ATELIER

Components:

Carlos Roca Coscollá

Ángela Lorenzo Bravo

Ana Cristina Cerezo Vicente

22/June/2012

Hogeschool Sint-Lukas

Polytechnic University of Valencia

INDEX

- Evacuation of water
    1. Design
    2. Sizing
    3. Plans
- Electricity

    1. Electrification negree
    2. Internal circuits
    3. Independent circuits
    4. Material and diameter
    5. Minimum circuits per room
    6. Total circuits used
    7. High electrification circuit
    8. Pressure group room, stairs and elevator circuit
    9. Illumination
    10. Plans

- Planning, Price and quantity and Measurement
    1. Exercise 1: measurement
    2. Exercise 2: Performance
    3. Exercise 3: Gantt and Network

- Fire Evacuation

    1. Evacuation of occupants

    2. Fire protection facilities

    3. Plans

- Calculation of structures.

    1. Application of the matrix method.

    2. Calculation of a beam

    3. Calculation of a pillar

    4. Calculation of a piece of wrought.

- Evacuation of water

    1-Design

    2-Sizing

    3-Plans

- Electricity

    1-Electrification negree

    2-Internal circuits

    3-Independent circuits

    4-Material and diameter

    5-Minimum circuits per room

    6-Total circuits used

    7-High electrification circuit

    8-Pressure group room, stairs and elevator circuit

    9-Illumination

    10-Plans

Water Supplies

Water supplies

1. **Quality of water.**

1.1. Criteria for the selection of materials.

- The materials that will be used in the installation, in relation to its effect on the water supply, it should conform to the following requirements:
    - For pipes and accessories use materials that do not produce concentrations of pollutants exceeding the allowed values.
    - They must not modify the potability, odor, color or the taste of the water.
    - They must be resistant to internal corrosion.
    - They must be able to operate effectively in the conditions of service laid down.
    - They must not submit electrochemical incompatibility.
    - They must be resistant to temperatures up to 40 ° c, and the external temperatures of its immediate surroundings.
    - They must be compatible with the water supply and they should not favour the migration of substances from materials in quantities that are a risk to the health and cleaning of water for human consumption.
    - Aging, fatigue, durability, and other mechanical, physical or chemical characteristics should not reduce the expected life of the installation.

1.1.Calculations for the determination of the quality of the water

We are using the data of the chemical composition of the water from the Ixelles station, that have been collected during the month of April.

The data obtained are the following:

Temperature= 20ºC

pH = 7,65 unit of pH

Electrical conductivity CE = 694,00 µS/cm

Magnesium (Mg^{2+})= 17,8 mg/l

Calcium (Ca^{2+})= 125,00 mg/l

Bicarbonate (HCO_3^-) = 350,3 mg/l

Bicarbonate (CO_3^{2-}) = 0,00 mg/l

1.1.1. pH of water

pH< 7 → Acid dissolution

pH = 7 → Neutral dissolution

pH > 7 → Alkaline dissolution

Alkaline water pH = 7, 65 units of pH

1.1.2. Conductividad de la corriente eléctrica

CE< 100 µS/cm → Weak mineralization

200 µS/cm < CE < 333 µS/cm → Medium mineralization

333 µS/cm < CE < 600 µS/cm → High medium mineralization

600 µS/cm < CE < 1000 µS/cm → Important mineralization

CE > 1000 µS/cm → Excessive mineralization

Water with important mineralization CE = 694,00 µS/cm

1.1.3. Total hardness of the water (TH)

$$TH = \left[\frac{Ca^{2+}}{40{,}078} + \frac{Mg^{2+}}{24{,}305}\right] \cdot 100{,}0872$$

$$TH = \left[\frac{125{,}00}{40{,}078} + \frac{17{,}80}{24{,}305}\right] \cdot 100{,}0872 = 385{,}436\, mg\ CaCO_3/l$$

Classification table of water depending on total hardness (TH)

0 a 50	Very soft water, weakly mineralized, often rich in CO2
51 a 120	Weakly mineralized water. Water of medium hardness
121 a 250	Moderately hard water
251 a 390	Hard water
390 a 500	Very hard water
> 500	Extremely hard water

Hard water TH = 386, 4636 mg $CaCO_3$/l

1.1.4. Index of water stability.

1.1.4.1.Index of Langelier (IS)

IS= $pH_A - pH_S$

Siendo:

IS = Index of Langelier

pH_A= current pH of the water. Indicator parameter: minimum 6.5 and maximum 9.5

pH_S = saturation pH.

$$pH_S = \left[9{,}3 + \frac{log[0{,}64 \cdot CE] - 1}{10}\right] - 13{,}12 \cdot log[T + 273{,}15] + 34{,}55 - log\left[Ca^{2+} \cdot \frac{100{,}0872}{40{,}078}\right] - 0{,}4 + log\left[HCO_3^- \cdot \frac{100{,}0872}{61{,}0872} + 2 \cdot CO_3^{2-} \cdot \frac{100{,}0872}{60{,}0092}\right]$$

$$IS = 7{,}65 - \left[9{,}3 + \frac{\log[0{,}64 \cdot 694{,}00] - 1}{10} - 13{,}12 \cdot log[20 + 273{,}15] + 34{,}55 - log\left[125{,}00 \cdot \frac{100{,}0872}{40{,}078}\right] - 0{,}4 + log\left[350{,}3 \cdot \frac{100{,}0872}{61{,}078} + 2 \cdot 0{,}00 \cdot \frac{100{,}0872}{60{,}0092}\right]\right] = -3{,}86017$$

Values of the Index of Langelier to determine if the water is corrosive or encrusting.

IS = 0 → Water in chemical equilibrium (There is no embedding of CaCO3)

IS < 0 → Water with a tendency to be corrosive.

IS > 0 → Water with a tendency to be encrusting. Optimum value IS = 0.5. Higher values produce excessive inlays that can clog pipes with the passage of time.

Water with a tendency to be corrosive IS = -3,86017

1.1.4.2.Index Ryznar (IR)

IR = 2 · pH_S - pH_A

IR: Index of Ryznar

pH_A = current pH of the water. Indicator parameter: minimum 6.5 and maximum 9.5

pH_S = saturation pH.

$$IR = 2 \cdot \left[9{,}3 + \frac{\log[0{,}64 \cdot 694{,}00] - 1}{10} - 13{,}12 \cdot log[20 + 273{,}15] + 34{,}55 - log\left[125{,}00 \cdot \frac{100{,}0872}{40{,}078}\right] - 0{,}4 + log\left[350{,}3 \cdot \frac{100{,}0872}{61{,}078} + 2 \cdot 0{,}00 \cdot \frac{100{,}0872}{60{,}0092}\right]\right] - 7{,}65 = 15{,}37034$$

Values of the Index of Ryznar to determine if the water is corrosive or encrusting.

IR de 4 a 5,5 → Strongly encrusting

5,5 < IR < 6,2 → Slightly encrusting

6,2 <IR < 6,8 → In balance

6,8 < IR < 8,5 → Significantly corrosive.

8,5 < IR < 9,0 → Strongly corrosive

IR > 9,0 → Unacceptably corrosive

Unacceptably corrosive water IR = 15,37034.

1.1.4.3.Index of Puckorius (PSI).

PSI = 2 · pH_S - pH_{eq}

Siendo:

PSI = Index of Puckorius

pH_{eq}= equivalent pH.

pH_S= saturation pH.

$$pH_{eq} = 1{,}465 \cdot log[HCO_3^- + 2CO_3^{2-}] + 4{,}54$$

$$PSI = 2 \cdot \left[9{,}3 + \frac{\log[0{,}64 \cdot 694{,}00] - 1}{10} - 13{,}12 \cdot log[20 + 273{,}15] + 34{,}55 - log\left[125{,}00 \cdot \frac{100{,}0872}{40{,}078}\right] - 0{,}4 + log\left[350{,}3 \cdot \frac{100{,}0872}{61{,}078} + 2 \cdot 0{,}00 \cdot \frac{100{,}0872}{60{,}0092}\right]\right] - [1{,}465 \cdot log[HCO_3^- + 2CO_3^{2-}] + 4{,}54] = 8{,}2676$$

Values of the Index of Puckorius to determine if the water is corrosive or encrusting.

PSI > 4,5 → Inlay tendency

4,5 < PSI < 6,5 → Optimum range (no corrosion)

PSI > 6,5 → Tendency to corrosion

Water with tendency to corrosion PSI = 8,2676

1.1.5. <u>Choice of materials</u>

Calculations have obtained that the water in the area of Brussels is corrosive, therefore we used polymeric materials, metals such as copper and steel is not recommended.

The supply connection and the supply line are in PVC. The rest of the pipes are in cross-linked polyethylene.

2. Properties of the installation

2.1. Protection against returns

- To prevent the reversal of flow direction systems for the protection against returns are placed in the next points:
  - After water meters.
  - On the base of downspouts.
  - Before of water treatment equipment.
  - Before of no domestic use pipes.
  - Before air conditioning systems.
  - Any other place that was necessary.
- The installations of water supply are not allowed to be directly connected to sewage systems or another installation water supply non come from the public network.
- A drainage tap is with each protection against returns , that makes empty each part of the net possible.

2.2. Minimum supply conditions

- The minimum pressure at points of use must be:
  - 100 kPa for common taps.
  - 150 kPa for Flush valves and heaters.
- The maximum pressure at any point of use must not exceed 500kPa.
- The temperature of hot water must be between 50ºC y 65ºC.

2.3. Maintenance.

- The elements and equipment of the installation that require it, such as pressure groups, the treatment systems or water meters, must be installed in rooms whose dimensions are sufficient to permit maintenance carried out properly.
- The pipeline networks, including private indoor facilities if it is possible, must be designed so that they are accessible for maintenance and repair. They should be visible.

2.4.Saving water

- There should be a counting system of cold water and hot water consumption for each unit of individual service.
- A return net system must be placed for hot water when the length of the pipeline until the farthest point of use is equal or greater than 15 meters.
- The taps in toilets and tanks must be equipped with water saving devices in public gathering areas.

3. Design.

The installation of water supply developed at building contract is composed by the connection, general installation and collective divisions.

3.1.Outline of the general installation

The following outline of the general installation is taken:

Network with single general meter, and composed by the connection, the general installation containing a closet or chest of general meter, feeding pipe and a main dealer, and collective divisions.

3.2.Components of the installation

3.2.1. Cold water main

3.2.1.1.Connection

The connection is composed as a minimum by the following elements:

- A shut off valve on the distribution pipe that allow the flow into the connection
- A pipeline between shut off valve and the main stopcock.
- A main stopcock outside of the property.

3.2.1.2.General installation

Depending on the type of installation adopted, the general installation must content some of the following points.

3.2.1.2.1. General stopcock

The general stopcock is used to interrupt the supply to the building, and is located inside of the property in an area commonly accessible for handling and properly marked to allow identification. If a closer or chest meter is available, the general stopcock must be arranged in its interior.

3.2.1.2.2. Filter of the installation.

The filter of the general installation must retain the water wastes that may lead to corrosion in metal pipes. Be installed below the general stopcock. If there is a closer or chest meter must be placed in it. The filter must be of type Y and with a filtering threshold between 25 and 50 μm. and with stainless steel mesh and plated to prevent the formation of bacteria and self-cleaning. The situation of the filter should allow the adequately perform the cleaning and maintenance without outage.

3.2.1.2.3. Locker for the general counter

The locker of the general counter contains, in this order, general stopcock, a filter of the general installation, general counter, valve, tap, a check valve and an exit stopcock. Its installation should be in a plane parallel to the ground.

The exit stopcock should allow disconnection of the building. The general stopcock and the exit stopcock will serve for the assembly and disassembly of general water meter.

3.2.1.2.4. Supply pipe.

It should be available for inspection and leakage tests, at least in its extreme and changes direction.

3.2.1.2.5. Distributor of water.

It should be available for inspection and leakage tests, at least in its extreme and changes direction.

A stopcock must be in each division in order to not stop the supply of water in all the points in case of breakdown.

3.2.1.2.6. Ascending pipes.

- At the bases of the ascending pipes must be a check valve, stopcock for maintenance, and a valve with tap. They must be available for inspection. The check valve has to be on first place (according with the water direction).

- On the top must be a manual or automatic drainage system

3.2.1.3.Control systems and pressure regulation

3.2.1.3.1. Superelevation systems: pressure groups.

The pressure group is drive controlled, it may dispense the auxiliary tank of supply, and have an inverter that powers the pumps with constant outlet pressure regardless of flow rate requested or available. One of the pumps maintain the flow necessary to maintain adequate pressure

The pressure groups are installed at a local exclusive use may also harbor the water treatment system. The dimensions of this room will be sufficient to perform maintenance operations.

3.2.1.3.2. System pressure reduction.

Be installed pressure relief valves to not exceed the established maximum operating pressure and when providing significant increases in system pressure so as not to exceed the maximum working pressure at the point of use.

1.1.1.1.Water treatment system.

1.1.1.1.1. Performance requirements.

Suitable divisions were performed in the network so that the momentary stop of the system does not involve discontinuity in the water supply of the building.

Treatment systems will be equipped with measuring devices in order to check the expected efficacy in the treatment of water.

Treatment teams must have a meter to measure, on entry, the water used for maintenance.

1.1.1.1.2. Treatment products

The chemicals used in the process must be stored safely according to their nature and method of use. The entrance to the place destined to storage should be equipped with a system where access is restricted to authorized persons for handling.

1.1.1.1.3. Location of the system.

The place in where the water treatment equipment is installed must preferably be used exclusively for it.
Access takes place from the outside or from areas of the building, being restricted to authorized personnel. The size of the venue will be appropriate to accommodate the necessary devices

3.2.2. Hot water installation.

3.2.2.1.Distribution (impulsion and return)

- The distribution main must be equipped with a main of return when the length of the drive pipe to the point of farthest consumption is equal to or greater than 15 m.
- The return main should consist in:
  - A collector of return in the distributions for multiple groups of columns. The collector must have slope pipe from the top of the drive columns till to the return column. Each collector can collect all or some of the drive columns, that have equal pressure
  - Return columns: from the top of the columns that goes, or from the collector of return, until the accumulator.
- Return main run in parallel to the impulsion main.
- In the ascending pipes, the return should be done from its top and below the last particular derivation. Seat valves will be available on the basis of these figures to regulate and balances hydraulically return.
- There will be a pump of double recirculation, mounted in parallel or "twins", functioning similarly to as specified for the cold water pressure group.
- Mains of drive and return pipes must be isolated.

3.2.2.2.Control and regulation

In hot water installations the temperature of preparation and distribution is regulated and controlled.

3.3.Protection against returns

3.3.1. General conditions of the installation of supply.

The constitution of the equipment and devices installed and their installation mode must be such that prevents the introduction of any fluid in the installation and return of the water leaving.

The installation cannot connect directly to a sewage pipe.

Joints between internal conducts spliced with public distribution main and other installations, such as the use of water that is coming from the public distribution main, cannot be set.

The supply installations that have water treatment system must be fitted with a device to prevent the return; this device must be located before the system and as closely as possible to the general counter.

3.3.2. Direct power consumption points.

In all devices that feed directly on the distribution of water, such as bathtubs, washbasins, bidets, sinks, utility sinks, and in general, in all containers, the lower level of the arrival of the water must be poured to 20 mm, at least above the top edge of the container.

Manual shower sprinkler must have built-in non return device.

3.3.3. Closed deposits.

In deposits closed even if they are in communication with the atmosphere, the supply pipe will lead 40 mm above the maximum water level, or above the highest point of the mouth of the spillway. This spillway must have the sufficient capacity to evacuate a double flow than the expected maximum of water inlet flow.

3.3.4. Derivations of collective use

Supply pipes that are not exclusively intended for domestic needs should be equipped with a non-return device and a purge of control.

The derivations of collective use of buildings cannot be connected directly to the public distribution main.

3.3.5. Copper connection.

The copper of steam or hot water with overpressure cannot be spliced directly to the public main of distribution. Any device or unit of power used will start in a deposit, for which the previous provisions shall be fulfilled.

3.3.6. Motor-pump group.

Pumps should not be connected directly to arrival of water supply pipes, but it must be nurtured from a deposit, except when they are equipped with devices of protection and isolation to prevent that depression occurs in the main.

This protection must also reach the pumps of variable flow that have been installed in the pressure group of action adjustable and shall include a device that causes the closing of the suction and the stop of the pump in case of depression in the supply pipe and a deposit of protection against overpressure caused by water hammer.

In the superelevation groups of conventional type, we must install a non-return valve, of membrane type, to absorb possible shocks of water hammer.

3.4.__Separation to other installations.__

The laying of pipelines of cold water should be done in the way that they are not affected by focuses of heat and therefore should run always separate from the pipes of hot water at a distance of 4 cm, minimum. When two lines are in the same vertical plane, cold water should always be below the hot water.

Pipes must be below any pipeline or element that contains electrical or electronic devices, as well as of any telecommunications network, keeping a distance of at least 30 cm.

3.5.__Markedof the pipes of water supplies.__

The pipes of potable water will be marked in dark green or blue.

3.6.__Water saving__

All buildings which expected used is public turnout must have devices of saving water in the taps. The devices that can be installed for this purpose are: taps with vents, thermostatic taps, taps with infrared sensors, taps with push button timer, fluxors and keys of regulation before the points of consumption.

Equipment that use water for human consumption in the condensation of refrigerant agents must be fitted with water recovery systems.

4. <u>Sizing of the cold water main.</u>

4.1.Calculation of the number of equivalent supplies.

The calculation of general installation process involves obtaining the number of equivalent supplies, adopting the most unfavorable equivalence, what is the one that determines a higher diameter.

As first question, it is necessary to know the instantaneous minimum flow of each type of supply, which is obtained from the flows of each one of the units that we found in the building.

Floor	Location	Sanitary units	Number of units N	Flow Q (l/s)	Instantaneous minimum flow Qi (l/s)	Total instantaneous minimum flow Qi (l/s)
Underground	Changing room for men	Shower	1	0,2	1,45	2,9
		Fluxor toilet	1	1,25		
	Changing room for women	Shower	1	0,2	1,45	
		Fluxor toilet	1	1,25		
Ground floor	Toilet 1	Fluxor toilet	1	1,25	1,35	4,05
		Washbasin	1	0,1		
	Toilet 2	Fluxor toilet	1	1,25	1,35	
		Washbasin	1	0,1		
	Toilet 3	Fluxor toilet	1	1,25	1,35	
		Washbasin	1	0,1		
1º Floor	Toilet 4	Fluxor toilet	1	1,25	1,35	2,7
		Washbasin	1	0,1		

	Toilet 5	Fluxor toilet	1	1,25	1,35	
		Washbasin	1	0,1		
2º Floor	Toilet 6	Fluxor toilet	1	1,25	1,35	2,7
		Washbasin	1	0,1		
	Toilet 7	Fluxor toilet	1	1,25	1,35	
		Washbasin	1	0,1		
3º Floor	Toilet 8	Fluxor toilet	1	1,25	1,35	2,7
		Washbasin	1	0,1		
	Toilet 9	Fluxor toilet	1	1,25	1,35	
		Washbasin	1	0,1		
Total flow to supply to the building						15,05

The total instantaneous flow of the building is 15.05 l/s.

The equivalent number of supplies of a kind of supply will be given by the ratio between the total flow to supply and the amount of the instantaneous flow of supply type.

The number of equivalent supplies is obtained from the following equation:

$$nv(j) = \frac{Qi\,TOTAL}{Qi(j)}$$

Kind of equivalent supply	Instantaneous flow Qi (l/s)	Total flow Qt (l/s)	Nunber of equivalent supplies nv
Underground	2,9	15,05	$\frac{Q_t}{Q_i(1)} = \frac{15{,}05\ l/s}{2{,}9\ l/s} = 5{,}189 \Rightarrow 6$
Ground floor	4,05		$\frac{Q_t}{Q_i(2)} = \frac{15{,}05\ l/s}{4{,}05\ l/s} = 3{,}716 \Rightarrow 4$
1º floor	2,7		$\frac{Q_t}{Q_i(3)} = \frac{15{,}05 l/s}{2{,}7\ l/s} = 5{,}574 \Rightarrow 6$
2º floor	2,7		$\frac{Q_t}{Q_i(4)} = \frac{15{,}05 l/s}{2{,}7\ l/s} = 5{,}574 \Rightarrow 6$
3º floor	2,7		$\frac{Q_t}{Q_i(5)} = \frac{15{,}05 l/s}{2{,}7\ l/s} = 5{,}574 \Rightarrow 6$

4.2.<u>Calculation of simultaneous flows.</u>

The simultaneous flow corresponding to a certain number of supplies is obtained applying the following equation:

$$Qs = nv \cdot Ks \cdot Kn \cdot Qi$$

Where:

Qs = Simultaneous flow (l/s)

nv = Number of equivalent supplies

Ks = Coefficient of simultaneity of a supply type.

$$Ks = \frac{1}{\sqrt{N-1}} + \alpha \cdot [0{,}035 + 0{,}035 \cdot \log(\log N)]$$

N = Number of units of the supply

α = Coefficient of the type of use of the supply (when the building is used for schools, universities, clubs, gyms, etc. α = 4).

Kn= Coefficient of simultaneity of the building.

$$Kn = \frac{19 + nv}{10 \cdot (nv + 1)}$$

Qi = Flow instantaneous of supply type (l/s).

Instantaneous flow depending on the kind of equivalent supply.

Kind	Number of equivalent supplies nv	Number of units in each supply N	Coefficient of simultaneity depending on:		Instantaneous flow of supply type Qi (l/s)	Instantaneous flow Qs (l/s)
			Number of units Ks	Number of supplies Kn		
Underground	6	4	0,686	0,357	2,900	4,266
Ground floor	4	6	0,572	0,460	4,050	4,262
1º floor	6	4	0,686	0,357	2,700	3,972
2º floor	6	4	0,686	0,357	2,700	3,972
3º floor	6	4	0,686	0,357	2,700	3,972

Higher flow: 4,266 l/s.

4.3. Diameter of the supply connection and the supply pipe.

4.2.1. Supply connection.

From the simultaneous flow of the stretch of the supply connection and by prefixing a recommended speed of 1 m/s, the diameter of calculation is:

Qs = 4,266 l/s

$$D = \sqrt{\frac{4 \cdot Q}{\pi \cdot c}} = \sqrt{\frac{4 \cdot 4{,}266 \cdot 10^{-3}}{\pi \cdot 1}} = 0{,}0737\ m = 73{,}7\ mm$$

The supply connection is in polyethylene with the following commercial diameters:

Polyethylene pipes PE40 PN-10 UNE 12201-2/2003		
Nominal diameter DN	Thickness e(mm)	Inside diameter
20	3,00	14,00
25	3,50	18,00
32	4,40	23,20
40	5,50	29,00
50	6,90	36,20
63	8,60	45,80
75	10,30	54,40
90	12,30	65,40
110	15,10	79,80

The ideal diameter is the most approximate to the one obtained by calculation, provided that the movement of the fluid speed is within the range 0.6 ≤ c ≤ 1.5 m/s.

For D = 79,80 mm

$$c = \frac{4 \cdot Q}{\pi \cdot D^2} = \frac{4 \cdot 4{,}266 \cdot 10^{-3}}{\pi \cdot (79{,}80 \cdot 10^{-3})^2} = 0{,}853\ m/s$$

The speed is within the recommended range, we can take D = 79, 8 mm, DN-110.

Diameter of the supply connection: DN-110 (D=79,80 mm)

4.2.2. Supply pipe diameter

The supply pipe is in polyethylene.

The circulating flow in this section is the same as the supply connection, so we take the same diameter of pipe.

The supply pipe diameter is: DN-110 (D = 79, 80 mm).

4.2.3. Diameter of the main dealer pipe

The main dealer pipe is in polyethylene.

The circulating flow in this section is the same as the supply pipe, so we take the same diameter of pipe.

The main dealer pipe diameter is: DN-110 (D = 79, 80 mm).

4.3.Locker of the general counter.

The building is equipped with a single counter, therefore provide a space for a cabinet to accommodate the general counter of the following dimensions:

Dimensions (mm)	Nominal diameter of the counter (mm)										
	Locker					Room					
	15	20	25	32	40	50	65	80	100	125	150
Long	600	600	900	900	1300	2100	2100	2200	2500	3000	3000
Width	500	500	500	500	600	700	700	800	800	800	800
High	200	200	300	300	500	700	700	800	900	1000	1000

4.4.Diameter of the ascending pipes.

The diameter of the ascending pipes depends on de simultaneous flow of the supply type.

$$Qs = ks \cdot Qi = [\frac{1}{\sqrt{N-1}} + \alpha \cdot [0{,}035 + (0{,}035 \cdot \log(\log N))] \cdot Qi$$

The ascending pipes are in polyethylene.

4.4.1. Ascending pipe to the underground

$$Qs = ks \cdot Qi = [\frac{1}{\sqrt{4-1}} + \alpha \cdot [0{,}035 + (0{,}035 \cdot \log(\log 4))] \cdot 2{,}9 = 1{,}99\ l/s$$

The ascending pipe to the underground has a simultaneous flow of: 1,99 l/s.

