity	W10/W35	18,9 kW
Power Consumption	W10/W35	3,7 kW
Coefficient of Performance	W10/W35	6,1
Drawn Current	W10/W35	7,1 A
Heating Capacity	W10/W50	20,5 kW
Cooling Capacity	W10/W50	15,6 kW
Power Consumption	W10/W50	4,9 kW
Coefficient of Performance	W10/W50	4,2
Drawn Current	W10/W50	8,8 A
Heating Capacity	W10/W60	19,2 kW
Cooling Capacity	W10/W60	13 kW
Power Consumption	W10/W60	6,2 kW
Coefficient of Performance	W10/W60	3,1
Drawn Current	W10/W60	10,2 A
Heating Capacity	W10/W65	18,6 kW
Cooling Capacity	W10/W65	11,7 kW
Power Consumption	W10/W65	6,9 kW
Coefficient of Performance	W10/W65	2,7
Drawn Current	W10/W65	10,8 A

<b>Performance Data reverse mode</b>		
Cooling Capacity	W10/W18	23,1 kW
Waste heat Capacity	W10/W18	26,5 kW
Power Consumption	W10/W18	3,4 kW
Coefficient of Performance	W10/W18	6,8
Drawn Current	W10/W18	6,4 A
<b>Compressor</b>		
Type	Fully-hermetic/Scroll	
Number	1 units	
Max. Operating Current	11,5 A	
Starting Current	62,2 A	
Max. Starting Current w/ Discharge	31,1 A	
<b>Evaporator</b>		
Type	Flat-plate Heat Exchanger	
Material	Stainless Steel 1.4401	
Number	1 units	
Max. Operating Pressure (brine)	6 bar	
Max. Operating Pressure (refrigerant)	30 bar	
Internal Pressure Difference	17 bar	
Working Fluid Temperature Difference	4 m <sup>3</sup> /h	