The diameter of the ascending pipe to the underground is:

$$D = \sqrt{\frac{4 \cdot Q}{\pi \cdot c}} = \sqrt{\frac{4 \cdot 1{,}99 \cdot 10^{-3}}{\pi \cdot 1}} = 0{,}05033\ m = 50{,}33\ mm$$

The ascending pipe is of polyethylene and the commercial diameters are the following:

Polyethylene pipes PE-X S4 UNE EN ISO 15875-2		
Nominal diameter DN	Thickness e(mm)	Inside diameter
12	1,4	9,2
16	1,8	12,4
20	2,3	15,4
25	2,8	19,4
32	3,6	24,8
40	4,5	31
50	5,6	38,8
63	7,1	48,8
75	8,4	58,2
90	10,1	69,8
110	12,3	85,4
125	14	97
140	15,7	108,6
160	17,9	124,2

The ideal diameter is the most approximate to the one obtained by calculation, provided that the movement of the fluid speed is within the range 0.6 ≤ c ≤ 1.5 m/s.

For D = 58,20 mm

$$c = \frac{4 \cdot Q}{\pi \cdot D^2} = \frac{4 \cdot 1{,}99 \cdot 10^{-3}}{\pi \cdot (58{,}2 \cdot 10^{-3})^2} = 0{,}748\, m/s$$

The speed is within the recommended range, we can take D = 58, 2 mm, DN-75.

Dameter of the ascending pipe to the underground: DN-75 (D=58,2 mm)

4.4.2. <u>Ascending pipe to the Groundfloor.</u>

$$Qs = ks \cdot Qi = [\frac{1}{\sqrt{6-1}} + \alpha \cdot [0{,}035 + (0{,}035 \cdot \log(\log 6))] \cdot 4{,}05 = 2{,}316\, l/s$$

The ascendig pipe to the groundfloor has a simultaneous flow of: 2,316 l/s.

The diameter of the ascending pipe to the groundfloor is:

$$D = \sqrt{\frac{4 \cdot Q}{\pi \cdot c}} = \sqrt{\frac{4 \cdot 2{,}316 \cdot 10^{-3}}{\pi \cdot 1}} = 0{,}0543\, m = 54{,}30\, mm$$

The ascending pipe is of polyethylene and the commercial diameters are the following:

Tuberías de polietileno PE-X S4 UNE EN ISO 15875-2		
Diámetro nominal DN	Espesor e(mm)	Diámetro interior
12	1,4	9,2
16	1,8	12,4
20	2,3	15,4
25	2,8	19,4
32	3,6	24,8
40	4,5	31
50	5,6	38,8
63	7,1	48,8
75	8,4	58,2
90	10,1	69,8
110	12,3	85,4
125	14	97
140	15,7	108,6
160	17,9	124,2

The ideal diameter is the most approximate to the one obtained by calculation, provided that the movement of the fluid speed is within the range 0.6 ≤ c ≤ 1.5 m/s.

For D = 58,20 mm

$$c = \frac{4 \cdot Q}{\pi \cdot D^2} = \frac{4 \cdot 2{,}316 \cdot 10^{-3}}{\pi \cdot (58{,}2 \cdot 10^{-3})^2} = 0{,}870\ m/s$$

The speed is within the recommended range, we can take D = 58, 2 mm, DN-75

Diameter of the ascending pipe to the groundfloor DN-75 (D=58,2 mm)

4.4.3. Ascending pipes to 1º, 2º y 3º floor.

The acending pipes to the 1st, 2nd and 3rd floor have the same instantaneous flow, therefore the same flow simultaneously, therefore the same diameter.

$$Qs = ks \cdot Qi = [\frac{1}{\sqrt{4-1}} + \alpha \cdot [0{,}035 + (0{,}035 \cdot \log(\log 4))] \cdot 2{,}7 = 1{,}853\ l/s$$

The ascending pipes to the 1st, 2nd and 3rd floor has a simultaneous flow of 1,853 l/s.

The diameter of the ascending pipe to the 1st, 2nd and 3rd floor is:

$$D = \sqrt{\frac{4 \cdot Q}{\pi \cdot c}} = \sqrt{\frac{4 \cdot 1{,}853 \cdot 10^{-3}}{\pi \cdot 1}} = 0{,}04857\ m = 48{,}57\ mm$$

The ascending pipe is of polyethylene and the commercial diameters are the following:

Tuberías de polietileno PE-X S4 UNE EN ISO 15875-2		
Diámetro nominal DN	Espesor e(mm)	Diámetro interior
12	1,4	9,2
16	1,8	12,4
20	2,3	15,4
25	2,8	19,4
32	3,6	24,8
40	4,5	31
50	5,6	38,8
63	7,1	48,8
75	8,4	58,2
90	10,1	69,8
110	12,3	85,4
125	14	97
140	15,7	108,6
160	17,9	124,2

The ideal diameter is the most approximate to the one obtained by calculation, provided that the movement of the fluid speed is within the range $0.6 \leq c \leq 1.5$ m/s.

For D = 48,80 mm

$$c = \frac{4 \cdot Q}{\pi \cdot D^2} = \frac{4 \cdot 1{,}853 \cdot 10^{-3}}{\pi \cdot (48{,}8 \cdot 10^{-3})^2} = 0{,}990\ m/s$$

The speed is within the recommended range, we can take D = 48, 8 mm, DN-63.

The diameter of the ascending pipe to the 1st, 2nd and 3rd floor is: DN-63 (D=48,8 mm)

4.5. Diameter of the derivation of supply.

The diameter of the derivation of supply shall be the same than the diameter of the corresponding ascending pipe because we are maintaining the same speed and material criteria.

The minimum diameter established for particular derivation, is set 20 mm of inside diameter for polyethylene, our minimum value obtained is 48.8 mm, so the choice made is valid.

4.6.Diámetros mínimos de derivaciones a los aparatos.

The branches of link to the units are sized with the table 4.2. of the CTE, obtaining the following results:

Aparato	Diámetro de la tubería
Lavabo	12 mm.
Inodoro con fluxor	25 – 40 mm.
Ducha	12 mm.

4.7. Justification of the need of installing a pressure group.

4.6.1. Pressure of service (Hs).

The building is located in Roosdaal, municipality which has a total of 10934 habitants.

Habitants	Pressure of service Hs (mca)
Less than 1000	28
From 1000 to 6000	32
From 6000 to 12000	36
From 12000 to 50000	40
More than 50000	46

The pressure of service is Hs= 36 mca

4.6.2. Need of installing a pressure group.

The need of the pressure group is obtained by applying the following equation:

$$Hm_{min} = 1{,}20 \cdot Hg + h + H_{residual} + Hr_{counter} - Hs$$

Where:

Hg = geometric height of the building = 17,80 m.

h= depth of the supply connection = 0,6 m.

$H_{residual}$ = 15 mca.

$Hr_{counter}$= pressure loss in the counter = 5 mca.

Hs = pressure of service = 36 mca.

Substituting into the equation:

$$1{,}20 \cdot 17{,}80 + 0{,}6 + 15 + 5 - 36 = \ 5{,}96\, mca$$

5,96 > 0, so we need a pressure group.

4.6.3. Minimum pressure of the equipment

Hm_{min}= 5,96 mca.

4.6.4. Maximum pressure of the equipment.

Hm_{max}= Hg +h + Hmax – Hs

Hmax= 50 mca

Hm_{max}= 17,80 + 0,60 + 50 – 40

Hm_{max}= 28,4 mca.

4.6.5. Height gauge of start of the pump.

$Hm_{(start)}$= Hm_{min} + 5 mca

$Hm_{(start)}$= 5,96 + 5 mca

$Hm_{(start)}$= 10,96 mca

4.6.6. Height gauge of stop of the pump.

$Hm_{(paro\ bomba)} = Hm_{max} - 5mca$

$Hm_{(paro\ bomba)} = 28{,}4 - 5mca$

$Hm_{(paro\ bomba)} = 23{,}4\ mca$

4.6.7. Calculation of the mínimum flows of the pump

The simultaneous flow is Qst = 4,266 l/s

The number of pumps to install is set according to the normative to a minimum of two, because the flow is less than 10 l/s, without taking into account the pump in reserve.

A total of 3 equal pumps connected in parallel (2 service + 1 reserve) with a minimum flow for pump that will be installed of:

$$Qs = \frac{4{,}266}{2} = 2{,}133\ l/s$$

4.6.8. Calculation of the minimal volume of the hydraulic condenser in aspiration.

The capacity of the hydraulic aspiration condenser must provide a simultaneous flow of supply at the installation during a time that will be determined by the number of starts per hour planned in the pump, by the following way:

$$\forall_{calderín} = Qs \cdot t$$

Where:

∀ = Minimum volume of the hydraulic condenser in aspiration (litres)

Qs = Simultaneous flow of the system (l/s)

t = Time of supply continued between stops of the pumps.

This time is determined by the number of starts of the pump per hour Nc. It takes a number of 4 cycles per hour (dimensionless value).

$N_c = 4$

$$t = \frac{3600}{4} = 900\ s$$

The capacity of the aspiration condenser is:

$$\forall_{calderín} = 4{,}266 \cdot 900 = 3839{,}4\ litros$$

4.6.9. Calculation of the minimum volume of the hydraulic impulse condenser

Hydraulic discharge condensers may be with compressor and bladder or without compressor and bladder, but the one without compressor and bladder has a greater storage capacity for the same conditions of service, so we will installed in this case the one with compressor and bladder.

The equations that have to be applied to obtain the volume of the hydraulic condenser are given by the Valibouse equation.

For condenser with membrane:

$$\forall_{calderín} = 15 \cdot k \cdot \frac{Q_b}{N_c} \cdot \frac{(Hm_{max} + H_{atmosférica})}{(Hm_{max} - Hm_{min})}$$

Where:

$\forall$ = Minimum volume of the hydraulic condenser in impulsion. (litres)

k = Coefficient, that for condensers with membrane, usually take 1.25.

Qb = Caudal tip to raise by the pump asked by the system (l/min). It is estimated that Qb = Qs.

Hm_{min}= Minimum gauge height of the pump (mca)

Hm_{max}= Maximum gauge height of the pump (mca)

$H_{atmosféric}$= Atmosferic height (10,33 mca)

Nc = Maximum number of starts of the pump per hour. We're adopting 4 cycles per hour (dimensionless value).

$$\forall_{calderín} = 15 \cdot 1{,}25 \cdot \frac{4{,}266 \cdot 60}{4} \cdot \frac{(28{,}4 + 10{,}33)}{(28{,}4 - 5{,}96)} = 966{,}159\ litros$$

4.6.10. Characteristics of the pressure group.

Number of pumps: 3

Flow of the pump: 2,133 l/s

Start height gauge of the pump: 10,96 mca.

Stop height gauge of the pump: 23,4 mca.

Minimum volume of the hydraulic condenser in aspiration: 4000 litros.

Minimum volume of the hydraulic condenser in impulsion:1000 litros.

5. Sizing of the hot water main

5.1. Calculation of the instantaneous flow of distribution at a temperature of 50 ° C of each supply.

Floor	Location	Sanitary units	Number of units N	Flow Q (l/s)	Instantaneous minimum flow Qi (l/s)	Total instantaneous minimum flow Qi (l/s)
Underground	Changing room for men	Shower	1	0,1	0,165	0,33
		Toilet with fluxor	1	0		
		Washbasin		0,065		
	Changing room for women	Shower	1	0,1	0,165	
		Toilet with fluxor	1	0		
		Washbasin		0,065		
Groundfloor	Toilet 1	Toilet with fluxor	1	0	0,065	0,195
		Washbasin	1	0,065		
	Toilet 2	Toilet with fluxor	1	0	0,065	
		Washbasin	1	0,065		
	Toilet 3	Toilet with fluxor	1	0	0,065	
		Washbasin	1	0,065		
1º floor	Toilet 4	Toilet with fluxor	1	0	0,065	0,13
		Washbasin	1	0,065		
	Toilet 5	Toilet with fluxor	1	0	0,065	
		Washbasin	1	0,065		

2º floor	Toilet 6	Toilet with fluxor	1	0	0,065	0,13
		Washbasin	1	0,065		
	Toilet 7	Toilet with fluxor	1	0	0,065	
		Washbasin	1	0,065		
3º floor	Toilet 8	Toilet with fluxor	1	0	0,065	0,13
		Washbasin	1	0,065		
	Toilet 9	Toilet with fluxor	1	0	0,065	
		Washbasin	1	0,065		
Caudal total to supply to the building						0,915

5.2. ***Calculation of the simultaneous flow of each floor at a distribution temperature of 50 ° C.***

The calculated flow takes into account the fact that not all equipment installed in a building does not work at the same time, so it must be reduced depending on the number of installed units (n) and the use of the building by a correcting coefficient (a). Like it is a building for a school, the correcting coefficient α = 4.

$$Ks = \frac{1}{\sqrt{N-1}} + \alpha \cdot [0{,}035 + 0{,}035 \cdot \log(\log N)]$$

Floor	Coefficient α	Number of units per supply type N	Simultaneity coefficient of each unit Ks	Instantaneous flow (l/s)	Simultaneous flow $Cd_{simultáneo}=Ks \cdot Cd$ (l/s)
Underground	4	4	0,686	0,33	0,22654495
Groundfloor	4	3	0,802	0,195	0,15641239
1º floor	4	2	1	0,13	0,13
2º floor	4	2	1	0,13	0,13
3º floor	4	2	1	0,13	0,13

5.3.Obtaining the flow of calculation based on the simultaneity of supply

5.3.1. Obtaining the number of equivalent supplies.

Like in a building we can have different kinds of supplies, we need to reduce all the supplies to a single kind of equivalent supply.

The number of supplies of a single kind is obtained dividing total instant flow of all kind of supplies, powered by the section of pipe to study, by the maximum instantaneous flow corresponding to a supply type.

Kind of supply	Instantaneous flow Qi (l/s)	Total flow Qt (l/s)	Number of equivalent supplies nv
Underground	0,33	0,915	$\frac{Q_t}{Q_i(1)} = \frac{0{,}915\,l/s}{0{,}33\,l/s} = 2{,}77 \Rightarrow 3$
Ground floor	0,195		$\frac{Q_t}{Q_i(2)} = \frac{0{,}915\,l/s}{0{,}195\,l/s} = 4{,}69 \Rightarrow 5$
1º floor	0,13		$\frac{Q_t}{Q_i(3)} = \frac{0{,}915 l/s}{0{,}13 l/s} = 7{,}03 \Rightarrow 8$
2º floor	0,13		$\frac{Q_t}{Q_i(3)} = \frac{0{,}915 l/s}{0{,}13 l/s} = 7{,}03 \Rightarrow 8$
3º floor	0,13		$\frac{Q_t}{Q_i(3)} = \frac{0{,}915 l/s}{0{,}13 l/s} = 7{,}03 \Rightarrow 8$

5.3.2. Obtaining of the coefficient of simultaneity of the supplies.

The calculated flow takes into account the fact that all the units that are installed in all supplies do not work at the same time that’s why it should be reduced based on the number of equivalent supplies of a certain type.

The flow that circulates through a particular stretch will be reduced by the coefficient of simultaneity obtained depending on the supplies of the same kind that are fueled by the flow that circulates through this stretch.

The coefficient of simultaneity of the supplies corresponds to:

$$Kn = \frac{19 + nv}{10 \cdot (nv + 1)}$$

Kind	Coefficient of simultaneity of the supply	Coefficient of simultaneity per unit Ks
Underground	3	0,55
Ground floor	5	0,4
1º floor	8	0,3
2º floor	8	0,3
3º floor	8	0,3

5.3.3. Calculation of the total simultaneous flow.

The total simultaneous flow is derived from the number of equivalent supplies of a given type. We have to take into account the simultaneity of the units that make up that supply type, the simultaneity corresponding to the number of equivalent supplies and the instantaneous flow of this kind of supply.

$$Cd_{simultáneo\ total} = nv \cdot Kn \cdot Ks \cdot Cd_{instantáneo}$$

Kind	Number of equivalent supplies nv	Number of units per supply type N	Coefficient of simultaneity per		Instantaneous flow per supply type Qi (l/s)	Simultaneous flow Qs (l/s)
			Number of units Ks	Number of supplies Kn		
Underground	3	4	0,686	0,55	0,33	0,3735
Ground floor	5	3	0,802	0,4	0,195	0,3127
1º floor	8	2	1	0,3	0,13	0,3120
2º floor	8	2	1	0,3	0,13	0,3120
3º floor	8	2	1	0,3	0,13	0,3120

The total simultaneous flow will be Cdst = 0.3735 l/s

5.3.4. Obtención de los diámetros de las tuberías de ACS.

5.3.4.1. *Diameter of the main dealer pipe.*

From the simultaneous flow of the section of the main dealer and by prefixing a recommended speed of 1 m/s, the diameter of the calculation is:

$$D = \sqrt{\frac{4 \cdot Q}{\pi \cdot c}} = \sqrt{\frac{4 \cdot 0{,}3735 \cdot 10^{-3}}{\pi \cdot 1}} = 0{,}0218m = 21{,}8\, mm$$

The main dealer pipe will be in polyethylene with the following commercial diameters:

Tuberías de polietileno PE-X S4 UNE EN ISO 15875-2		
Diámetro nominal DN	Espesor e(mm)	Diámetro interior
12	1,4	9,2
16	1,8	12,4
20	2,3	15,4
25	2,8	19,4
32	3,6	24,8
40	4,5	31
50	5,6	38,8
63	7,1	48,8
75	8,4	58,2
90	10,1	69,8
110	12,3	85,4
125	14	97
140	15,7	108,6
160	17,9	124,2

The ideal diameter is the most approximate to the one obtained by calculation, provided that the movement of the fluid speed is within the range 0.6 ≤ c ≤ 1.5 m/s.

For D = 24,80 mm

$$c = \frac{4 \cdot Q}{\pi \cdot D^2} = \frac{4 \cdot 0{,}3735 \cdot 10^{-3}}{\pi \cdot (24{,}80 \cdot 10^{-3})^2} = 0{,}773\ m/s$$

The speed is within the recommended range, we can take D= 24,80 mm, DN-32.

5.3.4.2.Diameter of the ascending pipes.

5.3.4.2.1. Ascending pipe to the underground.

The simultaneous flow of the ascending pipe to the underground is the same as the main dealer pipe, so the diameter of the ascending pipe to the underground will be DN-32, D = 24, 80 mm.

5.3.4.2.2. Ascending pipe to the ground floor.

The ascending pipe to the ground floor has a simultaneous flow of 0,3127 l/s.

The diameter of the ascending pipe to the ground floor is:

$$D = \sqrt{\frac{4 \cdot Q}{\pi \cdot c}} = \sqrt{\frac{4 \cdot 0{,}3127 \cdot 10^{-3}}{\pi \cdot 1}} = 0{,}019953\ m = 19{,}953\ mm$$

The ascending pipe is in polyethylene and the commercial diameters are the followings:

Polyethylene pipes PE-X S4 UNE EN ISO 15875-2		
Nominal diameter DN	Thickness e(mm)	Inside diameter
12	1,4	9,2
16	1,8	12,4
20	2,3	15,4
25	2,8	19,4
32	3,6	24,8
40	4,5	31
50	5,6	38,8
63	7,1	48,8
75	8,4	58,2
90	10,1	69,8
110	12,3	85,4
125	14	97
140	15,7	108,6
160	17,9	124,2

The ideal diameter is the most approximate to the one obtained by calculation, provided that the movement of the fluid speed is within the range $0.6 \leq c \leq 1.5$ m/s

For D = 58,20 mm

$$c = \frac{4 \cdot Q}{\pi \cdot D^2} = \frac{4 \cdot 0{,}3127 \cdot 10^{-3}}{\pi \cdot (19{,}4 \cdot 10^{-3})^2} = 1{,}0578 m/s$$

The speed is within the recommended range, we can take D = 19, 4 mm, DN-25.

Diameter of the ascending pipe to the ground floor: DN-25 (D=19,4 mm)

5.3.4.2.3. Ascending pipes to the 1º, 2º and 3º floor.

The ascending pipes to the 1st, 2nd and 3rd floor have the same instantaneous flow, therefore the same flow simultaneously, therefore the same diameter.

The ascending pipes to the 1st, 2nd and 3rd floor have a simultaneous flow of 0,312 l/s.

The diameter of the ascending pipes to the 1st, 2nd and 3rd floor is:

$$D = \sqrt{\frac{4 \cdot Q}{\pi \cdot c}} = \sqrt{\frac{4 \cdot 0{,}312 \cdot 10^{-3}}{\pi \cdot 1}} = 0{,}019931\, m = 19{,}931\, mm$$

The ascending pipe is in polyethylene and the commercial diameters are the followings:

Polyethylene pipes PE-X S4 UNE EN ISO 15875-2		
Nominal diameter DN	Thickness e(mm)	Inside diameter
12	1,4	9,2
16	1,8	12,4
20	2,3	15,4
25	2,8	19,4
32	3,6	24,8
40	4,5	31
50	5,6	38,8
63	7,1	48,8
75	8,4	58,2
90	10,1	69,8
110	12,3	85,4
125	14	97
140	15,7	108,6
160	17,9	124,2

The ideal diameter is the most approximate to the one obtained by calculation, provided that the movement of the fluid speed is within the range 0.6 ≤ c ≤ 1.5 m/s.

For D = 19,4 mm

$$c = \frac{4 \cdot Q}{\pi \cdot D^2} = \frac{4 \cdot 0{,}312 \cdot 10^{-3}}{\pi \cdot (19{,}4 \cdot 10^{-3})^2} = 1{,}0578 m/s$$

The speed is within the recommended range, we can take D = 19, 4 mm, DN-25.

The diameter of the ascending pipes to the 1st,2nd and 3rd floor is: DN-25 (D=19,4 mm)

5.4. *__Diameter of the derivation of the supply.__*

The diameter of the derivation of supply shall be the same diameter as the corresponding ascending pipe because we are maintaining the same speed and material criteria.

The minimum diameter established for particular derivation is 20 mm. for inside diameter for polyethylene. Our minimum value obtained is 19.4, therefore the choice made is not valid for the ascending pipes of ground floor, 1st, 2nd and 3rd floor and we will have to increase the diameter at the top, that is DN-32 (D = 24, 8 mm). The speed for this diameter is 0,645 m/s, so it is within the range of speeds.

5.5. *__Minimum diameters of derivation to units.__*

The branches of link to the units will be sized respecting the table 4.2. of the CTE, obtaining the following results:

Unit	Diameter of the pipe
Washbasin	12 mm.
Shower	12 mm.

5.6. Sizing of return mains.

The flows of circulation in the return main and the minimums diameters to install must accomplish the following conditions:

- The maximum temperature loss between the output of the hot water production team and the point of farthest consumption is 3 °C.
- In each column of return the minimum flow provided for the sizing is 250 l.
- The flow of return could be estimated in 10% of the flow of impulsion for the sizing.
- The minimum return pipe diameter is 16 mm.

Floor	Recirculated flow (l/s)
Underground	0,03735
Ground floor	0,03127
1º floor	0,03120
2º floor	0,03120
3º floor	0,03120

According to the tables, the diameter of the pipe of return must be for polyethylene DN-16 (D = 11, 6 mm)

5.7. Hot water production equipment.

5.7.1. Calculation of accumulator tank of hot water.

Te = inlet temperature of the water in the installation of 15 ºC.

Ts = Temperature of distribution (at the exit of the accumulator) is set by 50 ° C.

Tp = Temperature of preparation for the prevention of Legionella is set to 60 ° C

C = Daily consumption of hot water at the temperature of use. Set according to the consumption of the installation.

The staffing of hot water in schools corresponds to 30 liters/person · day.

$$C = 30 \cdot 80 = 2400\ liters$$

Cp = Average hourly consumption tip.

Indicatively, it can be deemed as a fraction of the daily maximum consumption. In schools, this fraction corresponds to 1/5. Divided it by 3600 to get the volume in liters.

$$Cp = \frac{2400}{5 \cdot 3600} = 0{,}1333\ liters$$

hp = hours of preparation. Set out a time of 3 hours equivalent to 10 800 seconds

n = total hours of consumption in a day in schools is 10 hours, equivalent to 36 000 seconds.

Σhc = total hours of consumption tip. At a school it is 2 hours equivalent to 7 200 seconds.

hc = Duración máxima del consumo punta. El consumo en colegios es de 0,3.

$$hc_{schools} = 0{,}3 \cdot 2 = 0{,}6\ hours = \ 2160\ seconds.$$

5.7.1.1.Volume of accumulation (liters):

$$V = 1{,}15 \cdot \frac{hp \cdot hc}{hp + hc}(Ts - Te) \cdot \frac{Cp - \frac{C - C \cdot \sum hc}{n - \sum hc}}{Tp - 0{,}4 \cdot Td - 0{,}6 \cdot Te}$$

$$V = \frac{1{,}15 \cdot 10800 \cdot 2160}{10800 + 2160} \cdot (50 - 15) \cdot \frac{0{,}1333 - \frac{2400 - 0{,}1333 \cdot 10800}{36000 - 10800}}{60 - 0{,}4 \cdot 50 - 0{,}6 \cdot 15} = 624{,}316\ litros$$

5.7.1.2.Heating power (kW).

$$Nu = 4{,}1868 \cdot \frac{Td - Te}{hp + hc} \cdot \left[hc \cdot Cp + \left(C - C \sum hc\right) \cdot \frac{hp}{n - \sum hc}\right] \cdot 1{,}30$$

$$Nu = \frac{4{,}1868 \cdot (50 - 15) \cdot 1{,}3}{10800 + 2160} \cdot \left[2160 \cdot 0{,}1333 + (2400 - 0{,}1333 \cdot 10800) \cdot \frac{10800}{36000 - 10800}\right] = 10{,}2821\ kW$$

5.7.2. Calculation of the heating exchanger.

Temperature ºC	Copper	Primary circuit	Secondary circuit
Entrance	60	Tc = 87	Tf'= 15
Exit	90	Tc' = 63	Tf= 65

The flow required on the secondary circuit is 0,3735 l/s.

Te coefficient of transfer of the heating exchanger is: K= 4500 W/m^2ºC

The volumetric efficiency of the heating exchanger is: $\eta v = 0{,}95$

The thermal efficiency of the heating exchanger is: $\eta m = 0{,}85$

Fouling factor: $F_{\text{fouling factor}}$= 0,85

We can admit that the heat generated by the hot fluid per time unit is fully absorbed by the cold fluid:

$$Q = m_c \cdot ce_c \cdot (T_c - T_{c'}) = m_f \cdot ce_f \cdot (T_f - T_{f'})$$

Where:

Q = Amount of heating energy (joules)

mc = Mass of hot fluid that circulates at medium temperature (Tc+Tc')/2, (kg).

Ce_c= Specific heat of the hot fluid that circulates at medium temperature (Tc+Tc')/2, (Joules/kg·ºC)

Tc= Hot fluid inlet temperature (ºC)

Tc'= Hot fluid outlet temperature (ºC)

mf= Mass of cold fluid circulating at medium temperature (Tf+Tf')/2, (kg)

ce_f= Specific heat of the hot fluid that circulates at medium temperature (Tf+Tf')/2, (Joules/kg·ºC)

Tf= Cold fluid outlet temperature (ºC)

Tf'= Cold fluid inlet temperature (ºC)

5.7.2.1.Obtaining of the flow of fluid in the primary circuit (hot)

Medium temperature of the hot circuit:

$$Tm_{hot\ circuit} = \frac{Tc + Tc'}{2} = \frac{87 + 63}{2} = 75ºC$$

Medium temperatura of the cold circuit:

$$Tm_{cold\ circuit} = \frac{Tf + Tf'}{2} = \frac{15 + 65}{2} = 40ºC$$

Applying the equation of conservation of energy, the amount of heat transferred from hot circuit (primary) is the amount of heat brought to the cold (secondary) circuit.

$$Cc = Cf \cdot \frac{\rho f \cdot ce_f \cdot (Tf - Tf')}{\rho c \cdot ce_c \cdot (Tc - Tc')}$$

$$Cc = \frac{0{,}3735 \cdot 992{,}21 \cdot 4178{,}4 \cdot (65 - 15)}{974{,}86 \cdot 4192{,}5 \cdot (87 - 63)} = 0{,}7893\ l/s$$

5.7.2.2.Useful power of the heat exchanger..

$$Nu = Cc \cdot \rho c \cdot ce_c \cdot (Tc - Tc')$$

$$Nu = 0{,}7893 \cdot 10^{-3} \cdot 974{,}86 \cdot 4192{,}5 \cdot (87 - 63) = 77422{,}76\ W$$

5.7.2.3.Power of the exchanger

$$N_T = \frac{Nu}{\eta v} = \frac{77422{,}76}{0{,}95} = 81497{,}645\ W$$

5.7.2.4.Minimum area of the heat exchanger.

The increase in medium temperature is:

ΔT = Tc – Tf = 22ºC

ΔT = Tc’ – Tf’ = 48ºC

$$S_{min} = \frac{Nu' \cdot \ln(\frac{\Delta T}{\Delta T'})}{K \cdot (\Delta T - \Delta T')} = \frac{77422{,}76 \cdot \ln(\frac{22}{48})}{4500 \cdot (22 - 48)} = 0{,}516\ m^2$$

5.7.2.5.Minimum area of the heat exchanger

$$S = \frac{S_{min}}{F_{factor\ ensuciamiento}} = \frac{0{,}516}{0{,}85} = 0{,}607\ m^2$$

5.7.3. Calculation of the heat generator.

Temperature (ºC)	Generator	Exchanger of primary circuit
Entrance	Te=60	Tc= 87
Exit	Ts=90	Tc'= 63

The flow required in the primary circuit is: $C_{c\ exchanger}$= 0,7893 l/s

Thermal efficiency of the heat exchanger: ηv = 0,95

Coefficient of inertia of the generator: i = 1,15

The efficiency of the generator is of: η= 0,90

5.7.3.1.Obtaining of the flow and power of the generator.

Medium temperature of the fluid in the generator:

$$Tm_{generator} = \frac{Te + Ts}{2} = \frac{60 + 90}{2} = 75ºC$$

The real flow which must be moved by the generator depends on the flow obtained for circulate in the exchanger increased by the efficiency of this one.

$$C_{c\ generator} = \frac{C_{c\ exchager}}{\eta v} = \frac{0{,}7893 \cdot 10^{-3}}{0{,}95} = 0{,}0008308\ m^3/s$$

Applying the equation of conservation of energy, the amount of heat transferred by the generator is the amount of heat provided to the circulating flow to increase its temperature from the Te to the Ts.

$$Nu = C_{c\ generator} \cdot \rho \cdot ce \cdot (Ts - Te)$$

$$Nu = 0{,}0008308 \cdot 974{,}86 \cdot 4192{,}5 \cdot (90 - 60) = 101872{,}056\ W$$

5.7.3.2.Obtaining of the nominal power of the generator.

$$N_T = \frac{i \cdot Nu}{\eta} = \frac{101872{,}056 \cdot 1{,}15}{0{,}90} = 130169{,}8495\ W = 130{,}169\ kW$$

VIVAQUA

Laboratoire

Chaussée de Waterloo 764 - 1180 Bruxelles

Tél. 02/629.49.11 - Fax 02/629.49.15

Rapport d'essai N° 12-3016

BELAC

Accréditation N° 076-TEST
NBN EN ISO 17025

QUALITE DE L'EAU DISTRIBUEE

Période : 01/04/2012 - 30/04/2012

Paramètres	Unités	Normes légales (*)	Réservoir d'Ixelles
Température	°C	25,0	10,6
Couleur	mg/l Pt/Co	20	<5
Odeur quantitative	Taux dil25	3	<3
Saveur quantitative	Taux dil25	3	<3
Turbidité	NTU	1	<0,2
pH (20 °C)	pH	6,5<pH<9,2	7,65
Conductivité (20 °C)	µScm-1	2100	694
Dureté totale	°fH	15,0<TH<67,5	38,6
Titre alcalimétrique complet	°fH	pas de norme	28,7
Calcium	mg/l	270	125
Magnésium	mg/l	50	17,8
Sodium	mg/l	200	13,3
Potassium	mg/l	pas de norme	1,6
Ammonium	mg/l	0,5	<0,05
Bicarbonate	mg/l	pas de norme	350,3
Sulfate	mg/l	250	69,2
Chlorure	mg/l	250	33,3
Nitrate	mg/l	50	23,9
Nitrite	mg/l	0,1	<0,03
Fluorure	µg/l	1500	109
Phosphore total	mg P2O5/l	5	<0,23
Bromate	µg/l	10	<0,5
Cyanures totaux	µg/l	50	<1,0
Bactéries coliformes	/100 ml	0	0
Escherichia coli	/100 ml	0	0
Entérocoques	/100 ml	0	0
Clostridium perfringens	/100 ml	0	0
Germes totaux à 22°C	/ml	pas de norme	1
Aluminium total	µg/l	200	2
Arsenic total	µg/l	10	<1,0
Bore total	µg/l	1000	19
Cadmium total	µg/l	5	<0,1
Chrome total	µg/l	50	0,6
Cuivre total	µg/l	1000	<1
Fer total	µg/l	200	<5,0
Mercure total	µg/l	1	<0,05
Manganèse total	µg/l	50	<1,0
Nickel total	µg/l	20	1
Plomb total	µg/l	25	<0,10

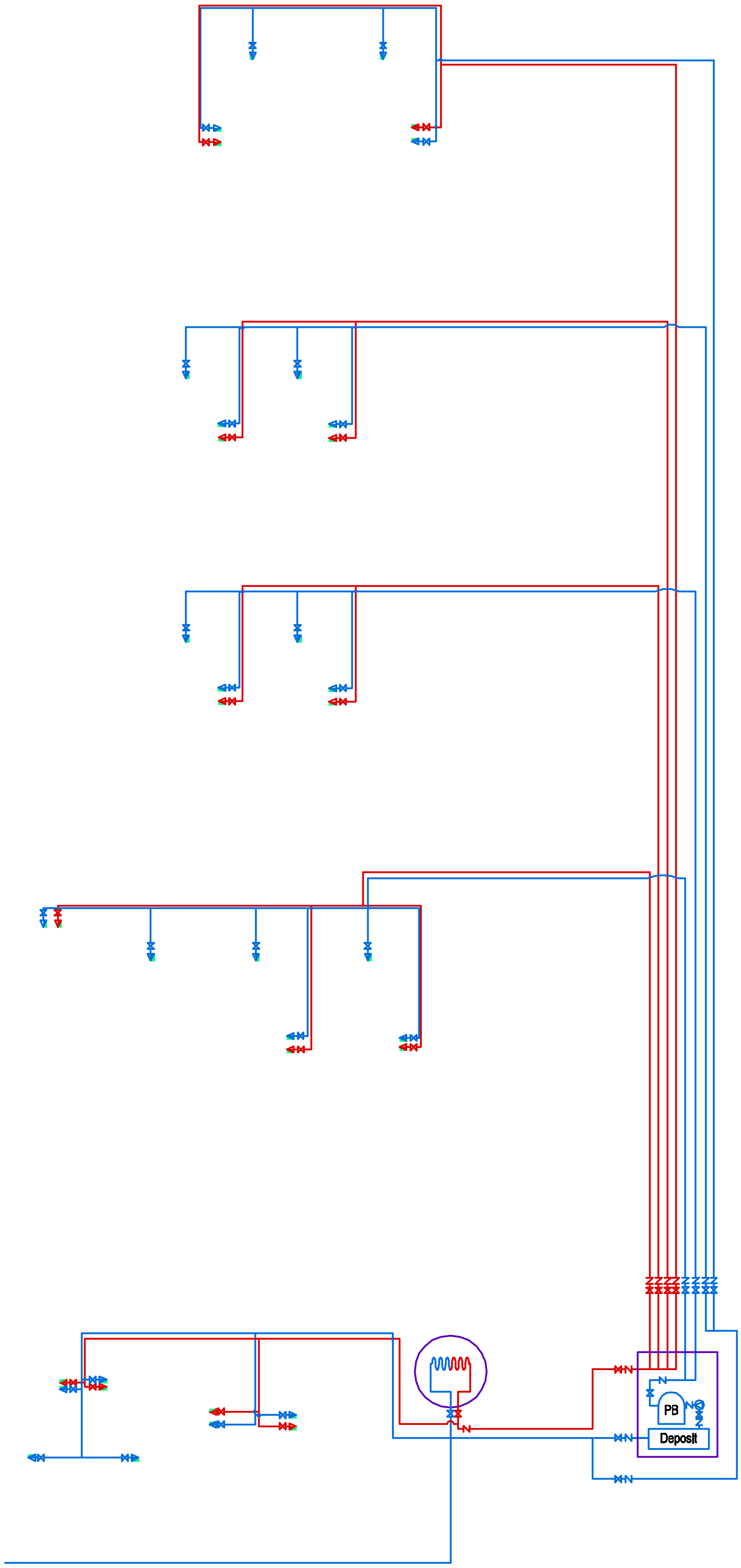
VIVAQUA
Laboratoire
Chaussée de Waterloo 764 - 1180 Bruxelles
Tél. 02/629.49.11 - Fax 02/629.49.15

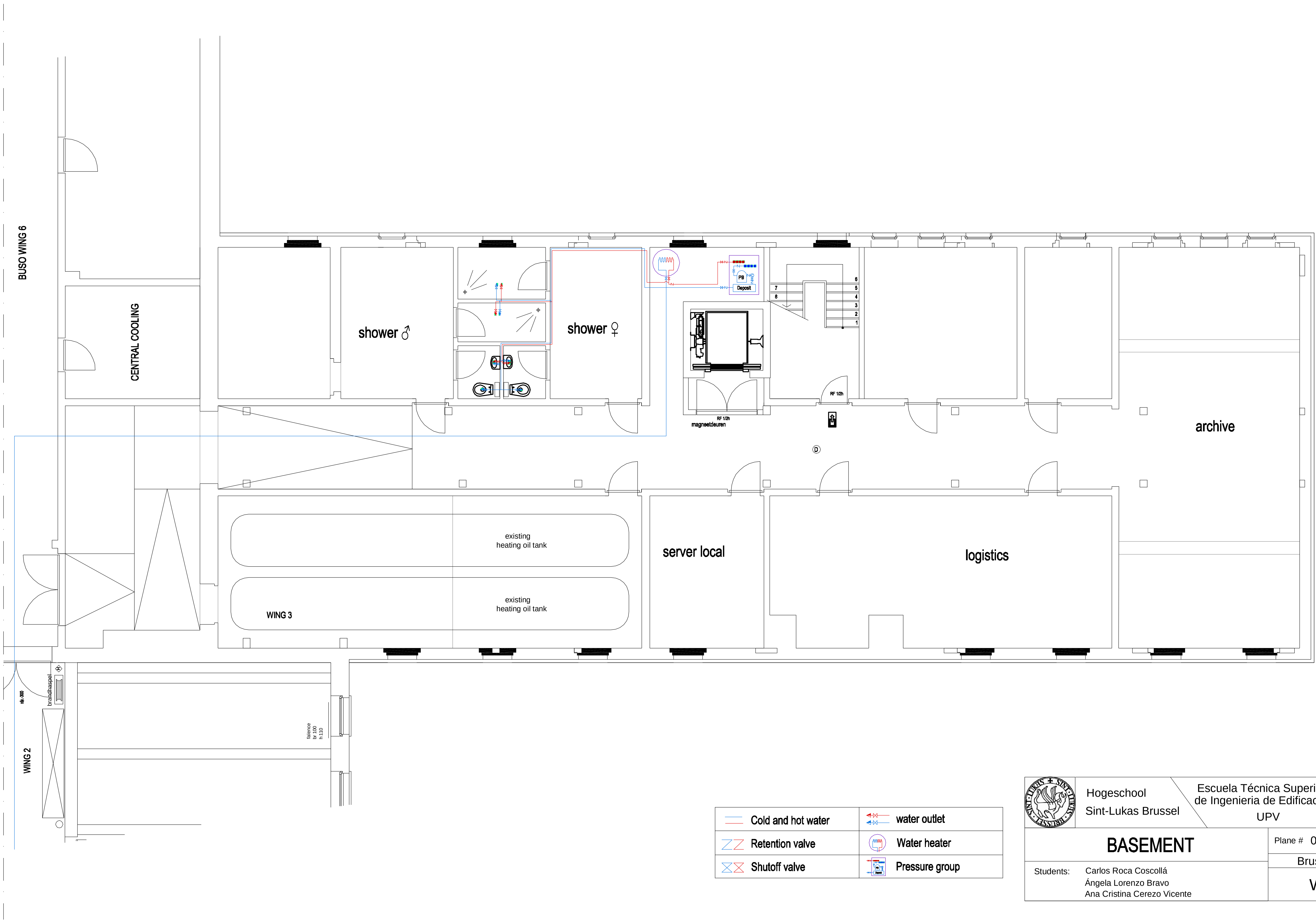
Rapport d'essai N° 12-3016

Accréditation N° 076-TEST
NBN EN ISO 17025

Paramètres	Unités	Normes légales (*)	Réservoir d'Ixelles
Antimoine total	µg/l	5	<0,10
Sélénium total	µg/l	10	<1,0
Zinc total	µg/l	5000	19
Benzène	µg/l	1,0	<0,10
Chlorure de vinyle	µg/l	0,5	<0,25
1,2-Dichloroéthane	µg/l	3,0	<0,10
Tétra- et trichloréthylène	µg/l	10	<0,10
Trihalogénométhanes totaux	µg/l	100	5,72
Benzo-3,4-pyrène	µg/l	0,010	<0,005
Hydrocarbures polycycliques aromatiques	µg/l	0,10	<0,005
Pesticides totaux	µg/l	0,50	0,109
Carbone organique total (NPOC)	mg/l	pas de norme	0,53

(*) Arrêté du Gouvernement de la Région de Bruxelles-Capitale du 24 janvier 2002 relatif à la qualité de l'eau distribuée par réseau (dans le réseau de distribution)


PB
Deposit



Cold and hot water	water outlet
Retention valve	Water heater
Shutoff valve	Pressure group

Hogeschool
Sint-Lukas Brussel

Escuela Técnica Superior
de Ingenieria de Edificación
UPV

BASEMENT

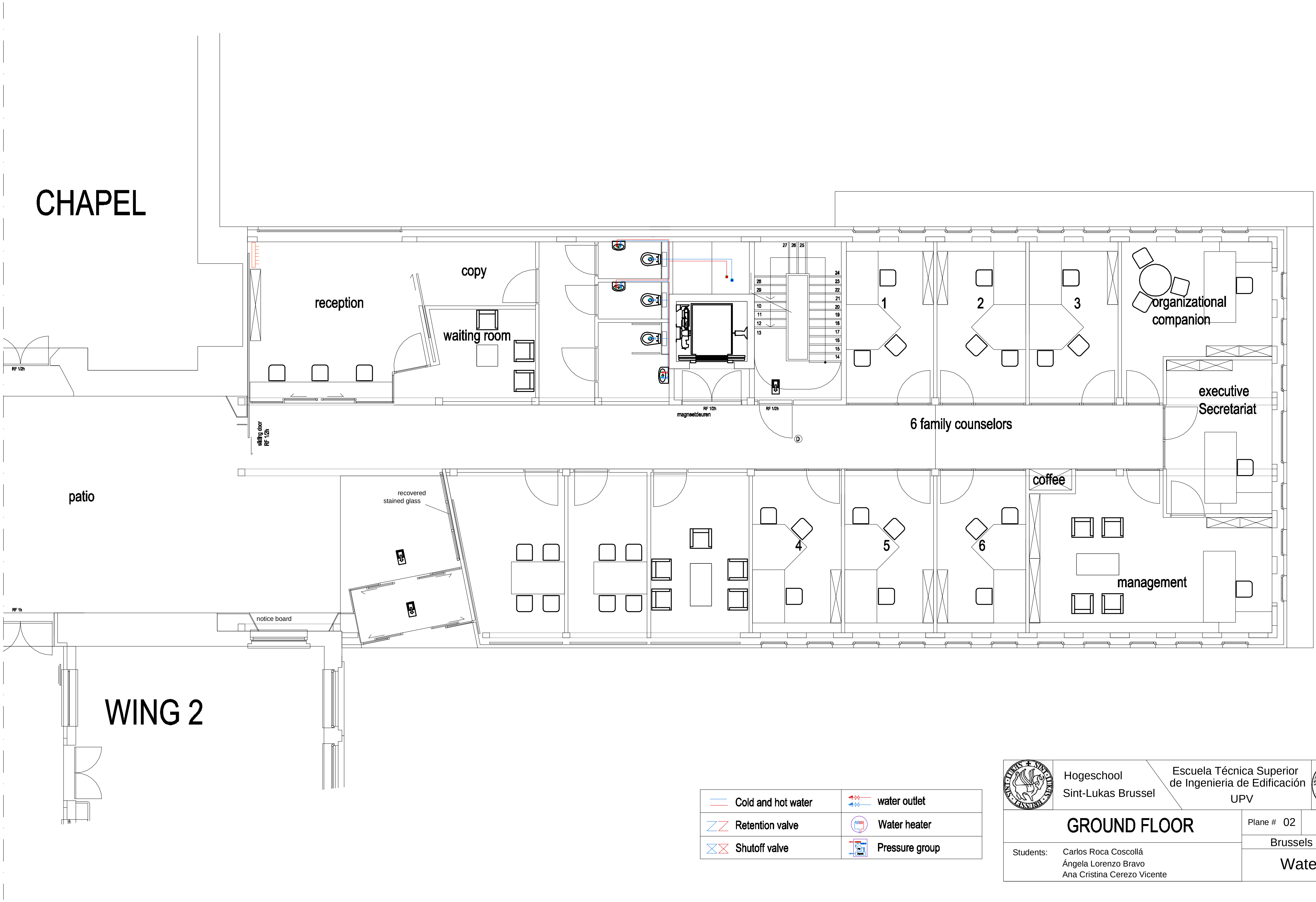
Plane # 01

Escale: 1:100

Brussels 2012

Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente

Water



Cold and hot water	water outlet
Retention valve	Water heater
Shutoff valve	Pressure group

Hogeschool Sint-Lukas Brussel

Escuela Técnica Superior de Ingenieria de Edificación UPV

GROUND FLOOR

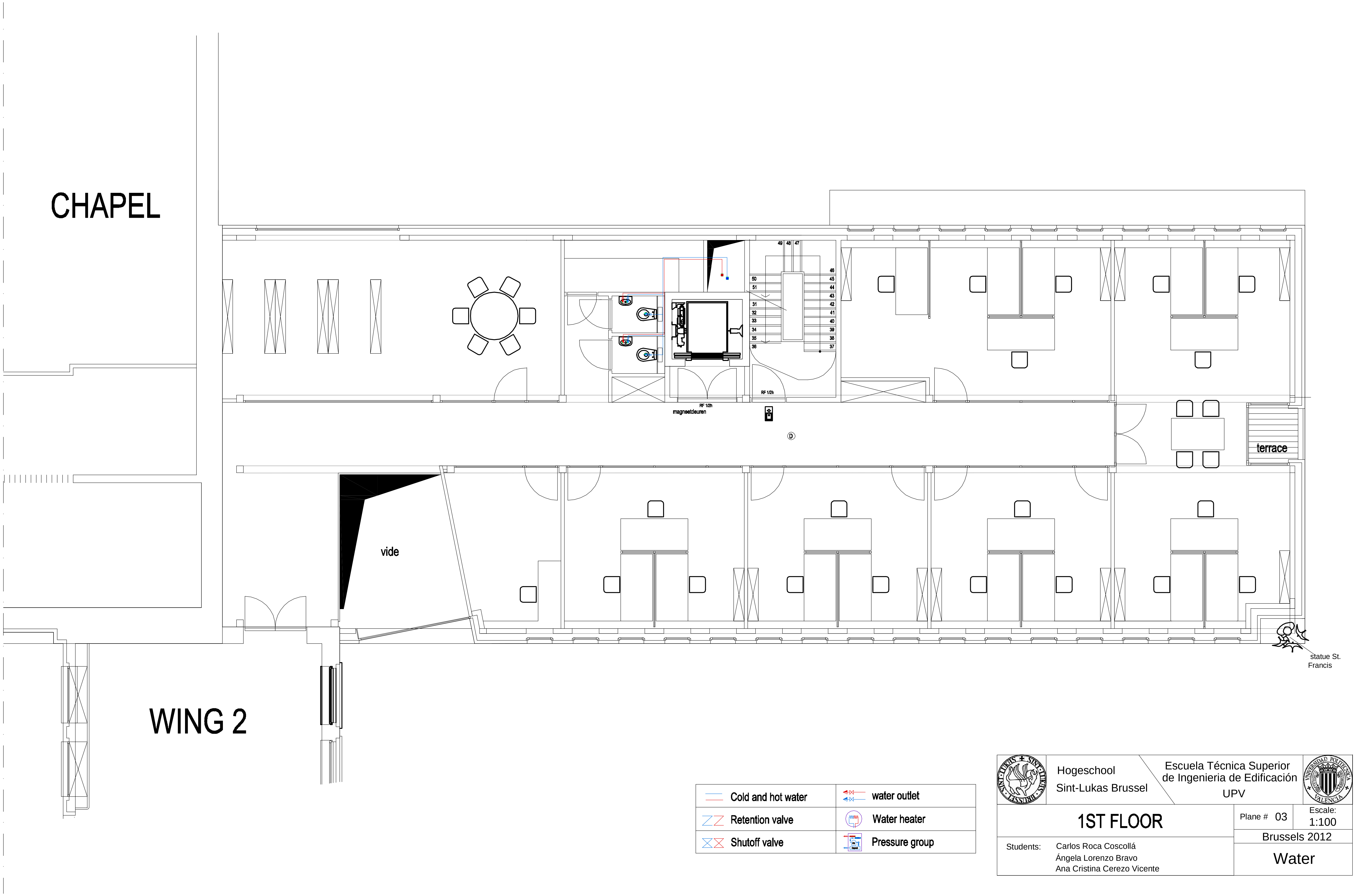
Plane # 02

Escale: 1:100

Brussels 2012

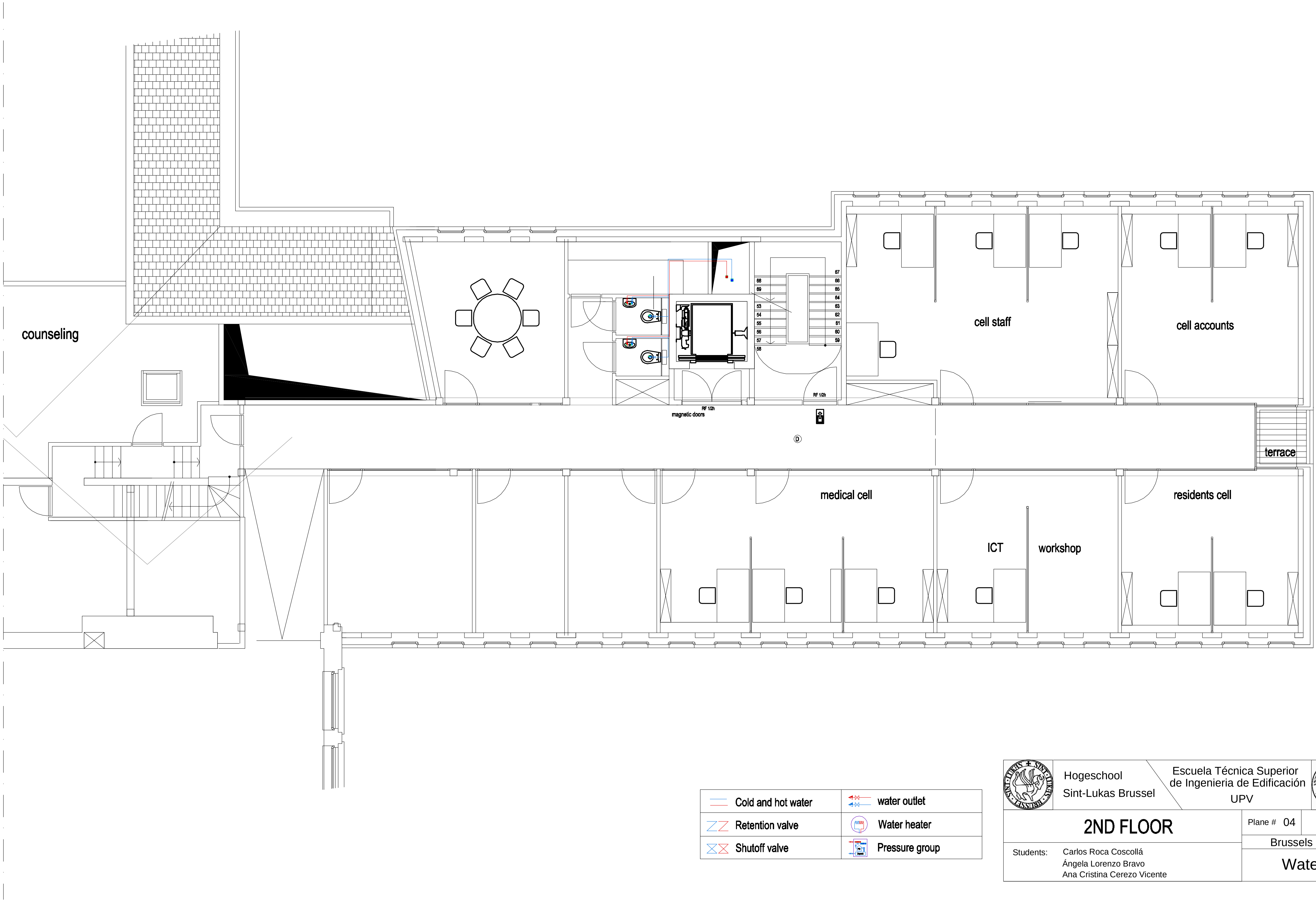
Water

Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente



Cold and hot water		water outlet	
Retention valve		Water heater	
Shutoff valve		Pressure group	