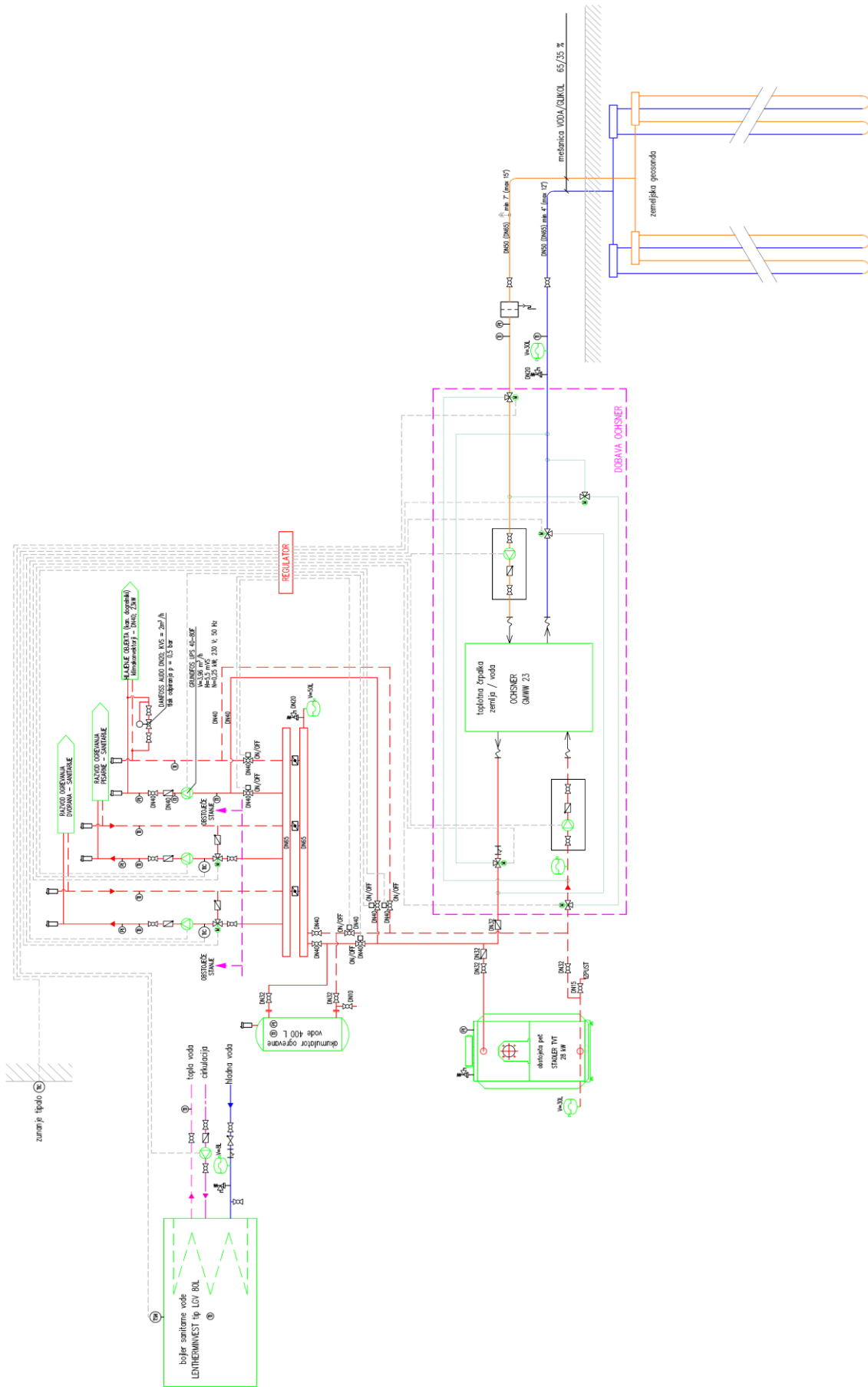
## III. 2 Indoor Loop Description

### *III.2.1 Hydraulic Loop Description*

It will be used two existing loops and it will be constructed a new loop which will be connected to the fan coil network, which will be constructed for supplementary heating of auditorium and for cooling of the auditorium.

It basically comprises the following parts:

- Three Circulating Pumps.
- Coriolis mass flow meter.
- Manometers.
- Expansion vessels.



### *III.2.2 Internal Tank: volume and position*

The tank is located at the outlet of the heat pump on the supply line and its volume is 400 l.

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

The thermostat control for the heat pump is located at the outlet of the tank.

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

The length and diameter of the different elements belonging to the indoor loop are given in the following table, also including the characterisation and number of the main accessories.

	<b>DESCRIPTION</b>	<b>UNIT</b>	
1	Armaflex and copper pipes different dimensions	m	30
2	Heating and cooling unit VEAB PGK 700X400-3-2,0	pieces	1
3	Grundfoss pump UP Basic 25-6-180, Belimo R 323 DM 25 3P, drive LR 24 ASR 2-10V	pieces	1
4	Internal tank 400 l	pieces	1
5	Expansion tank 30 l	pieces	1
6	Expansion tank 50 l	pieces	1
7	elbow 90°	pieces	20
8	tee	pieces	16
9	valves	pieces	14
10	straight joint	pieces	6
11	Mass Flow meter	pieces	1
12	Manometer 0 – 6 bar	pieces	1
13	Analogicalmtemperature probe 0 – 80 °C	pieces	1

### *III.2.5 Circulation pump selected:*

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

Pressure drop= 5,5m; Flow rate=3.96 m<sup>3</sup>/h

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

The circulation pumps for the internal hydraulic circuit is manufactured by Grundfos. It is a variable velocity one and can work at different frequencies from.

### III.2.3 Fan Coil/ AHU Technical Description

#### *Manufacturer & Model selected*

The manufacturer is VEAB and the selected model corresponds to PGK 700X400-3-2,0.