Hogeschool Sint-Lukas Brussel	Escuela Técnica Superior de Ingenieria de Edificación UPV		
1ST FLOOR		Plane # 03	Escale: 1:100
		Brussels 2012	
Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente		Water	



Hogeschool Sint-Lukas Brussel

Escuela Técnica Superior de Ingenieria de Edificación UPV

2ND FLOOR

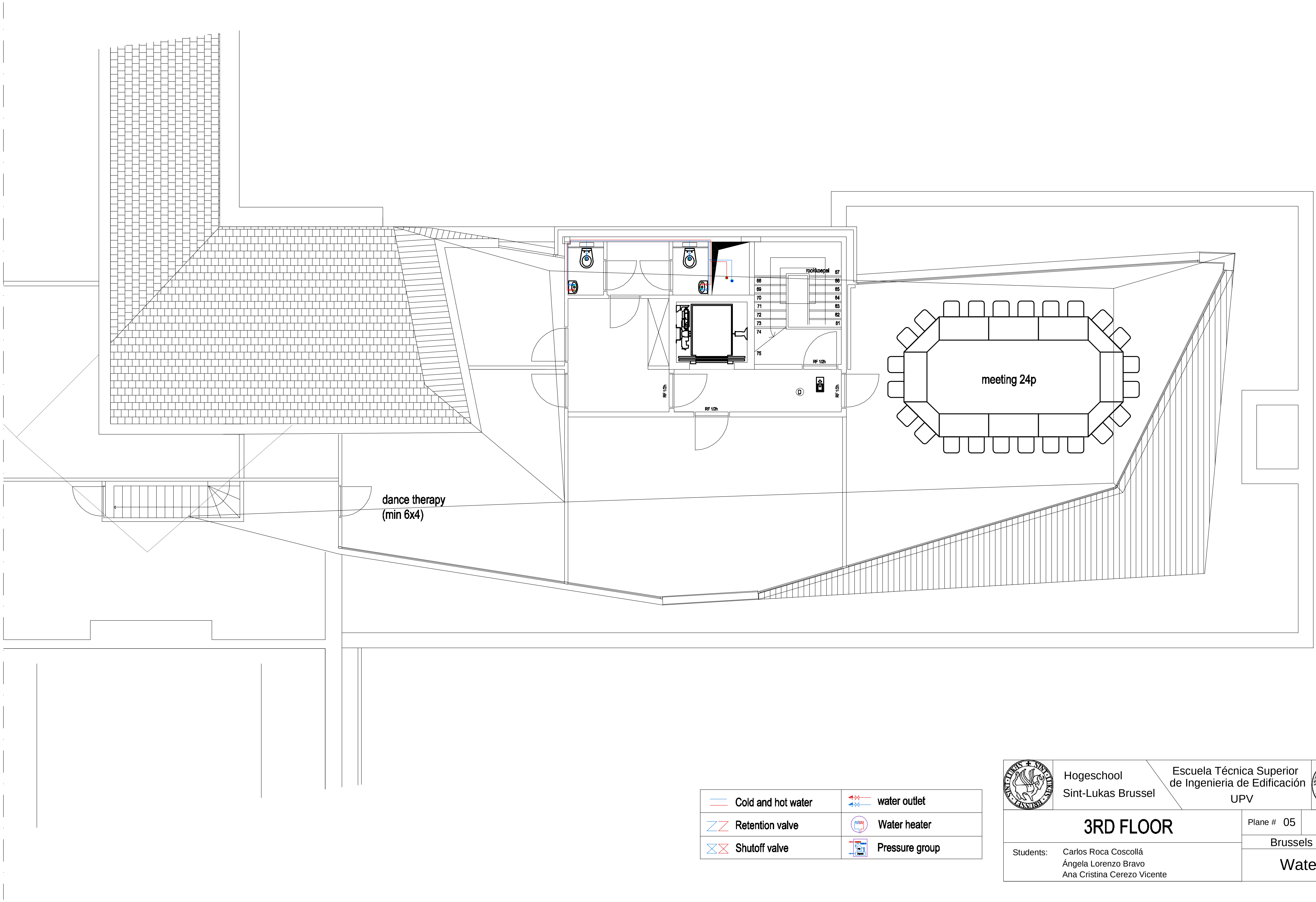
Plane # 04

Escale: 1:100

Brussels 2012

Water

Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente



Cold and hot water	water outlet
Retention valve	Water heater
Shutoff valve	Pressure group

Hogeschool Sint-Lukas Brussel	Escuela Técnica Superior de Ingenieria de Edificación UPV		
3RD FLOOR		Plane # 05	Escale: 1:100
		Brussels 2012	
Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente		Water	

Ventilation

VENTILATION.

Thermal installations will allow the maintaining of an acceptable indoor air quality, in the locals occupied by persons, eliminating contaminants that occur on a regular basis during the normal use of building, providing sufficient outdoor air flow and ensuring the removal and expulsion of stale air.

We should install a ventilation system for the provision of the sufficient flow of outside air to don't let the formation of high pollutant concentrations, in different locals in which any human activity are being carried out.

1. Categories of quality of the indoor air depending on the use of the buildings.

Depending on the use of the building or local, the category of indoor air quality (IDA) that has to be reached will be at least the following:

IDA 2 (good quality air): offices, residences (common rooms in hotels and similar, residences for the elderly and students), reading rooms, museums, court rooms, classrooms and swimming pools.

2. Minimum flow of the outdoor air ventilation.

We are using the "indirect method of flow of outdoor air per person". This method is used when people have a metabolic about 1.2 met activity, where the production of pollutants with different sources from human is low and when smoking is not allowed.

In the IDA 2 category, an outdoor flow of 12,5 dm^3/s per person is needed.

3. Filtration of the minimum air of ventilation.

The outdoor air of ventilation has to be filtrated before entering in the building.

The quality of the outdoor air (ODA) will be classified according to the following levels.

ODA1: pure air that may contain solid particles (pollen) on a temporary basis.

ODA2: air with high concentrations of particles.

ODA3: air with high concentrations of pollutant gaseous.

ODA4: air with high concentrations of pollutant gaseous and particles.

ODA5: air with very high concentrations of pollutant gaseous and particles.

In our case we have the ODA 1 level.

Filtering classes minimum to be used, depending on the quality of outside air (ODA) and the required indoor air quality (IDA), are indicated in the following table.

	IDA1	IDA2	IDA3	IDA4
ODA1	F9	F8	F7	F6
ODA2	F7/F9	F8	F7	F6
ODA3	F7/F9	F6/F8	F6/F7	G4/F6
ODA4	F7/F9	F6/F8	F6/F7	G4/F6
ODA5	F6/GF/F9	F6/GF/F9	F6/F7	G4/F6

The kind of filtration that we have to adopt is F8.

Pre-filters are used to keep clean the components of the ventilation and air handling units, as well as lengthen the life of final filters. Pre-filters are installed at the entrance of outside air to the treatment unit, as well as to the return air entrance.

Final filters will be installed after the treatment section and, when served locals are particularly sensitive to the dirt, after the fan drive, and make sure that the distribution of air over the filters section is uniform.

In all the sections of filtration, except those located in outdoor air entance, we should ensure the operation in dry conditions; the relative humidity of the air will always be less than 90%.

Heat recovery devices must always be protected with a section of filter of class F6 or more high.

4. Air of extraction

According to the building use, the extracted air is classified into different categories. In our case it corresponds to the following category:

AE1 (low level of pollution): air that comes from the locals in which the most important emissions of pollutants comes from materials of construction and decoration and people. The air that comes from locals where smoking is allowed are excluded. Included in this section: offices, classrooms, meeting rooms, local without specific emissions, spaces for public use, stairs and corridors.

The flow of the extraction air in locals of service will be at least 2 dm^3/s per m^2 of area of plant.

The air from category AE1, free from tobacco smoke, can be taken up to the locals.

5. Control of the quality of indoor air.

Indoor air quality will be controlled by the method IDA-C1, generally used wher the system is continuously working.

6. Conclusions.

In our building we are going to install an air conditioning system (hot and cold), so it will be a continued air renewal, accomplishing with the minimum air flows.

The filters will be installed in the heating pump that is going to take the air from outside of the building, and introduce it inside of the building.

Air conditioning

AIR CONDITIONING.

1. Thermal balance.

1.1.Characteristics of the building elements.

ELEMENT	COMPOSITION
Façade wall	
M-1 e = 36 cm.	Sheet of ½ feet of double hollow brick. e=115 mm. Plastering cement mortar 15 mm. Non-ventilated chamber 25 mm. Thermal insulation of polystyrene de 100 mm. Sheet of double hollow brick 70 mm. Gypsum plaster 15 mm.
M-2 e = 36 cm.	Sheet of ½ feet of double hollow brick. e=115 mm. Plastering cement mortar 15 mm. Non-ventilated camera 25 mm. Thermal insulation of polystyrene de 100 mm. Sheet of double hollow brick 70 mm. Cement mortar 15 mm. Ceramic tile 15 mm.
M3 e = 30 cm	Basement wall in reinforced concrete HA-25/B/20/IIa e = 300 mm.
Structural elements	
F1	Foundation in reinforced concrete HA-25/B/20/IIa e = 300 mm.
C1	Slate roof 10 mm. Wood board of 25 mm. Thermal insulation 200 mm expanded polystyrene EPS. Steel beams and air chamber 200 mm. Plaster ceiling 20 mm.
Windows	
PVC carpentry 3 cameras 6 cm wide. Climalit glazed double leaf, 4 mm, 6 mm camera and sheet 9 mm. The outside dimensions are:	
Hv1	L= 0,7 m y H= 0,4 m
Hv2	L= 0,7 m y H = 2,52 m
Hv3	L= 4,03 m y H = 2,52 m
Hv4	L= 1,44 m y H = 2,52 m
Hv5	L= 0,7 m y H = 2,33 m
Hv6	L= 4,03 m y H = 1,6 m
Hv7	L= 0,7 m y H = 1,6 m
Hv8	L= 3,27 m y H = 1,6 m
Out doors in aluminium	
Hp4	Anodized aluminum joinery with thermal break. Climalit double glazing sheet 4-6-6 mm. W= 3,20 m and H= 7,03 m
Hp5	Anodized aluminum joinery with thermal break. Climalit double glazing sheet 4-6-6 mm. W= 1,64 m and H= 2,28 m

Hp6	Anodized aluminum joinery with thermal break. Climalit double glazing sheet 4-6-6 mm. W= 1,16 m y H= 2,28 m
Hp7	Anodized aluminum joinery with thermal break. Climalit double glazing sheet 4-6-6 mm. W= 1,16 m y H= 1,55 m
Hp8	Anodized aluminum joinery with thermal break. Climalit double glazing sheet 4-6-6 mm.. W= 1,64 m y H= 1,55 m

*1.2.**Trasmittances coefficient of each element.***

To calculate the overall thermal conduction resistance (coefficient of thermal transmittance) per unit area of an enclosure composed of several layers, the following expression applies:

$$U = \frac{1}{\frac{1}{\alpha i} + \left(\sum_{i=1}^{n} \frac{ei}{\lambda i}\right)_{hoja\ interior} + \frac{1}{\alpha c} + \left(\sum_{i=1}^{n} \frac{ei}{\lambda i}\right)_{hoja\ exterior} + \frac{1}{\alpha e}}$$

Where:

U = Coefficient of transmittance through a flat wall composed ($W/m^2 \cdot K$)

αi= Internal convection coefficient ($W/m^2 \cdot K$)

αe= External convection coefficient ($W/m^2 \cdot K$)

αc= Convection coefficient of the air camera ($W/m^2 \cdot K$)

λi= Thermal conductivity coefficient of a material i (W/m·k)

e= Thickness (m)

$\frac{ei}{\lambda i}$ = Thermal resistance of the element ($m^2 \cdot K/W$)

The transmittance coefficient (U) total of the element will be obtained depending on the conductivity coefficients (λi) and internal convection coefficient (hi), external convection coefficient (I) and air camera coefficient (Rc) of non-ventilated enclosure.

1.2.1. Conductivity coefficients.

The coefficients of the elements used are listed in Attachment HE-1 and V1 correspond to the following materials:

Elemento	Conductividad térmica (λi) ($W/m \cdot k$)	Resistencia térmica ($m^2 \cdot k/W$)
Cement mortar d> 2000	1,80	
Gypsum plaster 1000<d<1300	0,57	
Plaster plate 750<d<900	0,25	
Hormigón armado d>2500	2,5	
Sheet of double hollow brick 60<e<90 mm	0,375	
Sheet of ½ feet of double hollow brick 80<G<100 mm	0,543	
Ceramic tile	1,30	
Terrazzo flooring	1,3	
Slate tile 2000<d<2800	2,2	
Dashboard wood compressed cork	0,1	
Expanded polystyrene	0,046	
Three cameras PVC carpentry	1,8	0,39
Galvanized steel door with thermal break, more than 12 mm	3,2	0,14
4 Mm glass U = 5.7 W/m2k and solar factor (g) = 0.88		
Glazing 4-6-6 U = 3 W/m2K and solar factor (g) = 0.76		

1.2.2. Internal convectioncoefficient (αi) external convection coefficient (αe) and air camera coefficient (αc).

The CTE shows the values of the thermal resistance of walls in contact with the outside which should be used for calculations and which correspond to the inverse value of the convection and it depends on the direction of the heating flow and of external situation or internal surfaces.

Thermal resistance of walls surface in contact with the outside. ($m^2 \cdot k/W$)		
Enclosure position and sense of the flow of heat	$1/\alpha e$ ó Rse	$1/\alpha ai$ ó Rsi
Vertical enclosure or sloping on the horizontal >60º and horizontal flow	0,04	0,13
Horizontal enclosures or slopping on the horizontal ≤60º and ascending flow	0,04	0,10
Horizontal enclosures and ascending flow	0,04	0,17

The CTE shows the values of thermal resistance to the passage of the heat of the air camera not ventilated continuous, whereas the air at rest. These values correspond to the value of the inverse of the convection in the camera and it depends on the situation of the air camera, of the direction of flow of heat and its thickness, to cameras formed by ordinary building materials.

Thermal resistance of non-ventilated air camera 1/αc ó Rc (m^2·k/W)		
Thickness (cm)	Horizontal	Vertical
1	0,15	0,15
2	0,16	0,17
5	0,16	0,18
10	0,18	0,19

1.2.3. <u>Coefficient of transmission of the constructive elements.</u>

1.2.3.1.M-1. Exterior façade with gypsum plaster

<table>
<tr><th rowspan="3">Element</th><th colspan="2">Thermal resistance</th><th rowspan="3">Thickness

e (mm)</th><th rowspan="3">Conductivity

λ (W/(m·K)</th><th rowspan="3">Coefficient of Transmission U (W/(m^2·k)</th></tr>
<tr><th>superficial</th><th>Camera</th></tr>
<tr><th>Rsi y Rse (m^2·k)/W</th><th>Rc (m^2·k)/ W</th></tr>
<tr><td>Outside</td><td>0,04</td><td></td><td></td><td></td><td rowspan="8">0,33329</td></tr>
<tr><td>Sheet of ½ feet of brick</td><td rowspan="6"></td><td rowspan="6">0,17</td><td>0,115</td><td>0,543</td></tr>
<tr><td>Cement mortar</td><td>0,015</td><td>1,8</td></tr>
<tr><td>Non ventilated camera</td><td></td><td></td></tr>
<tr><td>Expanded polystyrene EPS</td><td>0,10</td><td>0,046</td></tr>
<tr><td>Sheet of double hollow brick</td><td>0,09</td><td>0,375</td></tr>
<tr><td>Gypsum plaster</td><td>0,015</td><td>0,57</td></tr>
<tr><td>Inside</td><td>0,13</td><td></td><td></td><td></td></tr>
</table>

1.2.3.2.M-2 Exterior façade with ceramic tiles

Elemento	Resistencia térmica		Espesor	Conductividad	Coeficiente de transmisión
	superficial	Cámara			
	Rsi y Rse $(m^2 \cdot k)/W$	Rc $(m^2 \cdot k)/W$	e (mm)	λ (W/(m·K)	U $(W/(m^2 \cdot k)$
Outside	0,04				0,333
Sheet of ½ feet of brick		0,17	0,115	0,543	
Cement mortar			0,015	1,8	
Non ventilated camera					
Expanded polystyrene EPS			0,10	0,046	
Sheet of double hollow brick			0,09	0,375	
Cement mortar			0,015	1,8	
Ceramic tiles			0,015	1,3	
Inside	0,13				

1.2.3.3.M-3. Basement wall in reinforced concrete

Element	Thermal resistance		Thickness	Conductivity	Coefficient of Transmission U
	superficial	Camera			
	Rsi y Rse $(m^2 \cdot k)/W$	Rc $(m^2 \cdot k)/W$	e (mm)	λ (W/(m·K)	$(W/(m^2 \cdot k)$
Outside	0,04				0,247
Expanded polystyrene EPS			0,15	0,046	
Basement wall in concrete			0,3	2,5	
Inside	0,13				

1.2.3.4.Hv1, 2, 3, 4, 5, 6, 7, 8, and Hp 4, 5, 6, 7, 8

The transmittance of a hole or skylight depends on the semi-transparent part and the frame as following:

$$U_H = (1 - FM) \cdot U_{H,V} + FM \cdot U_{H,m}$$

$U_{H,V}$: Transmittance of the semi-transparent part (W/m^2·k).

$U_{H,m}$: Transmittance of the frame (W/m^2·k).

FM: Fraction of the hollow occupied by the framework.

All the Windows have the following features:

- PVC carpentry with thermal break and 6 cm in width.

  $U_{H,M}$ = 1,8 W/m^2·k

- Climalit type glazing double blade, 4 mm, 6 mm camera and 6 mm sheet.
  $U_{H,v}$= 3 W/m^2·k

Like the windows have different sizes the fraction occupied by the frame will be different in each case:

Window-Door	Transmittance		Dimension		Thickness of the frame	Fraction occupied by the frame FM	Transmission coefficient U ($W/m^2 \cdot k$)
	Semi-transparent U_H ($W/m^2 \cdot k$)	Opaque U_V ($W/m^2 \cdot k$)	Width L (mm)	Height H (m)	e (mm)		
Hv1	3	1,8	0,7	0,4	0,06	0,4457	2,4651
Hv2	3	1,8	0,7	2,52	0,06	0,2150	2,7420
Hv3	3	1,8	4,03	2,52	0,06	0,0767	2,9080
Hv4	3	1,8	1,44	2,52	0,06	0,1290	2,8452
Hv5	3	1,8	0,7	2,33	0,06	0,2185	2,7378
Hv6	3	1,8	4,03	1,6	0,06	0,1037	2,8756
Hv7	3	1,8	0,7	1,6	0,06	0,2400	2,7120
Hv8	3	1,8	3,27	1,6	0,06	0,1103	2,8676
Hp4	3	1,8	3,2	7,03	0,06	0,0542	2,9349
Hp5	3	1,8	1,64	2,28	0,06	0,1239	2,8513
Hp6	3	1,8	1,16	2,28	0,06	0,1534	2,8160
Hp7	3	1,8	1,16	1,55	0,06	0,1769	2,7878
Hp8	3	1,8	1,64	1,55	0,06	0,1478	2,8227

1.2.3.5.F1. Foundation of reinforced concrete.

Element	Thermal resistance		Thickness	Conductivity	Coefficient of Transmission U
	superficial	Camera			
	Rsi y Rse ($m^2 \cdot k$)/W	Rc ($m^2 \cdot k$)/W	e (mm)	λ (W/(m·K)	(W/($m^2 \cdot k$)
Outside	0,04				0,3533
Expanded polystyrene EPS			0,10	0,046	
Foundation of reinforced concrete			0,3	2,5	
Inside	0,17				

1.2.3.6.C-1. Slate roof

Element	Thermal resistance		Thickness	Conductivity	Coefficient of Transmission U
	superficial	Camera			
	Rsi y Rse $(m^2\cdot k)/W$	Rc $(m^2\cdot k)/W$	e (mm)	λ (W/(m·K)	$(W/(m^2\cdot k)$
Outside	0,04				0,18931
Slate tile			0,01	2,2	
Wood board			0,025	0,1	
Expanded polystyrene EPS			0,20	0,046	
Non ventilated camera		0,18			
Plaster ceiling			0,02	0,25	
Inside	0,1				

1.3.<u>Heating loss by transmission in each floor, depending on temperatures and constructive elements.</u>

1.3.1. <u>Calculation of the losses by transmission of each floor.</u>

Heating loss by transmission is determined by the equation:

$$Q_t = U \cdot S \cdot \Delta T \ (W)$$

Where:

Q_t= Heating loss by transmission (W)

U = Coefficient of transmittance $(W/(m^2\cdot k))$

S= Surface of the constructiv element (m^2)

ΔT = Ti – Te (K)

For losses of transmission of a particular site we should considered the coefficient of transmittance of each element that wraps it, with its surface and thermal jump for taking into account the direction of movement of the heat flow from higher to lower temperature. It is defined as what is known as heat losses when the sense of flow is removed from the enclosure and gain when it enters in the site. The sum of all gains and losses is what determines the thermal balance of the enclosure.

The following results have been obtained:

1.3.1.1.Underground.

Element	U	Surface (m^2)	nº windows	ΔT	Qt (W)
M3	0,247	53,8965		20	266,24871
HV1	2,4651	0,28	9	20	124,24104
M3	0,247	20,9979		20	103,729626
M3	0,247	49,5747		20	244,899018
F1	0,3533	328,466		20	2320,94076
Total					**3060,05915**

1.3.1.2.Ground floor.

Element	U	Surface (m^2)	nº windows	ΔT	Qt (W)
M1	0,333	55,8716	-	20	372,104856
HV3	2,908	10,1556	1	20	590,649696
HV2	2,742	1,764	26	20	2515,18176
HV4	2,845	3,6288	1	20	206,47872
M1	0,333	44,08	-	20	293,5728
M1	0,333	89,28	-	20	594,6048
M1	0,333	2,6	-	20	17,316
Total					**4589,90863**

1.3.1.3. 1st floor

Element	U	Surface (m^2)	nº windows	ΔT	Qt (W)
M1	0,333	67,7625		20	451,29825
HV6	2,8756	6,448	1	20	370,837376
HV5	2,7378	1,631	26	20	2321,98294
M1	0,333	17,71		20	117,9486
M1	0,333	15,0535		20	100,25631
M1	0,333	4,851		20	32,30766
M1	0,333	2,7335		20	18,20511
M1	0,333	83,0445		20	553,07637
M1	0,333	1,5015		20	9,99999
Hp5	2,8513	3,7392	1	20	213,231619
Hp6	2,816	2,6448	2	20	297,910272
M1	0,333	3,6424		20	24,258384
M1	0,333	2,5748		20	17,148168
Total					**3975,9126**

1.3.1.4. 2^{nd} floor

Element	**U**	**Surface (m^2)**	**nº windows**	**ΔT**	**Qt (W)**
M1	0,333	36,936		20	245,99376
M1	0,333	2,6144		20	17,411904
M1	0,333	38,7296		20	257,939136
M1	0,333	17,024		20	113,37984
M1	0,333	14,0448		20	93,538368
M1	0,333	44,968		20	299,48688
HV7	2,712	1,12	33	20	2004,7104
Hp7	2,7878	1,798	2	20	200,498576
Hp8	2,8227	2,542	1	20	143,506068
M1	0,333	3,4568		20	23,022288
M1	0,333	2,4436		20	16,274376
Total					**3415,7616**

1.3.1.5.3^{rd} floor

Element	**U**	**Surface (m^2)**	**nº windows**	**ΔT**	**Qt (W)**
M1	0,333	19,712		20	131,28192
C1	0,18931	263,244		20	996,694433
Total					1127,97635

1.3.2. Losses of heat by infiltration

The value of the losses of heat by infiltrations of air is determined by the equation:

$$Qi = V \cdot ce \cdot \rho \cdot \Psi \cdot \Delta T$$

Where:

Qi= Amount of heat losse by air infiltration (W)

V= Volum (m^3)

ce = Specific heat capacity of air (value taken for calculations 10^3 J/kg·K)

ρ = Density of the air (Value taken for calculation 1,2 kg/m^3)

Ψ = Number of air renewal: 0,5 per hour ($1{,}3889 \cdot 10^{-4}$ per second) in general use and 1 per hour ($2{,}7778 \cdot 10^{-4}$ per second) in dining rooms and toilets.

ΔT = (Ti – Te) = Thermal jump (K)

1.3.2.1.Underground

Surface (m^2)	Height (m)	Volume (m^3)	ce	ρ	Ψ	ΔT	Qi (W)
328,466	1,89	620,80074	1000	1,2	0,00027778	20	4138,70471

1.3.2.2.Ground floor

Surface (m^2)	Height (m)	Volume (m^3)	ce	ρ	Ψ	ΔT	Qi (W)
321,09	4	1284,36	1000	1,2	0,00027778	20	8562,4685

1.3.2.3.1st floor

Surface (m^2)	Height (m)	Volume (m^3)	ce	ρ	Ψ	ΔT	Qi (W)
331,82	3,85	1277,507	1000	1,2	0,00027778	20	8516,78147

1.3.2.4.2nd floor

Surface (m^2)	Height (m)	Volume (m^3)	ce	ρ	Ψ	ΔT	Qi (W)
317,43	3,04	964,9872	1000	1,2	0,00027778	20	6433,29947

1.3.2.5.3rd floor

Surface (m^2)	Height (m)	Volume (m^3)	ce	ρ	Ψ	ΔT	Qi (W)
178,33	3,6	641,988	1000	1,2	0,00027778	20	4279,95424

1.3.3. Losses of heat by supplement.

Supplements are an increase in the expected power due to the characteristics of the building, orientation and flashing of the heating equipment.

The value of supplements (F), has obtained depending on the cold outer surfaces heating service disruptions and orientation:

$$Q_F = \sum_{i=1}^{n} F_i(Q_t + Q_i)$$

Supplements	Valor (F)
Per north orientation	0,05 – 0,07
Per flashing: Nigt reduction	0,05
Per flashing: from 8 to 9 hours of stop	0,1
Per flashing: more than 10 hours of stop	0,2 – 0,25
More tan two walls to outside	0,05
Last floor of very high buildings.	0,02 / meter

The installation of air conditioning which is designed provides a flashing for more than 10 hours.

1.3.3.1 Underground.

Orientation		**Flashing**		**Outside walls**		**Last floor**		**Σ Fi**	**Qt (W)**	**Qi (W)**	**Qf (W)**
O - E - S	0	12 horas	0,2	3	0,05	-	-	0,15	3060,059	4138,704	1079,81445

1.3.3.2.Ground floor.

Orientation		**Flashing**		**Outside walls**		**Last floor**		**Σ Fi**	**Qt (W)**	**Qi (W)**	**Qf (W)**
O - E - S	0	12 hours	0,2	3	0,05	-	-	0,15	4589,908	8562,468	1972,8564

1.3.3.3.1st floor.

Orientation		**Flashing**		**Outside walls**		**Last floor**		**Σ Fi**	**Qt (W)**	**Qi (W)**	**Qf (W)**
O - E - S	0	12 hours	0,2	3	0,05	-	-	0,15	3975,9126	8516,78147	1873,90411

1.3.3.4.2nd floor.

Orientation		**Flashing**		**Outside walls**		**Last floor**		**Σ Fi**	**Qt (W)**	**Qi (W)**	**Qf (W)**
O - E - S	0	12 hours	0,2	3	0,05	-	-	0,15	3415,7616	6433,29947	1477,35916

1.3.3.5.3rd floor.

Orientation		Flashing		Outside walls		Last floor		Σ Fi	Qt (W)	Qi (W)	Qf (W)
O - E - S	0	12 hours	0,2	3	0,05	-	-	0,15	1127,97635	4279,95424	811,189589

1.3.4. Total losses of heat

The value of the total heat loss is determined by the sum of the heat loss obtained by transmission of the constructive elements, by infiltration and by supplement.

$$Q_{total} = Q_t + Q_i + Q_F$$

Floor	Qt	Qi	Qf	Q tot
Undergorund	3060,059	4138,704	1079,8145	8278,5775
Groundfloor	4589,908	8562,468	1972,8564	15125,2324
1st floor	3975,9126	8516,78147	1873,90411	14366,5982
2nd floor	3415,7616	6433,29947	1477,35916	11326,4202
3rd floor	1127,97635	4279,95424	811,189589	6219,12018
TOTAL				**55315,9485**

The total thermal power is 55315,9485 W.

2. Sizing of the heat pump.

We are going to install a heat pump in each floor. This pumps are going to provide our building with hot air conditioning during the winter and cold air conditioning during the summer.

The power of the heat pumps that we’re going to install at least have to be equal to the total losses of heat of the floor that they are providing. The powers are shown in the following table.

Location of the heat pump	Power of the heat pump (W)
Undergorund	8278,5775
Groundfloor	15125,2324
1st floor	14366,5982
2nd floor	11326,4202
3rd floor	6219,12018

3. Sizing of the air conditioning conducts.

3.1. ***Characteristics of the air of the conducts supplied by the heat pump.***

- Temperature of the dry bulb: 26ºC
- Relative humidity: 36,98%
- Specific humidity:7,73 g of H_2O/kg of dry air
- Enthalpy: 45,70 kJ/kg
- Temperature of the humid bulb: 16,42 ºC
- Temperature of dew: 10,19 ºC.
- Partial pressure of water vapor:1244 Pa
- Specific volum: 0,8579 m^3/kg
- Density of the air: 1,1657 kg/m^3
- Kinematic viscosity of the air : $1{,}58475 \cdot 10^{-5}$ m^2/s

3.2. Charcteristics of the air in each floor.

- Temperature of the dry bulb: 20ºC
- Relative humidity: 50%
- Specific humidity:7,73 g of H_2O/kg of dry air
- Enthalpy: 40,63 kJ/kg
- Temperature of the humid bulb: 14,59 ºC
- Temperature of dew: 10,19 ºC.
- Partial pressure of water vapor:1244 Pa
- Specific volum: 0,8435 m^3/kg
- Density of the air: 1,1855 kg/m^3
- Kinematic viscosity of the air : $1{,}53845 \cdot 10^{-5}$ m^2/s

*3.3.**Air flow necessary.***

The air flow necessary to inject through the drive conducts to each architectural area, is obtained from the following equation:

$$V = \frac{Q\ total}{\rho c(p) \cdot ce\ (p) \cdot (tc - tl)}$$

Where:

V= Air flow needed in the local (m^3/s^{-1})

Qtotal = Total termal charge (W)

ρc(p) = Density of air at constant pressure supply conducts ($kg \cdot m^{-3}$). At a temperature of distribution of 26ºC we can adopt the approximate value of 1,1657 kg · m^3.

ce(p) = Specific heat of air at a constant pressure inside the conducts. ($J \cdot kg^{-1} \cdot {}^{o}C^{-1}$). Fort he calculation we can take ce(p) = 1295,8 $J \cdot kg^{-1} \cdot {}^{o}C^{-1}$.

tc = The air temperature in conducts supply (ºC). For calculations the air conduct temperature is 26 °C.

tl = The air temperature in the interior of each local. The value adopted according to the project is 20 ° C.

The air flow necessary in each flow are the followings:

Floor	**Q total (W)**	**V t (m^3/s)**
Underground	8278,5775	3946,05847
Ground floor	15125,2324	7209,57815
1st floor	14366,5982	6847,96833
2nd floor	11326,4202	5398,84013
3rd floor	6219,12018	2964,39961

3.4.Air flow necessary in each spreader

We have obtained it dividing the total flow of the floor by the number of spreaders to install.

Floor	**Q total (W)**	**V t (m^3/s)**	**Nº difusores**	**V difusor (m^3/s)**
Underground	37664,0808	3946,05847	13	**303,5429**
Ground floor	15125,2324	7209,57815	17	**424,092832**
1st floor	14366,5982	6847,96833	11	**622,542576**
2nd floor	11326,4202	5398,84013	12	**449,903344**
3rd floor	6219,12018	2964,39961	7	**423,485658**

3.5.Pressure at the exit of the heat pump and at the spreaders.

Pressure at the exit of the ventilator of the heat pump: 180 mm.c.a. (4ºC)

Pressure at the exit of the spreaders: 50 mm.c.a (4ºC)

We should install flow regulating valves, calibrated with the necessary air flow in each spreader.

3.6.General characteristics of the drive conducts.

Geometric shape: circular

Absolute roughness of the material: ε= 0,09 mm.

Maximum speed of the air inside of the conducts:

Principal conducts: 5 m/s

Derivations: 3 m/s

3.7.Sizing of the conducts.

The conducts that we are going to install have a height of 30 cm and are made with a smooth sheet of metal.

We have calculated the diameter of the conducts by a graphic method, obtaining like that the circular interior diameter of the conduct, the speed and the loss of pressure in each conduct.

3.7.1. Underground

Tramo	Caudal	Velocidad (m/s)	Diámetro circular (mm)	Perdidas de carga (Pa/Le)	Longitud conducto	
Tramo 1 - 2	3946,05847	5	550	0,3	2,09	4,8
Tramo 2 - 3	303,5429	3	200	0,5	2,21	2,7
Tramo 2 - 4	303,5429	3	200	0,5	2,21	2,7
Tramo 2 - 5	3338,97267	5	500	0,4	4,28	4,9
Tramo 5 - 6	303,5429	3	200	0,5	3,58	2,7
Tramo 5 - 7	3035,42977	5	500	0,35	1,58	4,2
Tramo 7 - 8	303,5429	3	200	0,5	3,15	2,7
Tramo 7 - 9	2731,88687	5	450	0,4	2,23	4,35
Tramo 9 - 10	303,5429	3	200	0,5	3,5	2,7
Tramo 9 - 11	2428,34397	5	450	0,3	2,2	4,1
Tramo 11 - 12	303,5429	3	200	0,5	3,16	2,7
Tramo 11 - 13	1821,25817	5	400	0,35	3,81	3,9
Tramo 13 - 14	303,5429	3	200	0,5	3,16	2,7
Tramo 13 - 15	1517,71527	5	350	0,35	3,05	4,1
Tramo 15 - 16	303,5429	3	200	0,5	4,08	2,7
Tramo 15 - 17	1214,17237	5	300	0,7	4,63	4,5
Tramo 17 - 18	303,5429	3	200	0,5	3,23	2,7
Tramo 17 - 19	607,08657	5	250	0,5	1,41	3,5
Tramo 19 - 20	303,5429	3	200	0,5	3,57	2,7
Tramo 19 - 21	303,54367	5	200	0,5	3,27	2,7
Tramo 21-22	303,5429	5	200	0,5	3,57	2,7

3.7.2. Ground floor

Stretch	**Flow**	**Max speed (m/s)**	**Circular diameter (mm)**	**Charge losses (Pa/Le)**	**Length of the conduct (m)**	**Speed (m/s)**
Tramo 1-2	7209,57815	5	750	0,3	2,31	4,5
Tramo 2-3	424,092832	3	250	0,2	3,26	2,3
Tramo 2-4	6785,48532	5	700	0,35	1,8	4,7
Tramo 4-5	424,092832	3	250	0,2	3,25	2,3
Tramo 4-6	6361,39249	5	700	0,3	2,48	4,6
Tramo 6-7	424,092832	3	250	0,2	3,58	2,3
Tramo 6-8	5937,29965	5	650	0,4	1,58	4,5
Tramo 8-9	424,092832	3	250	0,2	3,23	2,3
Tramo 8-10	5089,11399	5	650	0,3	3,09	4,1
Tramo 10-11	424,092832	3	250	0,2	3,5	2,3
Tramo 10-12	424,092832	3	250	0,2	3,22	2,3
Tramo 10-13	4240,92833	5	600	0,2	2,1	3,5
Tramo 13-14	424,092832	3	250	0,2	3,15	2,3
Tramo 13-15	3816,83549	5	500	0,6	3,05	5
Tramo 15-16	424,092832	3	250	0,2	3,15	2,3
Tramo 15-17	2968,64983	5	500	0,3	2,44	4,2
Tramo 17-18	424,092832	3	250	0,2	3,17	2,3
Tramo 17-19	2544,557	5	450	0,35	1,29	4,3
Tramo 19-20	424,092832	3	250	0,2	3,38	2,3
Tramo 19-21	2120,46417	5	400	0,5	1,37	4,9
Tramo 21-22	424,092832	3	250	0,2	3,17	2,3
Tramo 21-23	1696,37133	5	350	0,4	1,01	4,5
Tramo 23-24	424,092832	3	250	0,2	2,69	2,3
Tramo 23-25	1272,2785	5	300	0,7	4,16	4,9
Tramo 25-26	424,092832	3	250	0,2	3,21	2,3
Tramo 25-27	424,092838	3	250	0,2	3,59	2,3

3.7.3. First floor.

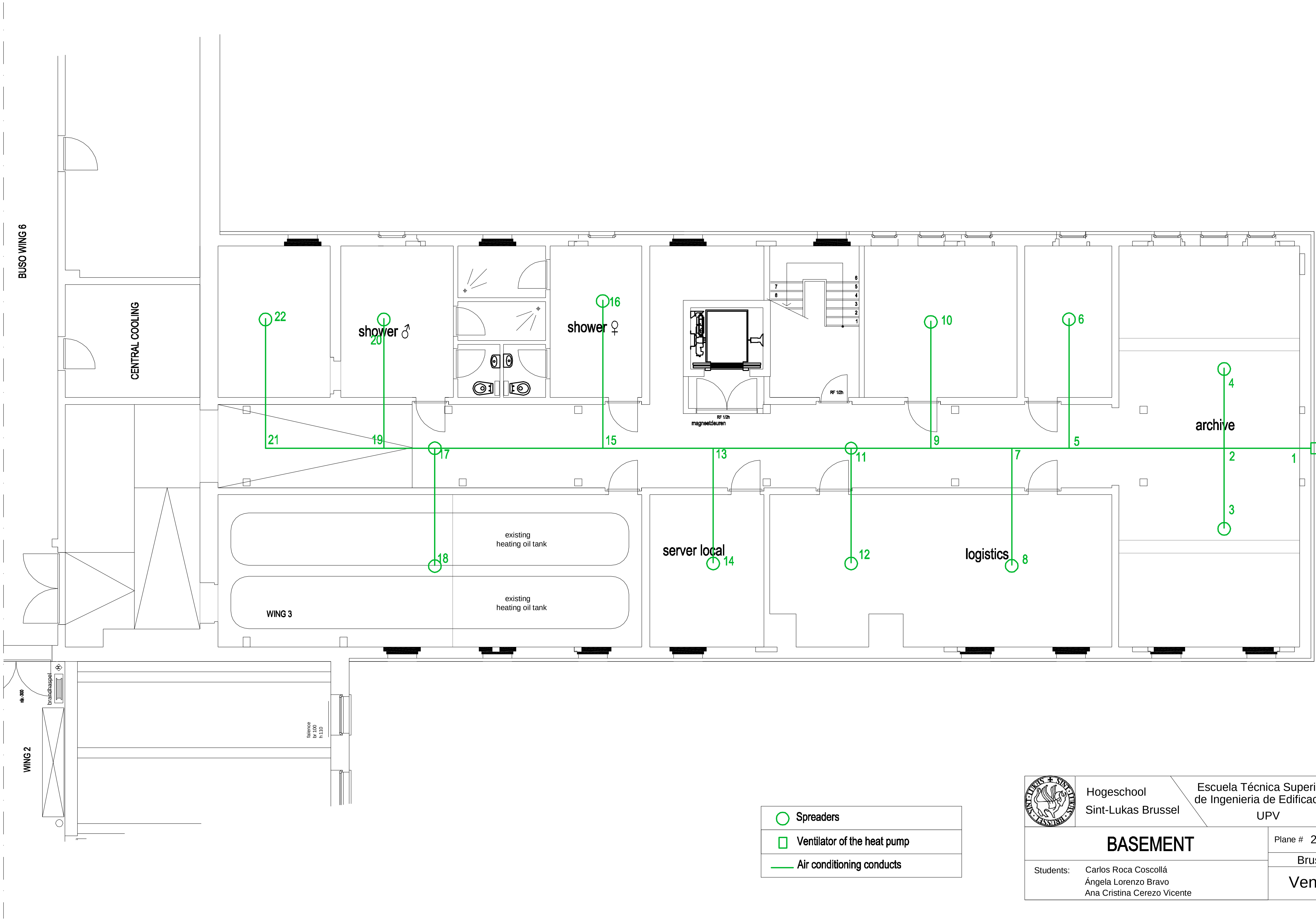
Stretch	Flow	Max speed (m/s)	Circular diameter (mm)	Charge losses (Pa/Le)	Length of the conduct (m)	Speed (m/s)
Tramo 1 - 2	6847,9683	5	700	0,3	0,84	4,8
Tramo 2 - 3	622,54258	3	300	0,2	1,8	2,6
Tramo 2 - 4	622,54258	3	300	0,2	1,8	2,6
Tramo 2 - 5	5602,8832	5	650	0,3	5,86	4,6
Tramo 5 - 6	622,54258	3	300	0,2	3,22	2,6
Tramo 5 - 7	4980,3406	5	600	0,4	1,04	4,9
Tramo 7 - 8	622,54258	3	300	0,2	3,58	2,6
Tramo 7 - 9	3735,2555	5	550	0,25	3,94	4,2
Tramo 9 - 10	622,54258	3	300	0,2	3,16	2,6
Tramo 9 - 11	3112,7129	5	500	0,7	5,15	4,5
Tramo 11 -12	622,54258	3	300	0,2	3,16	2,6
Tramo 11 - 13	2490,1703	5	450	0,7	1,88	4,3
Tramo 13 - 14	622,54258	3	300	0,2	3,01	2,6
Tramo 13 - 15	1245,0851	5	350	0,35	2,61	3,9
Tramo 15 - 16	622,54258	3	300	0,2	3,23	2,6
Tramo 15 - 17	622,54257	3	300	0,2	2,72	2,6
Tramo 17 - 18	622,54258	3	300	0,2	3,57	2,6

3.7.4. Second floor.

Stretch	Flow	Max speed (m/s)	Circular diameter (mm)	Charge losses (Pa/Le)	Length of the conduct (m)	Speed (m/s)
Tramo 1 - 2	5398,84013	5	650	0,3	0,91	4,5
Tramo 2 - 3	449,903344	3	250	0,25	3,26	2,6
Tramo 2 - 4	449,903344	3	250	0,25	2,92	2,6
Tramo 2 - 5	4499,03344	5	600	0,3	5,86	4,4
Tramo 5 - 6	449,903344	3	250	0,25	3,23	2,6
Tramo 5 - 7	4049,1301	5	550	0,3	1,04	4,7
Tramo 7 - 8	449,903344	3	250	0,25	3,58	2,6
Tramo 7 - 9	3149,32341	5	500	0,3	4,76	4,6
Tramo 9 - 10	449,903344	3	250	0,25	3,16	2,6
Tramo 9 - 11	2699,42007	5	450	0,3	5,36	4,6
Tramo 11 - 12	449,903344	3	250	0,25	3,16	2,6
Tramo 11 - 13	2249,51672	5	450	0,25	0,84	4,3
Tramo 13 - 14	449,903344	3	250	0,25	3,01	2,6
Tramo 13 - 15	1349,71003	5	350	0,4	2,21	4
Tramo 15 - 16	449,903344	3	250	0,25	3,25	2,6
Tramo 15 - 17	899,80669	5	300	0,3	0,7	3,7
Tramo 17 - 18	449,903344	3	250	0,25	3,57	2,6
Tramo 17 - 19	449,903346	3	250	0,25	2,49	2,6
Tramo 19 - 20	449,903344	3	250	0,25	3,25	2,6

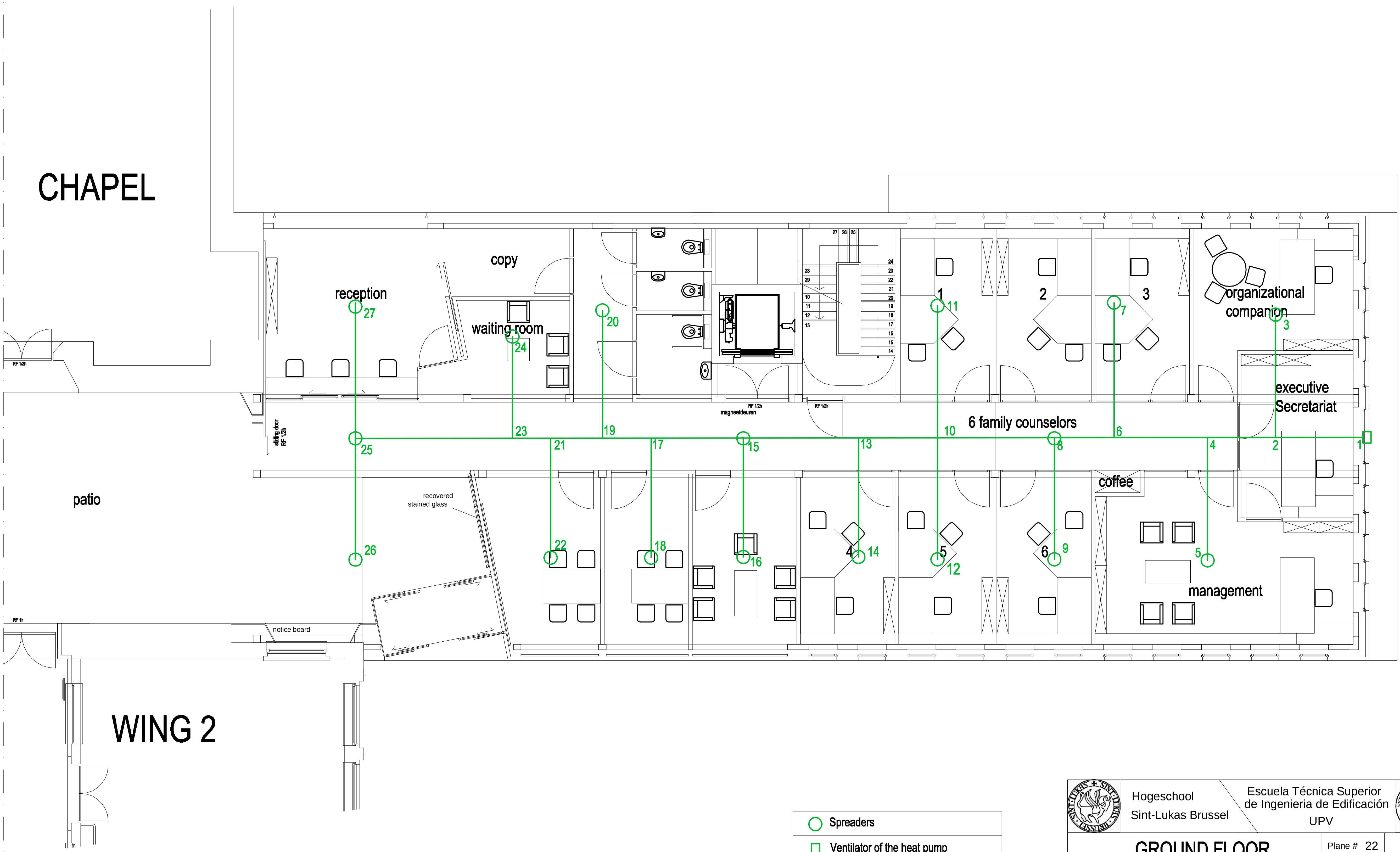
3.7.5. Third floor.