#### *Catalogue performance data*

Its air flow rate, cooling and heating capacity, and power demand values are shown in the table below:

#### **Capacity of PGK 700x400-3-2.0      Water temperature 6/12°C**

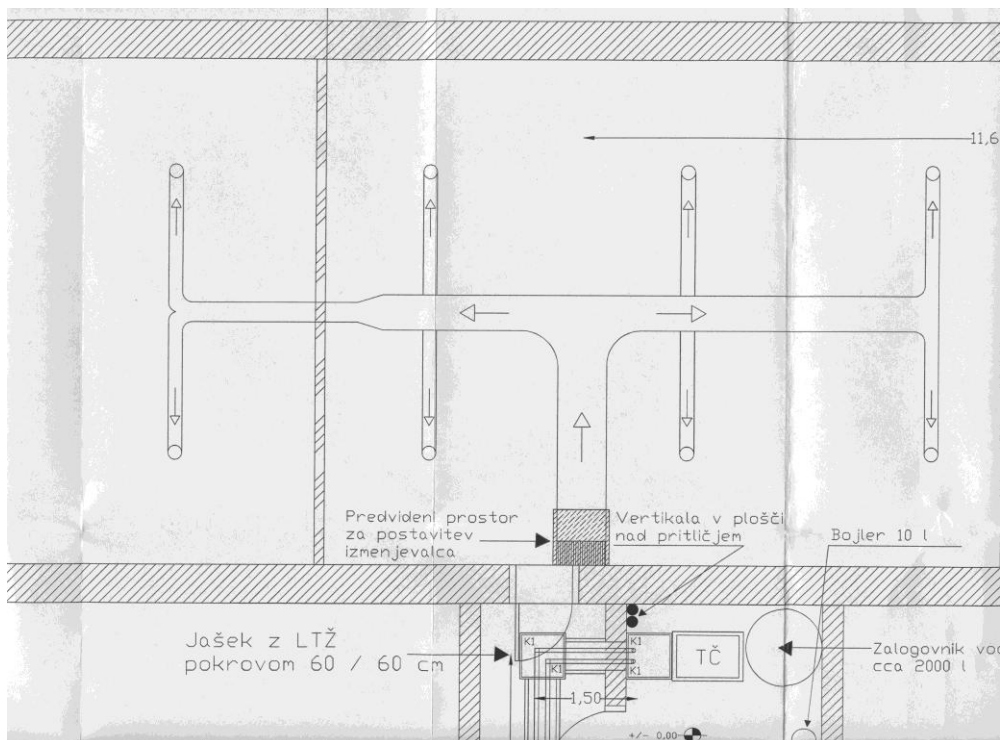
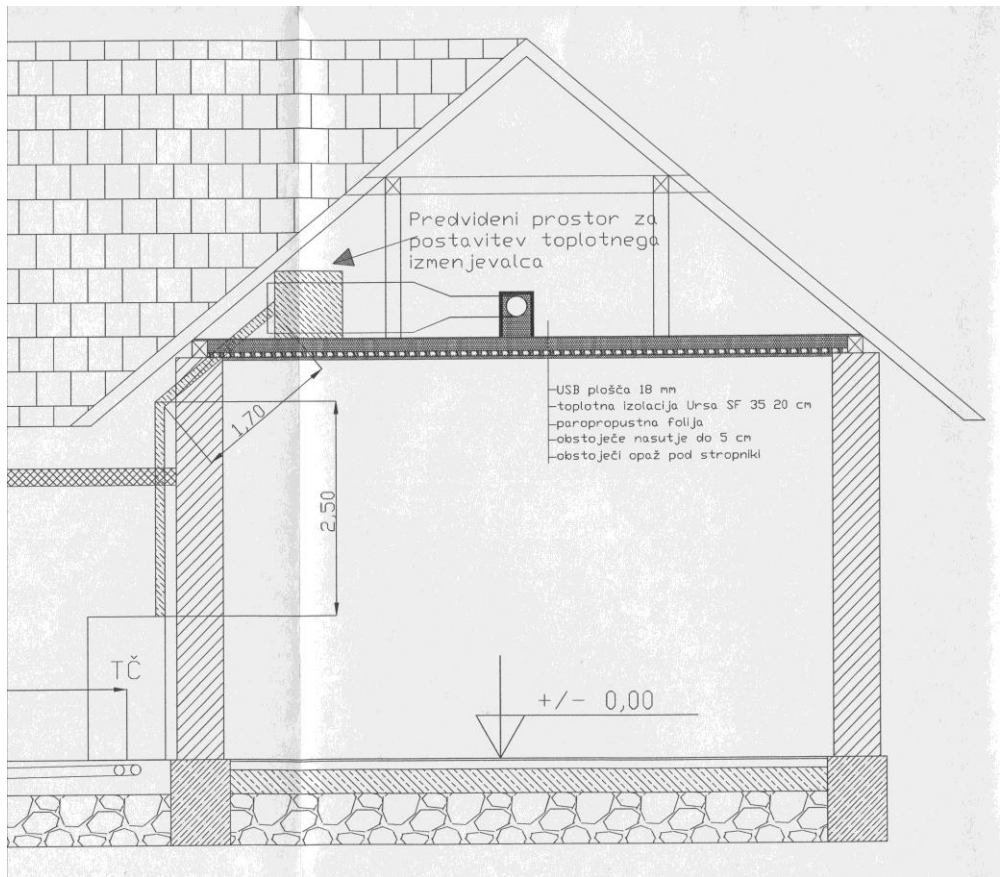
<b>Air flow</b>	<b>Pressure. drop</b>	<b>Inlet air temp.</b>	<b>Inlet air humidity</b>	<b>Outlet air temp.</b>	<b>Output</b>	<b>Water flow</b>	<b>Water press. drop</b>
<b>m<sup>3</sup>/h</b>	<b>Pa</b>	<b>°C</b>	<b>% RH</b>	<b>°C</b>	<b>kW</b>	<b>l/s</b>	<b>kPa</b>
1920	47	25	50	17,1	5,02	0,20	1
1920	74	30	45	18,1	8,66	0,35	2
2880	91	25	50	18,5	6,20	0,25	1
2880	142	30	45	18,8	12,94	0,52	4
3840	142	25	50	19,3	7,26	0,29	2
3840	222	30	45	19,0	18,41	0,73	8