Stretch	**Flow**	**Max speed (m/s)**	**Circular diameter (mm)**	**Charge losses (Pa/Le)**	**Length of the conduct (m)**	**Speed (m/s)**
Tramo 1 - 2	2964,39961	5	500	0,35	6,05	4,2
Tramo 2 - 3	846,971316	3	350	0,15	6,06	2,5
Tramo 3 - 4	423,485658	3	250	0,3	3,01	2,5
Tramo 2 - 5	1693,94264	5	350	0,4	5,94	4,8
Tramo 5 - 6	423,485658	3	250	0,3	3,01	2,5
Tramo 5 - 7	1270,45698	5	350	0,3	2,91	3,8
Tramo 7 - 8	423,485658	3	250	0,3	1,94	2,5
Tramo 7 - 9	423,485658	3	250	0,3	3,57	2,5



○	Spreaders
□	Ventilator of the heat pump
—	Air conditioning conducts

Hogeschool Sint-Lukas Brussel	Escuela Técnica Superior de Ingenieria de Edificación UPV	
BASEMENT	Plane # 21	Escale: 1:100
Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente	Brussels 2012	
	Ventilation	



○	Spreaders
□	Ventilator of the heat pump
—	Air conditioning conducts

Hogeschool Sint-Lukas Brussel

Escuela Técnica Superior de Ingenieria de Edificación UPV

GROUND FLOOR

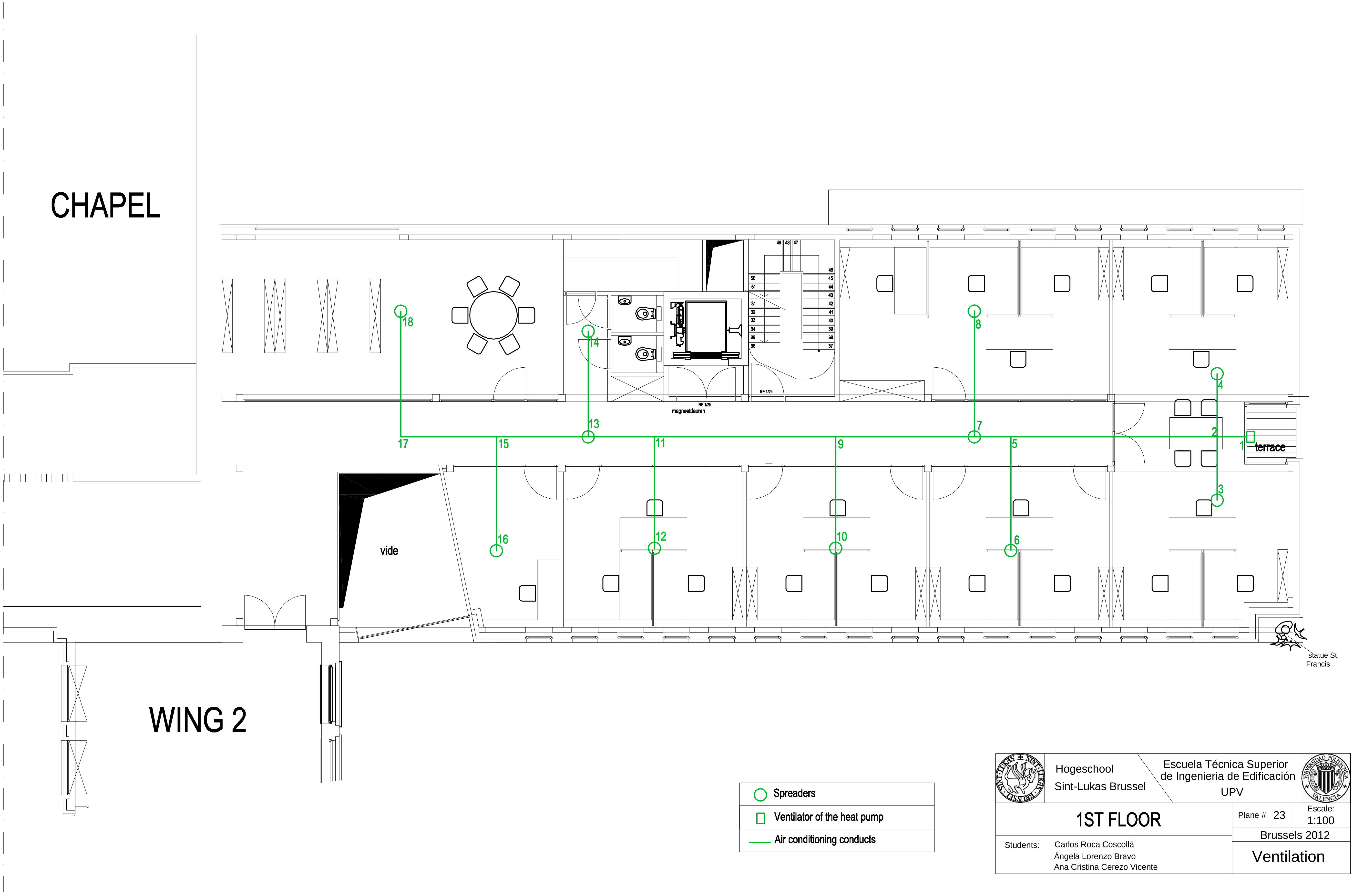
Plane # 22

Escale: 1:100

Brussels 2012

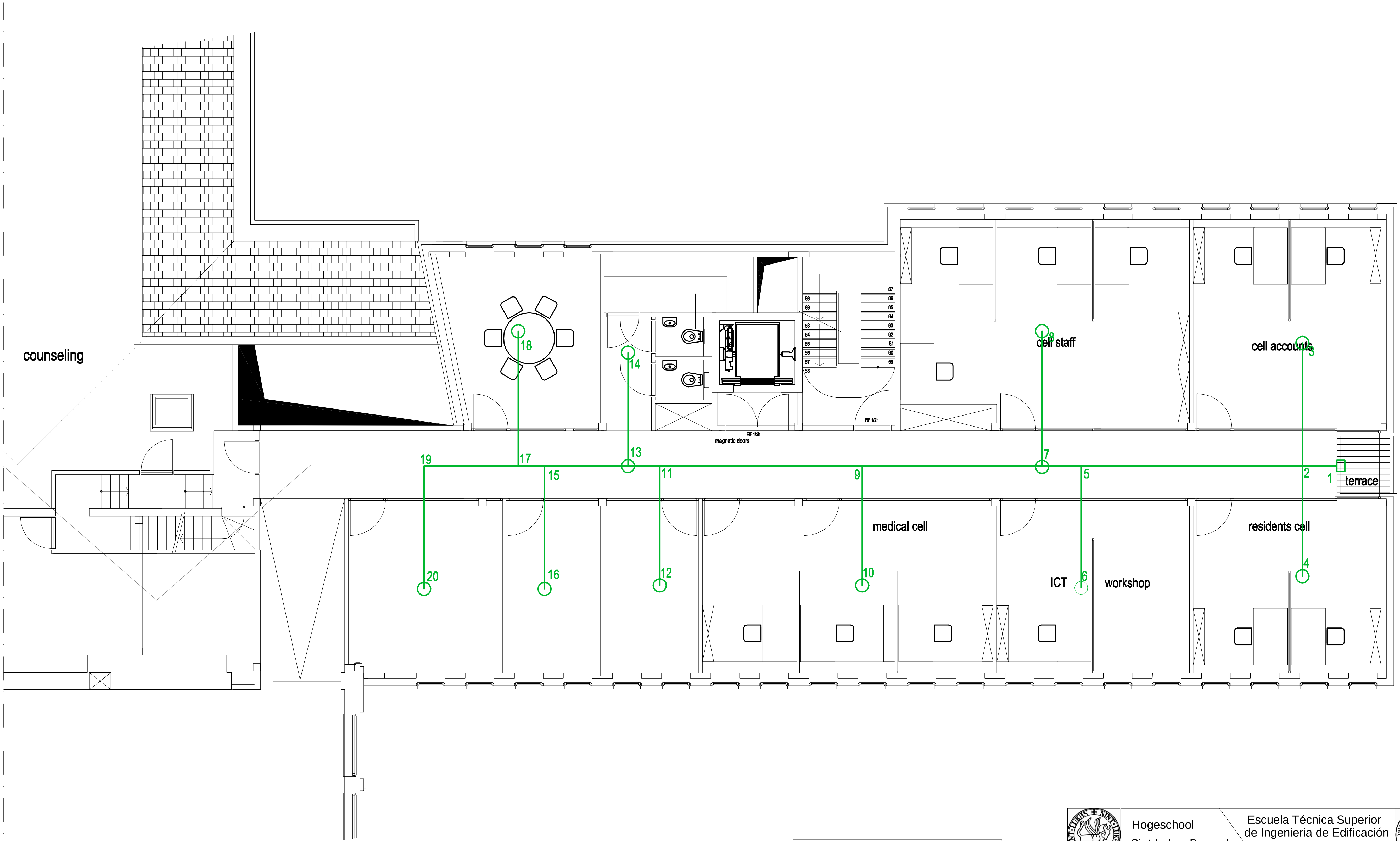
Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente

Ventilation



○	Spreaders
□	Ventilator of the heat pump
—	Air conditioning conducts

Hogeschool Sint-Lukas Brussel		Escuela Técnica Superior de Ingenieria de Edificación UPV	
1ST FLOOR		Plane # 23	Escale: 1:100
		Brussels 2012	
Students:	Carlos Roca Coscollá Ángela Lorenzo Bravo Ana Cristina Cerezo Vicente	Ventilation	



Spreaders
Ventilator of the heat pump
Air conditioning conducts

Hogeschool
Sint-Lukas Brussel

Escuela Técnica Superior
de Ingenieria de Edificación
UPV

2ND FLOOR

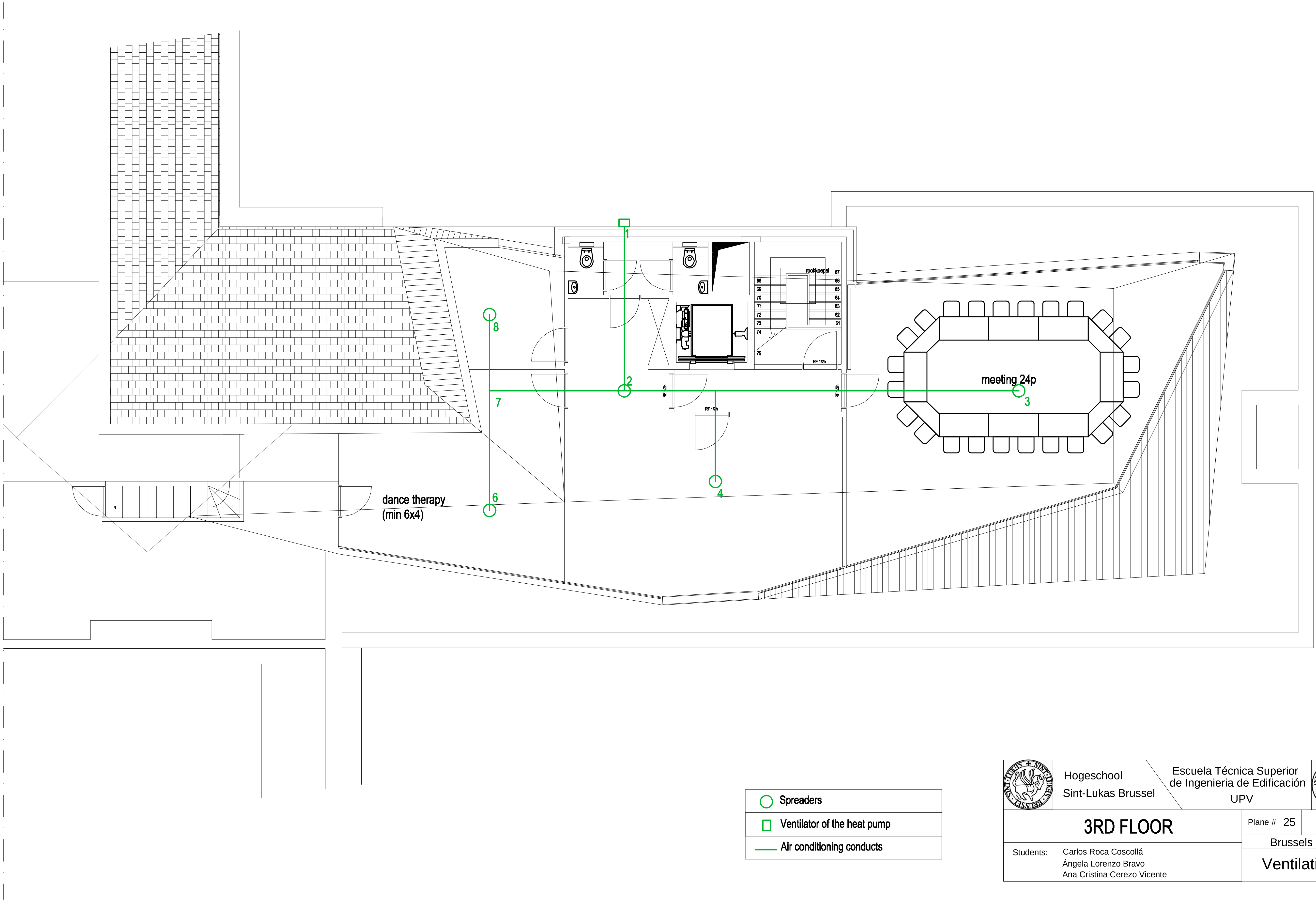
Plane # 24

Escale:
1:100

Brussels 2012

Students:
Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente

Ventilation



○	Spreaders
□	Ventilator of the heat pump
—	Air conditioning conducts

Hogeschool Sint-Lukas Brussel	Escuela Técnica Superior de Ingenieria de Edificación UPV	
3RD FLOOR	Plane # 25	Escale: 1:100
	Brussels 2012	
Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente	Ventilation	

Evacuation of water

Evacuation of water.

1. Design.

1.1.General conditions of the evacuation.

The collectors of the building drain by gravity in the general trap, which is the point of connection between the installation of evacuation and the main of public sewers.

Only a part of the installation of sanitary pipework has been designed. We should take into account that there are other rooms (like kitchens) where we must install a main of drainage as well as in the bathrooms.

1.2.Configuración de los sistemas de evacuación.

We have provided the building with a separated system, where only the sewage is draining in the main of public sewers.

The rainwater drainage is made by a main of gutters and downpipes that drain in the ground.

1.3.Components of the istallation.

1.3.1. Components of the evacuation main.

1.3.1.1.Hydraulic closures.

The hydraulic closures that are available in the installation are:

- Individual siphons in each machine.
- Trap boats, when it's a connection of several machines.

The hydraulic closures have the following characteristics:

- They will be self-cleaning, so water traversing them will drag the solids in suspension.
- Their inner surfaces shall not retain solids.
- They won't have moving parts to prevent their correct operation.
- They will have a record cleaning, easily accessible and manipulable.
- The minimum height of the hydraulic closures will be 50 mm for continuous use and 70 mm for intermittent use. The maximum height is 100 mm. The Crown will be at a distance equal or greater than 60 cm below a drain of tract valve. The

diameter of the siphon will be equal or greater than the diameter of the valve of drain and equal or lower than the drain branch. When there is a difference of diameters, the size will increase in the sense of flow.

- They will be installed as closer as possible to the appliance drain valve, to limit the length of dirty tube without protection for the environment.
- They won't be installed in series, therefore, when we are going to install a trap boat for a group of units, these units won't be equipped with individual siphon.
- When we are going to install only a hydraulic closure for several units, we will reduce the maximum distance to the closure.

1.3.1.2.Small evacuation main.

- The path of the main is the easiest way to get a natural flow by gravity, avoiding sudden changes of direction and using the appropriate special parts.
- In cases where it has not been possible to connect the main directly to the downspout, it is connected to the toilet shank.
- The distance from the trap boat to the downspout is not greater than 2.00 m.
- The derivations that end in the trap boat have a length equal or less than 2.50 m, with a slope between 2 and 4%.
- In the units with individual sifon it has been taken into account the following characteristics:
    - In the washbasin the distance to the drainpipe will be 4 meters long maximum with incline between 2,5-5%
    - In the showers the incline will be ≤10%
    - The wastepipe from drain pipe to the water will be directly connected with a sleeve from the connection which length ≤10 m.
- There will be overflow in the washbasin.
- There won't be wastepipe connected directly to a common pipe.
- The unions between wastepipe to the attack will have the most possible inclination and never less of 45º.

When individuals siphons systems are used, the branches to the wastepipe of the units are joined to the derivation pipe which flow into the drainpipe, when it hasn't be possible the branch of the water, and has the registrable top with screwed plug.

1.3.1.3.Drainpipe and gutter.

The drainpipes will be made with no derivations or setback and with a constant diameter in all its high.

The diameter won't decrease in the direction of the current.

1.3.1.4.Sewer

Made of PVC will be hanged or buried.

1.3.1.4.1. Hanged sewers

- The drainpipes will be connected with specials pieces.
- There won't be two sewers at the same place.
- In straight stretches, every encounter in horizontal or vertical, like in derivations, there will be placed shutoff valves formed by specials pieces by the way that strecht between them won't be >15 meters long.

1.3.1.4.2. Buried sewers

- Trenches will have the adequate dimensions placed under the mains of distribution of potable water.
- The incline will be of the 2%.
- The main connection of the downspouts and the shank to this main will be in the interposition of a coffer under the downspout which won't be siphonic.
- There will be shutoff valves every 15 meters long.

1.3.1.4.3. Connection elements

When we work with buried mains, the meeting between the vertical main and the horizontal one will be made with coffers above concrete, with a practicable top with an only sewer for each coffer forming angle of 90º between the sewer and the exit.

Characteristics:

- The coffer at the base of the downpipe must be used for the check of the downpipes when the conduction of a certain point will be buried.
- The coffer won't have three sewers at the same place.
- The check coffers will have registered and practicables tops.
- At the end of the installation and before the connection will be installed the general building well.
- It will be installed cleaning checkers in any coffer and in every change of direction and inserted in the straight stretches.

1.3.2. Special elements

1.3.2.1.Nonreturn security valves

It will be installed for preserve from possible floodings when the main out from the outside of the sewer system is overloaded. It will be placed in an easy place for its check and maintenance.

1.3.3. Subsystems of ventilation in the installations.

1.3.3.1.Subsystem of primary ventilation.

It will be placed in the building because it has less than 7 levels and the drainmain less than 5 meters long.

The downpipes of residual waters will be extended at least 1.30 meters long over the cover of the building.

The exit from the ventilation won't be placed under 6 meters from any point of outside air for climate control or ventilation and should exceed the height. It will be protected at the entre from any odd object and its design will be done for favor the expulsion of gases.

2. Sizing

2.1.Sizing of the evacuation main of residual waters.

2.1.1. Individual derivations

2.1.1.1.Units of drainage of the building

Floor	Location	Sanitary units	Number of units N	Units of discharge	Total units of discharge
Underground	Changing room for men	Shower	1	3	3
		Toilet with fluxor	1	10	10
		Washbasin	1	2	2
	Changing room for women	Shower	1	3	3
		Toilet with fluxor	1	10	10
		Washbasin	1	2	2
Ground floor	Toilet 1	Toilet with fluxor	1	10	10
		Washbasin	1	2	2
	Toilet 2	Toilet with fluxor	1	10	10
		Washbasin	1	2	2
	Toilet 3	Toilet with fluxor	1	10	10
		Washbasin	1	2	2
1º floor	Toilet 4	Toilet with fluxor	1	10	10
		Washbasin	1	2	2
	Toilet 5	Toilet with fluxor	1	10	10
		Washbasin	1	2	2
2º floor	Toilet 6	Toilet with fluxor	1	10	10
		Washbasin	1	2	2
	Toilet 7	Toilet with fluxor	1	10	10
		Washbasin	1	2	2
3º floor	Toilet 8	Toilet with fluxor	1	10	10
		Washbasin	1	2	2
	Toilet 9	Toilet with fluxor	1	10	10
		Washbasin	1	2	2
Total of the building			**24**		**138**

We have obtained in the whole building, an amount of 138 units of discharge fot 24 units.

2.1.1.2.Minimum diameter siphon and individual derivatiom

Floor	Location	Sanitary units	Units of discharge	Minimum diameter of the siphon and individual derivation (mm)
Underground	Changing room for men	Shower	3	50
		Toilet with fluxor	10	100
		Washbasin	2	40
	Changing room for women	Shower	3	50
		Toilet with fluxor	10	100
		Lavabo	2	40
Groundfloor	Toilet 1	Toilet with fluxor	10	100
		Washbasin	2	40
	Toilet 2	Toilet with fluxor	10	100
		Washbasin	2	40
	Toilet 3	Toilet with fluxor	10	100
		Washbasin	2	40
1ºfloor	Toilet 4	Toilet with fluxor	10	100
		Washbasin	2	40
	Toilet 5	Toilet with fluxor	10	100
		Washbasin	2	40
2º floor	Toilet 6	Toilet with fluxor	10	100
		Washbasin	2	40
	Toilet 7	Toilet with fluxor	10	100
		Washbasin	2	40
3º floor	Toilet 8	Toilet with fluxor	10	100
		Washbasin	2	40
	Toilet 9	Toilet with fluxor	10	100
		Washbasin	2	40

2.1.1.3.Trap boats and individual siphons

The individual siphons shall have the same diameter as the attached drain valve.

The trap boats will have the right number and size of entries and a high enough to prevent the discharge of a sanitary unit goes out in another sanitary unit with lower in height.

2.1.1.4.Sewer Branches

The collectors of residual water will be in double-walled corrugated PVC.

We calculate the average flow of residual water applying the AFNOR norm.

Sewer	Sanitary unit	Unit of discharge	Number of units	Total units of discharge	Total number of units	Ks	Average flow of residual water Qmd
CR1	Toilet with fluxor	10	1	12	2	1	$5{,}6 \times 10^{-3}$
	Washbasin	2	1				
CR2	Toilet with fluxor	10	1	12	2	1	$5{,}6 \times 10^{-3}$
	Washbasin	2	1				
CR3	Toilet with fluxor	10	2	22	3	0,8021	$8{,}234 \times 10^{-3}$
	Washbasin	2	1				
CR4	Toilet with fluxor	10	2	22	3	0,8021	$8{,}234 \times 10^{-3}$
	Washbasin	2	1				
CR5	Toilet with fluxor	10	1	12	2	1	$5{,}6 \times 10^{-3}$
	Washbasin	2	1				
CR6	Toilet with fluxor	10	2	24	4	0,6864	$7{,}687 \times 10^{-3}$
	Washbasin	2	2				
CR7	Washbasin	2	2	14	3	0,8021	$5{,}240 \times 10^{-3}$
	Toilet with fluxor	10	1				
CR8	Shower	3	2	16	3	0,8021	$5{,}989 \times 10^{-3}$
	Toilet	10	1				

	with fluxor						
CR9	Washbasin	2	2	4	2	1	$1{,}866 \times 10^{-3}$
CR10	Shower	3	2	6	2	1	$2{,}8 \times 10^{-3}$

$$Ks = \frac{1}{\sqrt{N-1}} + \alpha \cdot [0{,}035 + 0{,}035 \cdot \log(\log N)]$$

N: Total number of devices installed in the supply type (units).

α: Coefficient of the kind of supply (when it is for schools, universities, clubs, gyms etc. α = 4).

$$Qmd(i-j) = \frac{28 \cdot udes(i-j)}{60 \cdot 1000} \cdot Ks$$

First we sized the branches of sewers by the CTE.

Sizing of the sewers of residual water using the table 4.5 DB-HS-5 of the CTE with a slope of 2%.

Sewer	Units of discharge	Slope	Minimum diameter (mm)
CR1	12	2%	75
CR2	12	2%	75
CR3	22	2%	90
CR4	22	2%	90
CR5	12	2%	75
CR6	24	2%	90
CR7	14	2%	75
CR8	16	2%	75
CR9	4	2%	50
CR10	6	2%	50

Secondly, we carry out the sizing of the rainwater downpipes applying the equations of Manning-Robert.

Sewer	Downspout preceding section	Maximum flow	Manning coefficent	Slope	Minimum diameter (mm)	Commercial diameter
CR1	-	$5,6 \times 10^{-3}$	0,009	2%	102,2611	DN-110
CR2	-	$5,6 \times 10^{-3}$	0,009	2%	102,2611	DN-110
CR3	-	$8,234 \times 10^{-3}$	0,009	2%	118,1665	DN-125
CR4	-	$8,234 \times 10^{-3}$	0,009	2%	118,1665	DN-125
CR5	-	$5,6 \times 10^{-3}$	0,009	2%	102,2611	DN-110
CR6	-	$7,687 \times 10^{-3}$	0,009	2%	115,1593	DN-125
CR7	-	$5,240 \times 10^{-3}$	0,009	2%	99,744	DN-110
CR8	-	$5,989 \times 10^{-3}$	0,009	2%	104,869	DN-125
CR9	-	$1,866 \times 10^{-3}$	0,009	2%	67,722	DN-75
CR10	-	$2,8 \times 10^{-3}$	0,009	2%	78,854	DN-90

$$Dmín = \left[\frac{2^{13/3} \cdot n \cdot Qmáx}{\pi \cdot \sqrt{so}}\right]^{3/8} \cdot 10^{3}$$

2.1.2. Downspouts of residual water

We calculate the average flow of residual water applying the AFNOR norm.

Downspout	Stretch	Sanitary unit	Units of discharge	Number of units	Total units of discharge	Total number of units	Ks	Average flow of residual water Qmd
R1	1-1	Toilet with fluxor	10	2	20	4	0,68649	7,688 x 10^{-3}
		Washbasin	2	2	4			
	1-2	Toilet with fluxor	10	4	40	8	0,51176	11,463 x 10^{-3}
		Washbasin	2	4	8			
	1-3	Toilet with fluxor	10	6	60	12	0,44614	14,990 x 10^{-3}
		Washbasin	2	6	12			
	1-4	Toilet with fluxor	10	9	90	18	0,39635	19,976 x 10^{-3}
		Washbasin	2	9	18			
R2	2-1	Toilet with fluxor	10	2	20	6	0,57196	8,007 x 10^{-3}
		Washbasin	2	2	4			
		Shower	3	2	6			

$$Ks = \frac{1}{\sqrt{N-1}} + \alpha \cdot [0{,}035 + 0{,}035 \cdot \log(\log N)]$$

N: Total number of sanitary units installed in the supply (units).

α: Coefficient of the kind of supply (if it is for schools, universities, clubs, gyms, etc. α = 4).

$$Qmd(i-j) = \frac{28 \cdot udes(i-j)}{60 \cdot 1000} \cdot Ks$$

The downspouts of residual water are made of PVC.

At first we size the downspouts using the CTE.

Sizing of the downspouts of residual water using the *table 4.4 of DB-HS-5 from CTE* for a building with more than 3 floors..

Downspout	Stretch	Unit of discharge	Minimum diameter (mm)
R1	1-1	24	90
	1-2	48	90
	1-3	72	110
	1-4	108	110
R2	2-1	30	90

Secondly, we carry out the sizing of the downpipes of residual water applying empirical equation of Hunter-Babbitt and Dawson-Kalinske.

Downspout	Stretch	r	Flow Qm (m3/s)	Minimum diameter (mm)	Commercial diameter
R1	1-1	0,29	$7{,}688 \times 10^{-3}$	95,788	DN-110
	1-2	0,29	$11{,}463 \times 10^{-3}$	111,268	DN-125
	1-3	0,29	$14{,}990 \times 10^{-3}$	123,043	DN-160
	1-4	0,29	$19{,}976 \times 10^{-3}$	137,033	DN-160
R2	2-1	0,29	$8{,}007 \times 10^{-3}$	97,260	DN-110

$$D = \left[\frac{Q}{31{,}5 \cdot r^{5/3}}\right]^{3/8} \cdot 10^3$$

2.1.3. Horizontal sewer of residual water.

The collectors of residual water will be made of double-walled corrugated PVC.

We calculate the average flow of residual water by AFNOR norm.

Sewer	Sanitary unit	Units of discharge	Number of units	Total discharge units	Total number of units	Ks	Average flow of residual water Qmd
CR11	Toilet with fluxor	10	9	108	18	0,3963	$19,973 \times 10^{-3}$
	Washbasin	2	9				
CR12	Toilet with fluxor	10	11	138	24	0,3681	$23,705 \times 10^{-3}$
	Washbasin	2	11				
	Shower	3	2				

$$Ks = \frac{1}{\sqrt{N-1}} + \alpha \cdot [0{,}035 + 0{,}035 \cdot \log(\log N)]$$

N: Total number of sanitary units installed in the supply (units).

α: Coefficient of the kind of supply (if it is for schools, universities, clubs, gyms, etc. α = 4).

$$Qmd(i-j) = \frac{28 \cdot udes(i-j)}{60 \cdot 1000} \cdot Ks$$

At first we size the sewers using the CTE.

The sizing of the sewers of residual water is made with the *table 4.5 of DB-HS-5 from CTE* for a slope of 2%.

Sewer	Unit of discharge	Slope	Minimum diameter (mm)
CR11	108	2%	110
CR12	138	2%	110

Second, we carry out the sizing of sewers of residual water applying the equations of Manning-Robert.

Sewer	Strecht of preceding downsput	Maximu flow	Manning coefficient	Slope	Minimum diameter (mm)	Commercial diameter
CR11	R1	$19{,}973 \times 10^{-3}$	0,009	2%	164,742	DN-200
CR12	R2	$23{,}705 \times 10^{-3}$	0,009	2%	175,673	DN-200

$$Dm\acute{\imath}n = \left[\frac{2^{13/3} \cdot n \cdot Qm\acute{a}x}{\pi \cdot \sqrt{so}}\right]^{3/8} \cdot 10^3$$

2.2. <u>Sizing of the rainwater main.</u>

2.2.1. <u>Gutters</u>

The nominal diameter of the gutters for the disposal of rainwater to a rainfall intensity of 100 mm/h is obtained from the table 4.7 of the CTE, according to the area who has to be evacuated and the slope. The slope of the gutter will be 2%.

Area evacuated (m^2)	Nominal diameter of the gutter (mm)
215,044	200 mm
49,6838	100 mm
125,88	150 mm

2.2.2. Rainwater downspouts.

The nominal diameter of the downspouts of disposal of rainwater to a rainfall intensity of 100 mm/h is obtained from the table 4.8 of the CTE, according to the area who has to be evacuated.

Area evacuated (m^2)	Nominal diameter of the downspout (mm)
215,044	90 mm
49,6838	50 mm
125,88	75 mm

2.3. Sizing of ventilation main.

2.3.1. Primary ventilation

The primary ventilation shall have the same diameter as the downspout from that is extension. (DN-110)

2.3.2. Secondary ventilation.

Secondary ventilation diameters are obtained from table 4.10 on the CTE.

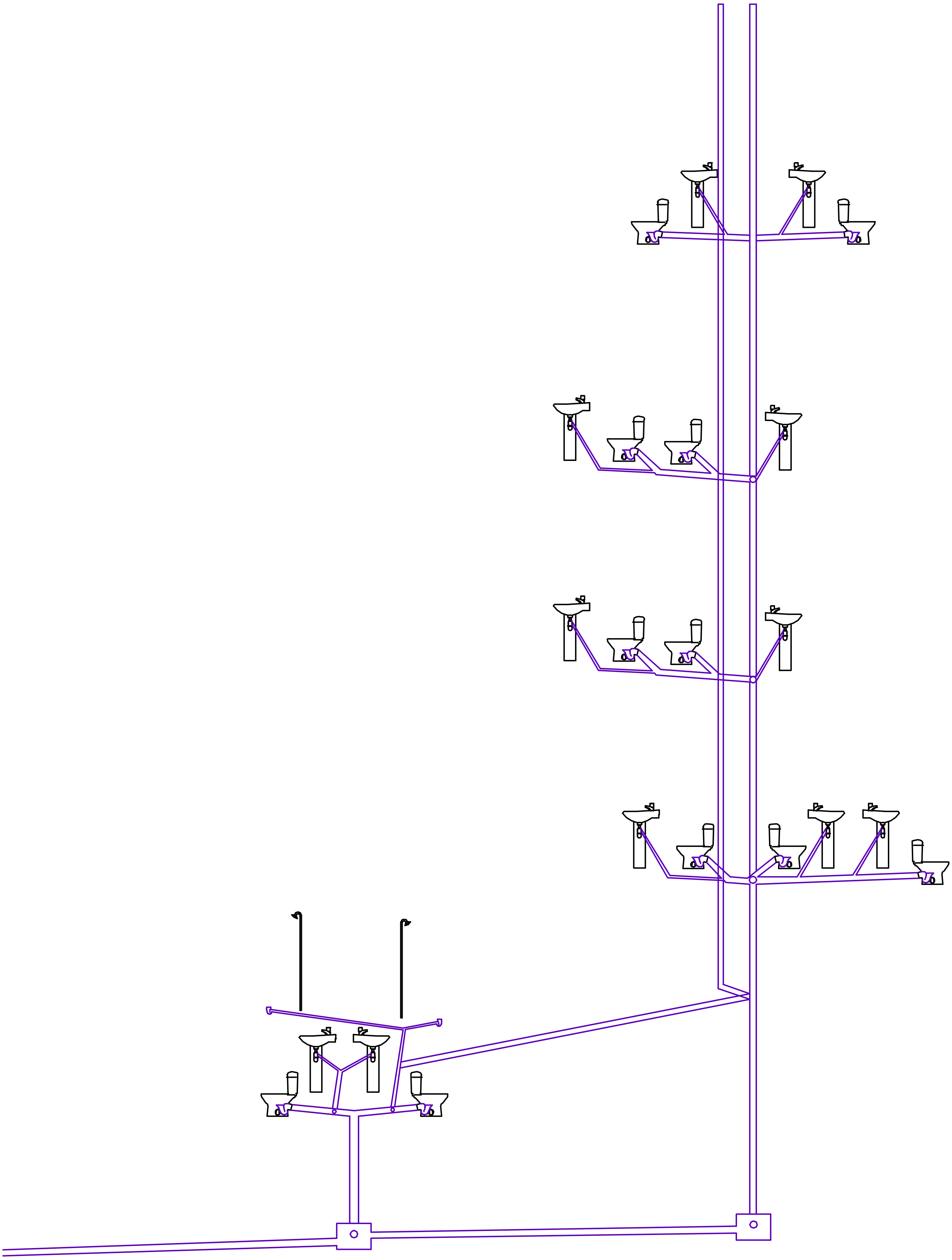
The diameter of the R2 downspout is 160 mm, therefore the secondary ventilation diameter is 80 mm.

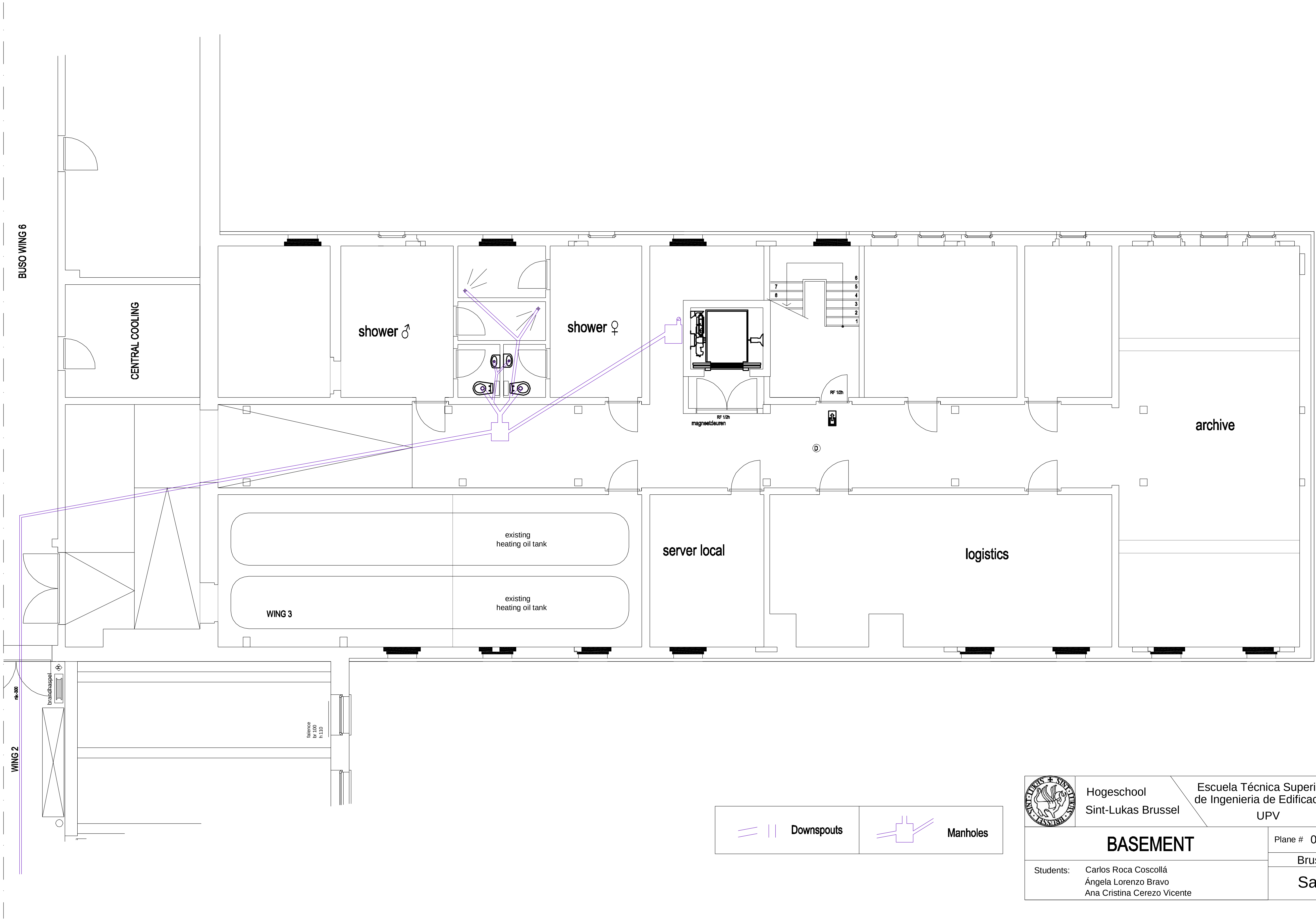
2.3.3. Tertiary ventilation.

The diameter of the drain line is 75 mm and with a slope of 2%, therefore the tertiary ventilation diameter is 32 mm.

2.4. Accessories

The diameter of the sewers of output is DN 200 diameter, so the traps have a dimension of 60 x 60 mm.





Hogeschool Sint-Lukas Brussel

Escuela Técnica Superior de Ingenieria de Edificación UPV

BASEMENT

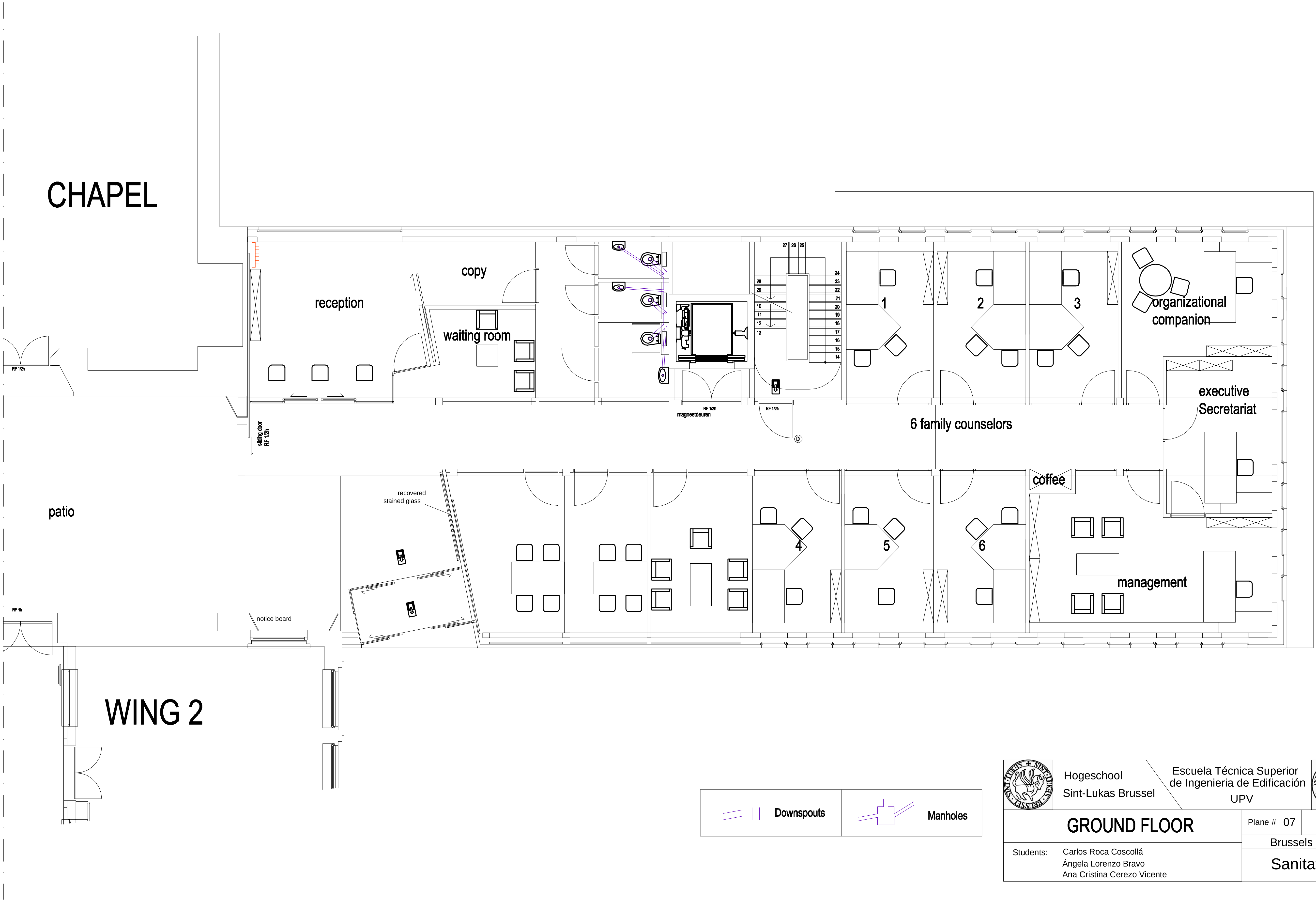
Plane # 06

Escale: 1:100

Brussels 2012

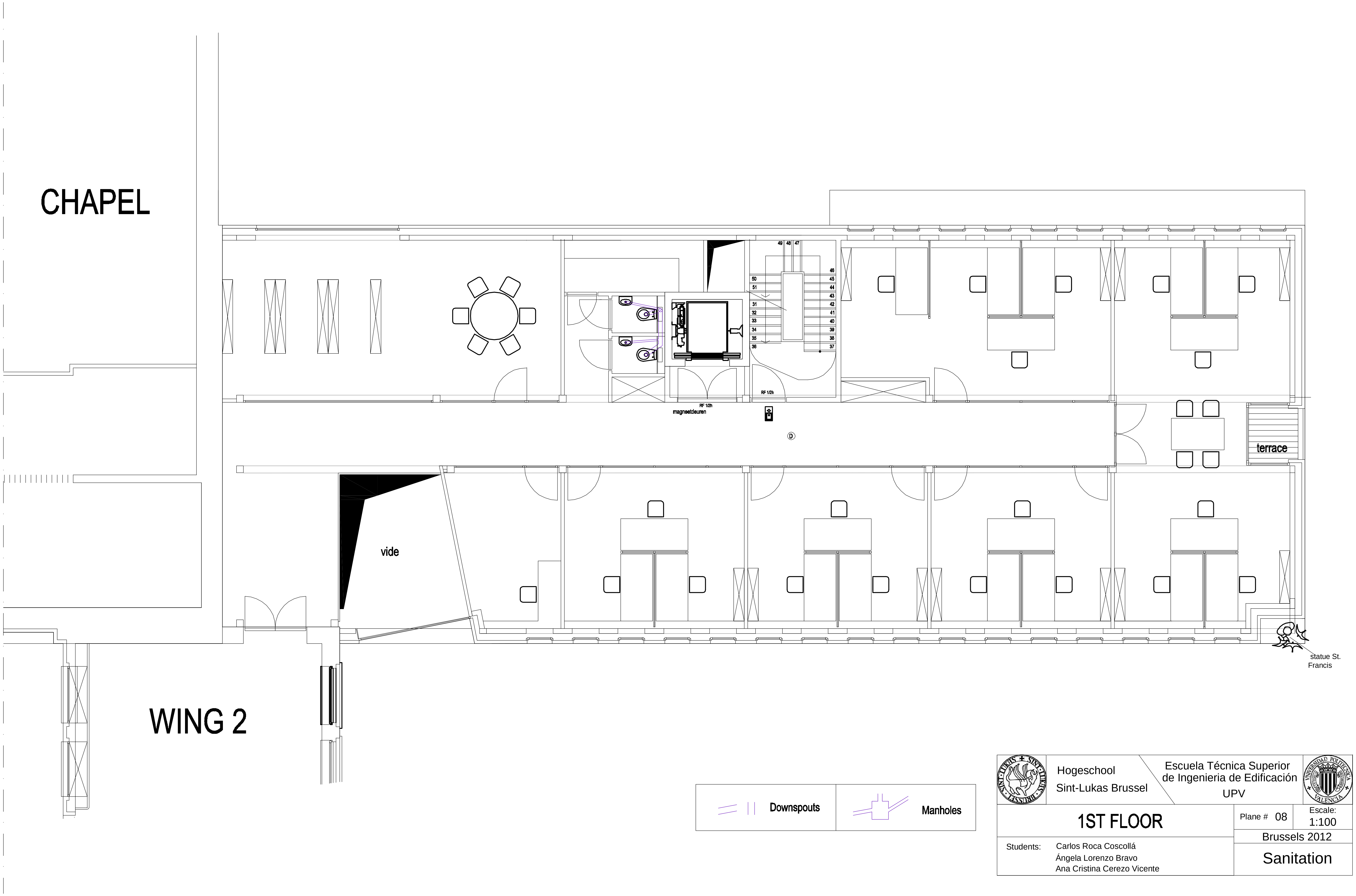
Sanitation

Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente



Downspouts	Manholes

Hogeschool Sint-Lukas Brussel	Escuela Técnica Superior de Ingenieria de Edificación UPV	
GROUND FLOOR	Plane # 07	Escale: 1:100
Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente	Brussels 2012	
	Sanitation	



Downspouts

Manholes

Hogeschool
Sint-Lukas Brussel

Escuela Técnica Superior
de Ingenieria de Edificación
UPV

1ST FLOOR

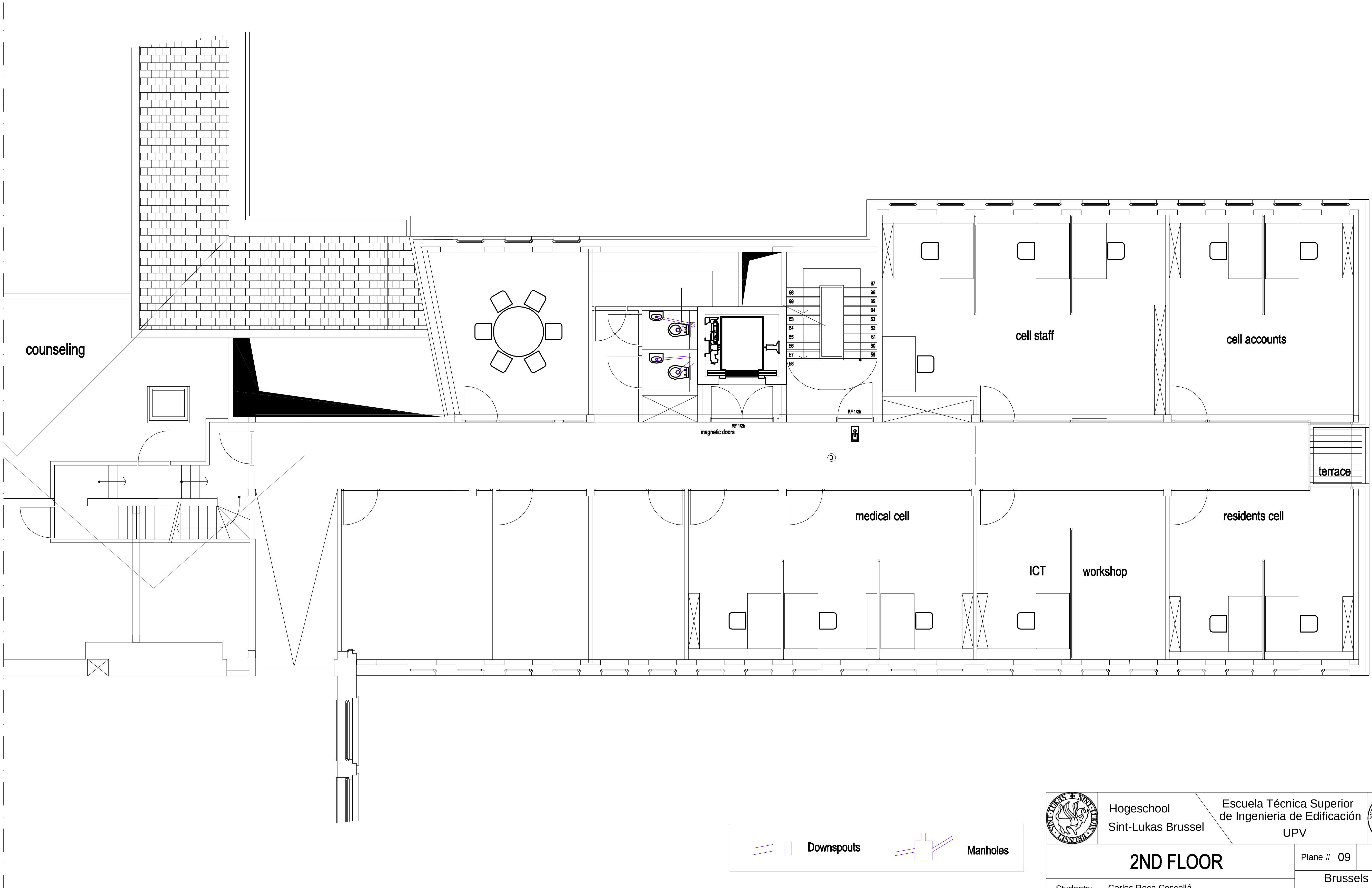
Plane # 08

Escale: 1:100

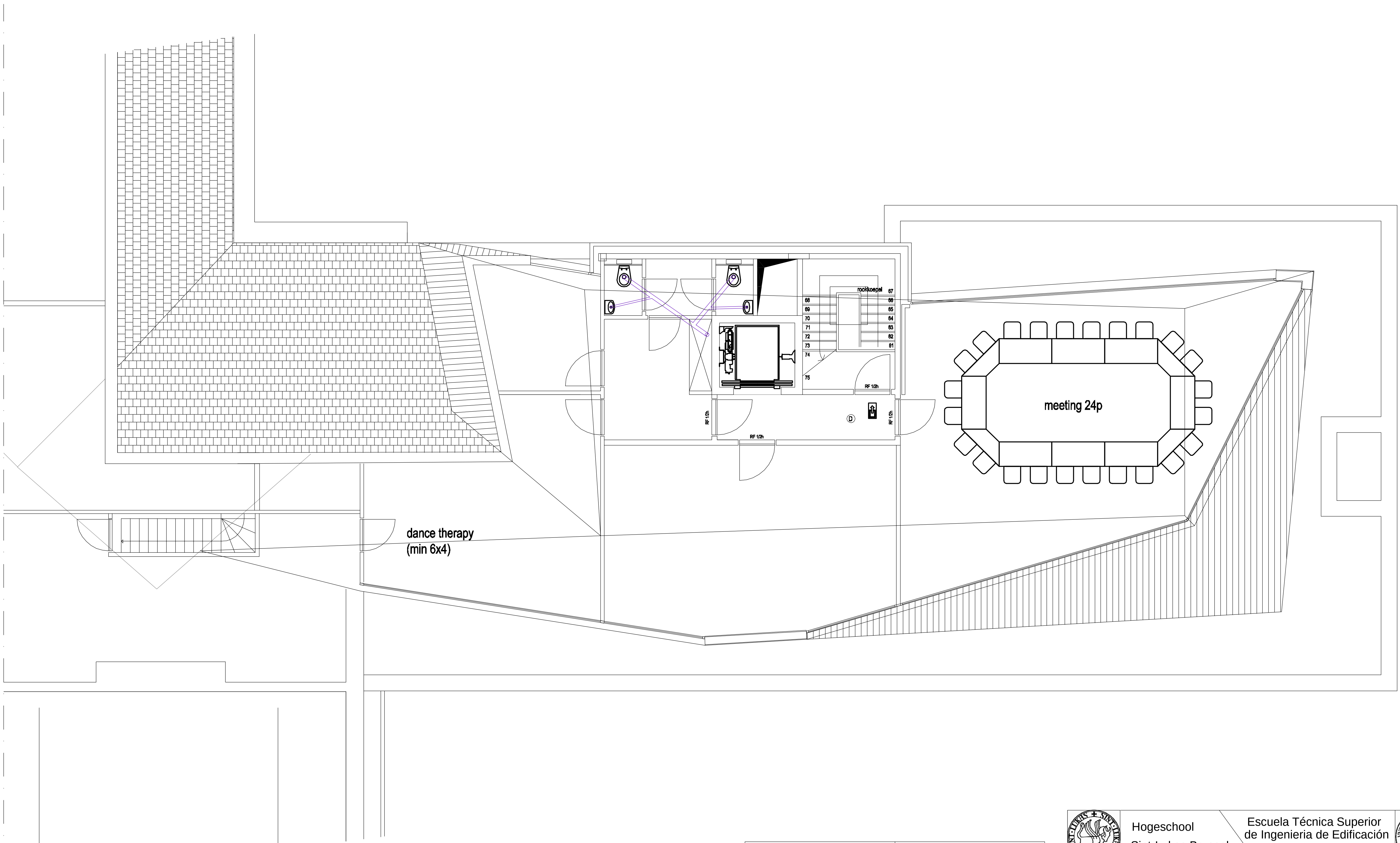
Brussels 2012

Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente

Sanitation



Hogeschool Sint-Lukas Brussel	Escuela Técnica Superior de Ingenieria de Edificación UPV	
2ND FLOOR	Plane # 09	Escale: 1:100
	Brussels 2012	
Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente	Sanitation	