#### *Water Flow rate*

The water flow rate will be the internal circuit flow rate of 3,96 m<sup>3</sup>/h.

#### *Location in the building (Schematic Distribution)*

Only the auditorium will be the air-conditioned space.



### Control system

The fan coil can be individually regulated by means of a thermostat and comfort temperature and fan speed can be selected by the user. The control for the fan is governed by a three way valve that allows the heating/cooling water to be modulated through the fan coil. The valve is controlled by the thermostat of the room.

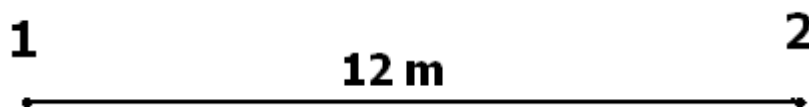


## III.3 Outdoor Loop Description

### III.3.1 Ground Source Heat Exchanger Description

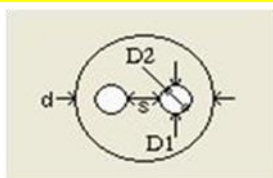
*Type of configuration (rectangular, line....etc)*

The GSHX itself consists of two vertical boreholes connected in a parallel configuration. The two boreholes are arranged in a line with the distance of 12 m.



*Single U or Double U (specifying diameters with drawings)*

#### U TUBE



Borehole diameter (d)	175	mm
Pipe internal diameter (D2)	32,6	mm
Pipe external diameter (D1)	40,0	mm
Shank spacing (s)	70	mm

*Borehole depth*

Each borehole is 250 m deep.

### *Borehole spacing*

There is a 12 m separation between boreholes.

### *Grout material and conductivity*

The grout material is quartz and it has a conductivity of 2,2 W/mK.

### *Depth below surface*

There is 1 m space between the surface and the top of the ground storage.

### *Pipe material*

The material used in pipes is high density polyethylene HDPE.

### *Working fluid*

Pure water is used as the working fluid.

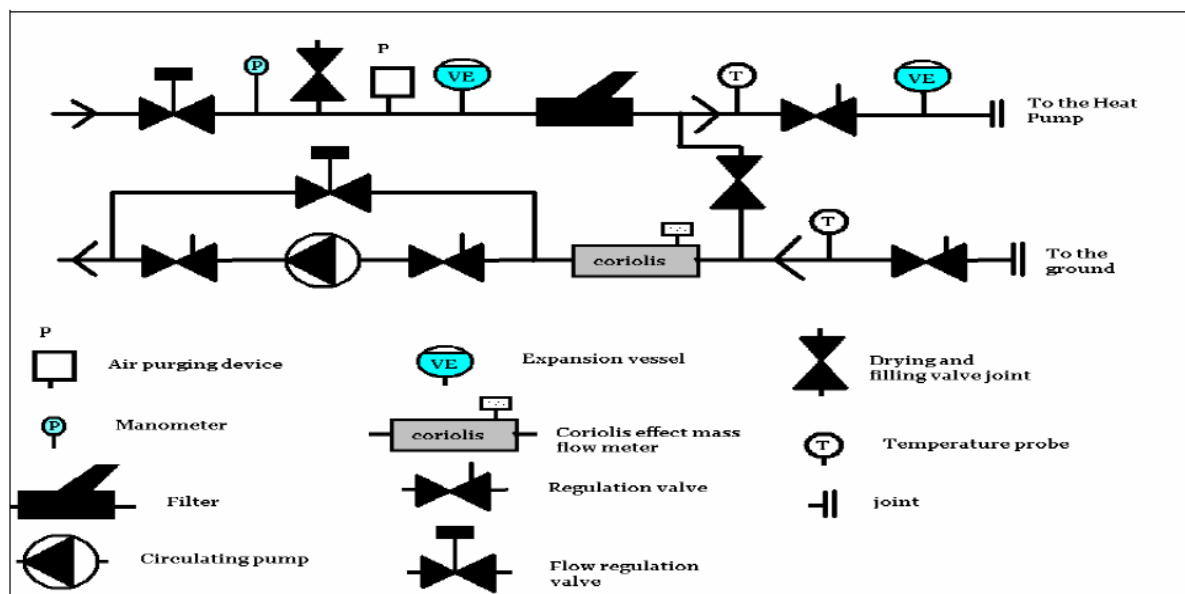
## *III.3.2 Hydraulic Loop Description*

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

There are two boreholes connected in parallel. The total external flow rate is 4 m<sup>3</sup>/h. So, the flow rate at each borehole will be 2 m<sup>3</sup>/h.

The outer hydraulic group consists of the following components:

- A circulating pump (Grundfoss)
- A mass flow meter (Coriolis effect, Danfoss).
- Manometers.
- Expansion vessels.
- Regulating and equalising valves.



The length and diameter of the different elements belonging to the outdoor loop are given in the following table, also including the characterization and number of the main accessories.

	<b>DESCRIPTION</b>	<b>UNIT</b>	
1	High density polyethylene pipe DN40	m	520
2	High density polyethylene pipe DN40 isolated	m	20
3	High density polyethylene pipe DN50 isolated	m	20
4	High density polyethylene 180° elbow DN40	pieces	2
5	High density polyethylene 90° elbow DN40	pieces	8
6	High density polyethylene tee DN40/50	pieces	2
7	High density polyethylene 90° elbow DN50	pieces	6
8	High density polyethylene tee DN50	pieces	4
9	High density polyethylene straight joint DN40	pieces	2
10	Threaded valve	pieces	8
11	Wired thermo resistance PT 100	pieces	2
12	Signal transmitter wire	m	500
13	Piping for the signal transmitter wire	m	20
14	Purging devices	pieces	1
15	Expansion tank 8 l	pieces	2
16	Mass Flow meter	pieces	1
17	Grundfoss pump Magna 32 – 10N	pieces	1
18	Manometer 0 – 6 bar	pieces	1
19	Analogical temperature probe 0 – 80 °C	pieces	1

### *III.3.4 Circulation pump selected:*

*Total pressure drop and water flow rate that must be provided by the circulation pump.*

Pressure drop= 6 +2 = 8 m; Flow rate=4 m<sup>3</sup>/h.

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

The circulation pumps for the external hydraulic circuit is manufactured by Grundfos. The model is Magna 32 – 100N.

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

There are no open issues.