Downspouts	Manholes

Hogeschool
Sint-Lukas Brussel

Escuela Técnica Superior
de Ingenieria de Edificación
UPV

3RD FLOOR

Plane # 10

Escale: 1:100

Brussels 2012

Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente

Sanitation

Electricity

Memory installation of electricity

1. Electrification degree

The degree of electrification is "high electrification " because the floor area exceeds 160 m², is scheduled to air conditioning system, the number of lighting points exceeds 30, the number of points sockets for general use is greater than 20, and the number of points of use of outlets of the fourth low and auxiliary cooking is above 6. According ITC-BT/RBT 2002.

2. Internal circuits

2.1 General protection.

Private protection circuits comprise:

- An automatic switch pole cut with conditioning manual, rated minimum 25 A and guards against short circuits. The main switch is independent switch for the power control (ICP) and can not be substituted for this.

- Differential switch to ensure protection against indirect contact of all circuits, with a residual differential current-maximum of 30 mA and rated not less than that of the switch. All circuits are protected from residual differential current-30mA maximum, being able to install other differentials greater than 30 mA intensity in series.

- Overvoltage protection devices.

2.2 Derivations.

Independent circuit types are listed below and are each protected by a circuit breaker pole cut with manual and protective devices against overloads and short circuits with a rated according to their application.

3. Independent circuits

C1	Internal distribution circuit, intended for the points of light.
C2	Internal distribution circuit, for sockets for general use and fridges.
C3	Internal distribution circuit, designed to feed the stove and oven.
C4	Internal distribution circuit, designed to feed the washing machine, dishwasher and electric boiler.
C5	Internal distribution circuit, designed to feed outlets bathrooms, as well as auxiliary plugs room kitchen.
C6	Internal distribution circuit, additional C1, intended to feed outlets bathrooms and auxiliary plugs room kitchen.
C7	Internal distribution circuit, additional C2, for every 20 outlets for general use (mandatory because the usable area of the building is greater than 160 m².
C10	Internal distribution circuit, designed to feed The dryer.
Differential switch circuitry for every five.	

4. Material and diameter

The conductors are charged, and its section is indicated in the table below, on condition that the voltage drop is at most 3%.

Utilization circuit	Power provided by socket (W)	Simultaneity factor Fs	Utilization factor Fu	Type of Jack	Automatic Switch	Maximum number of points of use or outlets per circuit	Driving section mm ² minimum	Diameter pipe or conduit mm
C1 Illumination	200	0.75	0.5	Point of Light	10	30	1.5	16
C2 General purpose plugs	3450	0.2	0.25	Plug 16A 2p+T	16	20	2.5	20
C3 Stove and oven	5400	0.5	0.75	Plug 25A 2p+T	25	2	6	25
C4 Washing machine, dishwasher and electric boiler	3450	0.66	0.75	Plug 16A 2p+T	20	3	4	20
C5 Bathroom, kitchen	3450	0.4	0.5	Plug 16A 2p+T	16	6	2.5	20
C10 dryer	3450	1	0.75	Plug 16A 2p+T	16	1	2.5	20

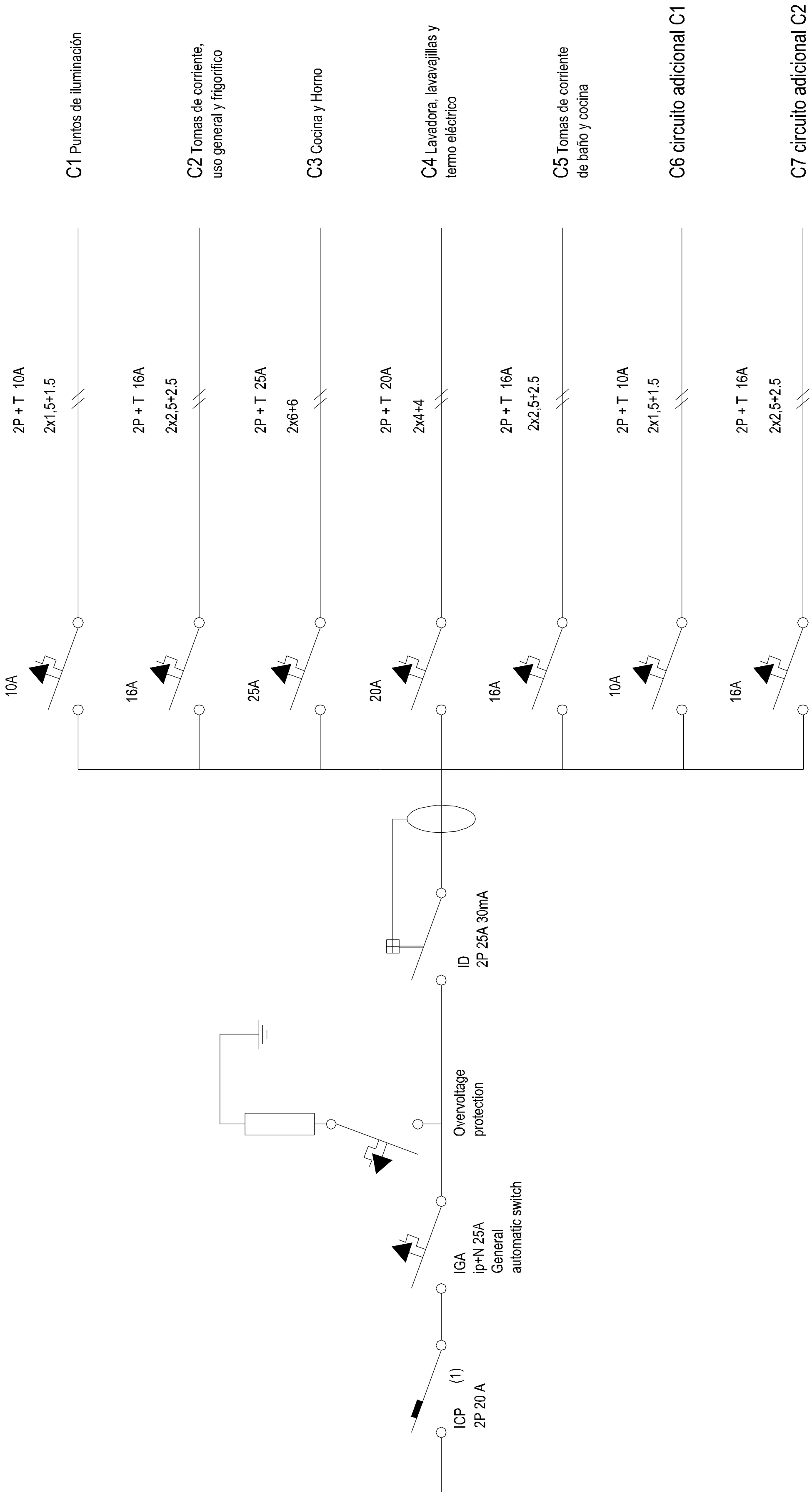
5. Minimum circuits per room

Place	Minium
Access	1 Ring
Hall	1 Point of Light 1 Switch 10A 1 Plug 16A 2P + T
Dining room (not shown on the planes)	1 Point of light (2 if <10m ²) 1 Switch 10A 3 Plugs 16A 2P + T (1 per 6m²) 1 Plugs 16A 2P + T TV
Room	1 Point of light (2 if <10m ²) 1 Switch 10A 3 Plugs 16A 2P + T (1 per 6m²)
Kitchen (not shown on the planes)	1 Point of light (2 if <10m ²) 1 Switch 10A 2 Plugs 16A 2P + T extractor and fridge 1 Plug 16A 2P + T Oven 1 Plug 16A 2p + T Washer / dishwasher and heat 1 Plug 16A 2p + T Worktop 1 Plug 2P + T 16A Dryer
Bath	1 Point of Light 1 Switch 10A 1 Plug 16A 2P + T
Corridor	1 Point of light (1 every 5 meters) 1 Switch 10A (1 on each access) 2 Plugs 16A 2P + T

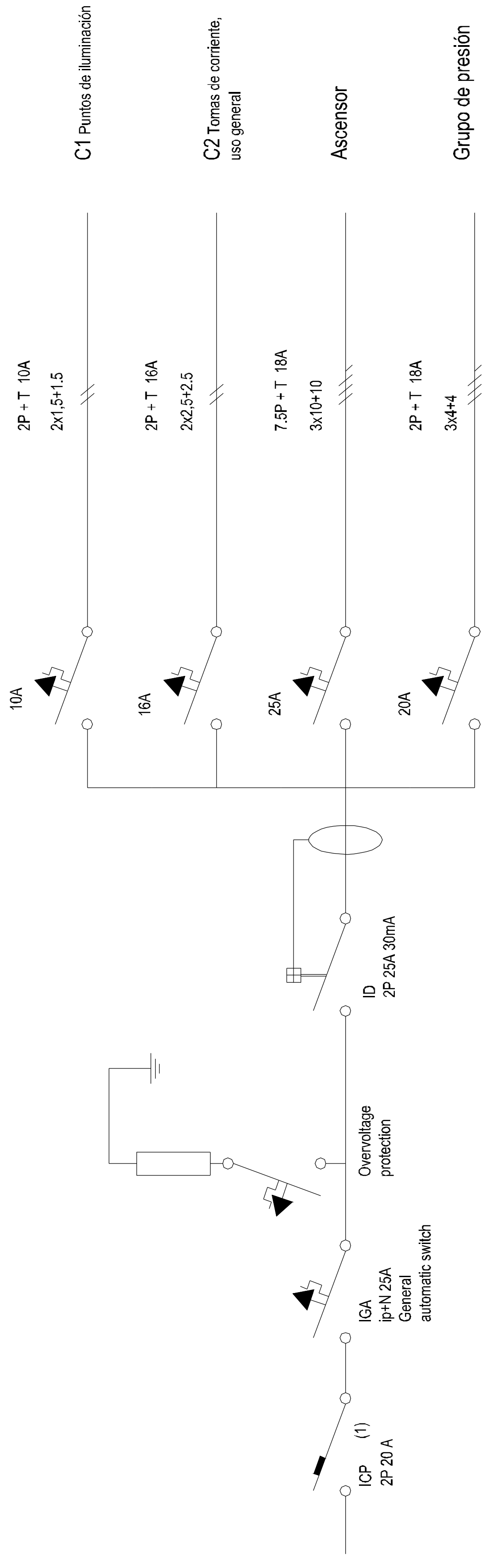
6. Total circuits used

Place	Circuit	Minium per room	Total used
Access	C1	1 Ring	1 Ring
Hall	C1	1 Point of Light 1 Switch 10A	2 Points of Light 1 Switch 10A
	C2	1 Plug 16A 2P + T	1 Plug 16A 2P + T
Dining room (not shown on the planes)	C1	1 Point of light (2 if $<10m^2$) 1 Switch 10A	Minium (not shown on the planes)
	C2	3 Plugs 16A 2P + T (1 per $6m^2$)	Minium (not shown on the planes)
Rooms	C1	1 Point of light (2 if $<10m^2$) 1 Switch 10A	108 Points of light 78 Switches 10A
	C2	3 Plugs 16A 2P + T (1 per $6m^2$)	147 Plugs 16A 2P + T
Kitchen (not shown on the planes)	C1	1 Point of light (2 if $<10m^2$) 1 Switch 10A	Minium (not shown on the planes)
	C2	2 Plugs 16A 2P + T extractor and fridge	Minium (not shown on the planes)
	C3	1 Plug 16A 2P + T Oven	Minium (not shown on the planes)
	C4	1 Plug 16A 2p + T Washer / dishwasher and heat	Minium (not shown on the planes)
	C5	1 Plug 16A 2p + T Worktop	Minium (not shown on the planes)
	C10	1 Plug 2P + T 16A Dryer	Minium (not shown on the planes)
Baths	C1	1 Point of Light 1 Switch 10A	18 Points of Light 6 Switches 10A
	C5	1 Plug 16A 2P + T	9 Plugs 16A 2P + T
Corridors	C1	1 Point of light (1 every 5 meters) 1 Switch 10A (1 on each access)	31 Points of light 50 Switches 10A (1 on each access)
	C2	2 Plugs 16A 2P + T	20 Plugs 16A 2P + T

7. High electrification circuit



8. Pressure Group room, stairs and elevador circuit



Meeting room

Contacto:
N° de encargo:
Empresa:
N° de cliente:

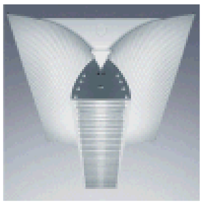
Date: 04.06.2012
Operator:

Operator
Telephone
Fax
e-Mail

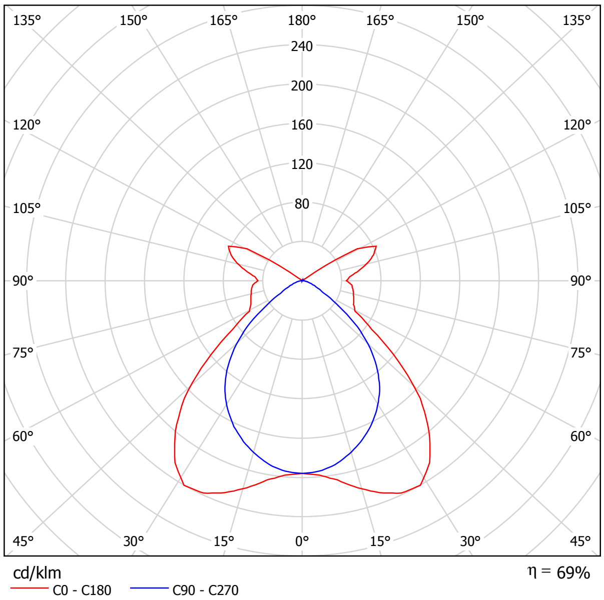
Table of contents

Operator
Telephone
Fax
e-Mail

DIAL 27 LZA 2/35W T16 EVG LME / Luminaire Data Sheet



Luminous emittance 1:



Luminaire classification according to CIE: 83
CIE flux code: 53 81 91 83 69

Anbauleuchte mit Techno Raster 2 x 35W, für T16, mit digital dimmbarem elektronischen Vorschaltgerät, Bivergenzspiegelraster aus matt eloxiertem Reinaluminim im HighTech-Design ohne äussere Rasterverkleidung; Anbaugehäuse aus Stahlblech weiss lackiert; hochoptimierte, in die Decke auslaufende Reflektoren aus matt eloxiertem Aluminium-Stufenprofil, werkzeuglos montierbar; 5-polige Steckklemme; Abmessungen: 304 x 1548 x 142 mm, Gewicht: 7 kg.

Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	13.5	14.6	14.1	15.1	15.7	12.2	13.3	12.8	13.8	14.4
	3H	14.7	15.6	15.2	16.2	16.8	12.4	13.4	13.0	13.9	14.5
	4H	15.5	16.4	16.1	16.9	17.6	12.5	13.4	13.1	13.9	14.6
	6H	16.5	17.3	17.1	17.9	18.5	12.6	13.4	13.1	14.0	14.6
	8H	17.0	17.8	17.6	18.4	19.1	12.6	13.4	13.2	14.0	14.6
	12H	17.6	18.3	18.2	18.9	19.6	12.6	13.4	13.2	14.0	14.6
4H	2H	13.7	14.6	14.3	15.1	15.8	12.7	13.6	13.3	14.2	14.8
	3H	15.1	15.9	15.7	16.5	17.2	13.3	14.0	13.9	14.6	15.3
	4H	16.2	16.9	16.8	17.5	18.2	13.6	14.2	14.2	14.9	15.6
	6H	17.5	18.0	18.1	18.7	19.4	13.8	14.4	14.5	15.1	15.8
	8H	18.1	18.7	18.8	19.3	20.1	14.0	14.5	14.6	15.2	15.9
	12H	18.8	19.3	19.5	20.0	20.8	14.1	14.6	14.8	15.3	16.0
8H	4H	16.4	16.9	17.1	17.6	18.4	14.5	15.1	15.2	15.7	16.5
	6H	17.9	18.4	18.6	19.1	19.9	15.3	15.7	16.0	16.4	17.2
	8H	18.8	19.2	19.5	19.9	20.7	15.6	16.0	16.3	16.7	17.6
	12H	19.7	20.1	20.4	20.8	21.6	16.0	16.3	16.7	17.0	17.9
12H	4H	16.4	16.9	17.1	17.6	18.4	14.9	15.4	15.6	16.1	16.8
	6H	18.0	18.4	18.7	19.1	19.9	15.9	16.3	16.6	17.0	17.8
	8H	19.0	19.3	19.7	20.0	20.9	16.5	16.9	17.2	17.6	18.4

Variation of the observer position for the luminaire distances S

	Viewing direction at right angles to lamp axis	Viewing direction parallel to lamp axis
S = 1.0H	+0.2 / -0.2	+0.3 / -0.3
S = 1.5H	+0.3 / -0.5	+0.6 / -0.7
S = 2.0H	+0.6 / -0.7	+0.9 / -0.9
Standard table	---	---
Correction Summand	---	---

Corrected Glare Indices referring to 6860lm Total Luminous Flux

Operator
Telephone
Fax
e-Mail

DIAL 27 LZA 2/35W T16 EVG LME / UGR-Table

Luminaire: DIAL 27 LZA 2/35W T16 EVG LME
Lamps: 2 x T16 35W

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	13.5	14.6	14.1	15.1	15.7	12.2	13.3	12.8	13.8	14.4
	3H	14.7	15.6	15.2	16.2	16.8	12.4	13.4	13.0	13.9	14.5
	4H	15.5	16.4	16.1	16.9	17.6	12.5	13.4	13.1	13.9	14.6
	6H	16.5	17.3	17.1	17.9	18.5	12.6	13.4	13.1	14.0	14.6
	8H	17.0	17.8	17.6	18.4	19.1	12.6	13.4	13.2	14.0	14.6
	12H	17.6	18.3	18.2	18.9	19.6	12.6	13.4	13.2	14.0	14.6
4H	2H	13.7	14.6	14.3	15.1	15.8	12.7	13.6	13.3	14.2	14.8
	3H	15.1	15.9	15.7	16.5	17.2	13.3	14.0	13.9	14.6	15.3
	4H	16.2	16.9	16.8	17.5	18.2	13.6	14.2	14.2	14.9	15.6
	6H	17.5	18.0	18.1	18.7	19.4	13.8	14.4	14.5	15.1	15.8
	8H	18.1	18.7	18.8	19.3	20.1	14.0	14.5	14.6	15.2	15.9
	12H	18.8	19.3	19.5	20.0	20.8	14.1	14.6	14.8	15.3	16.0
8H	4H	16.4	16.9	17.1	17.6	18.4	14.5	15.1	15.2	15.7	16.5
	6H	17.9	18.4	18.6	19.1	19.9	15.3	15.7	16.0	16.4	17.2
	8H	18.8	19.2	19.5	19.9	20.7	15.6	16.0	16.3	16.7	17.6
	12H	19.7	20.1	20.4	20.8	21.6	16.0	16.3	16.7	17.0	17.9
12H	4H	16.4	16.9	17.1	17.6	18.4	14.9	15.4	15.6	16.1	16.8
	6H	18.0	18.4	18.7	19.1	19.9	15.9	16.3	16.6	17.0	17.8
	8H	19.0	19.3	19.7	20.0	20.9	16.5	16.9	17.2	17.6	18.4

Variation of the observer position for the luminaire distances S

S = 1.0H	+0.2 / -0.2	+0.3 / -0.3
S = 1.5H	+0.3 / -0.5	+0.6 / -0.7
S = 2.0H	+0.6 / -0.7	+0.9 / -0.9
Standard table	---	---
Correction Summand	---	---

Corrected Glare Indices referring to 6860lm Total Luminous Flux

The UGR values have been calculated according to CIE Publ. 117 Spacing-to-Height-Ratio = 0.25.

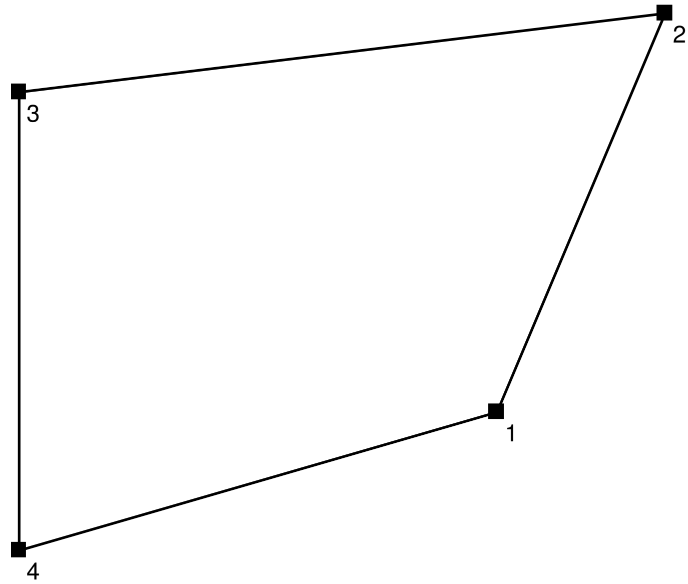
Operator
Telephone
Fax
e-Mail

Meeting room / Input Protocol

Height of working plane: 0.850 m
Boundary Zone: 2.000 m

Light loss factor: 0.80

Height of Room: 3.000 m
Ground area: 58.36 m²

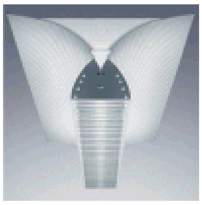


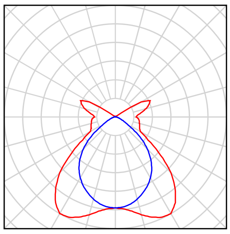
Surface	Rho [%]	from ([m] | [m])	towards ([m] | [m])	Length [m]
Terrazzo	15	/	/	/
Plaster Ceiling	70	/	/	/
Glass	30	(7.580 | 2.200)	(10.250 | 8.530)	6.870
Glass	6	(10.250 | 8.530)	(0.000 | 7.280)	10.326
Brick	20	(0.000 | 7.280)	(0.000 | 0.000)	7.280
Glass	30	(0.000 | 0.000)	(7.580 | 2.200)	7.893

Operator
Telephone
Fax
e-Mail

Meeting room / Luminaire parts list

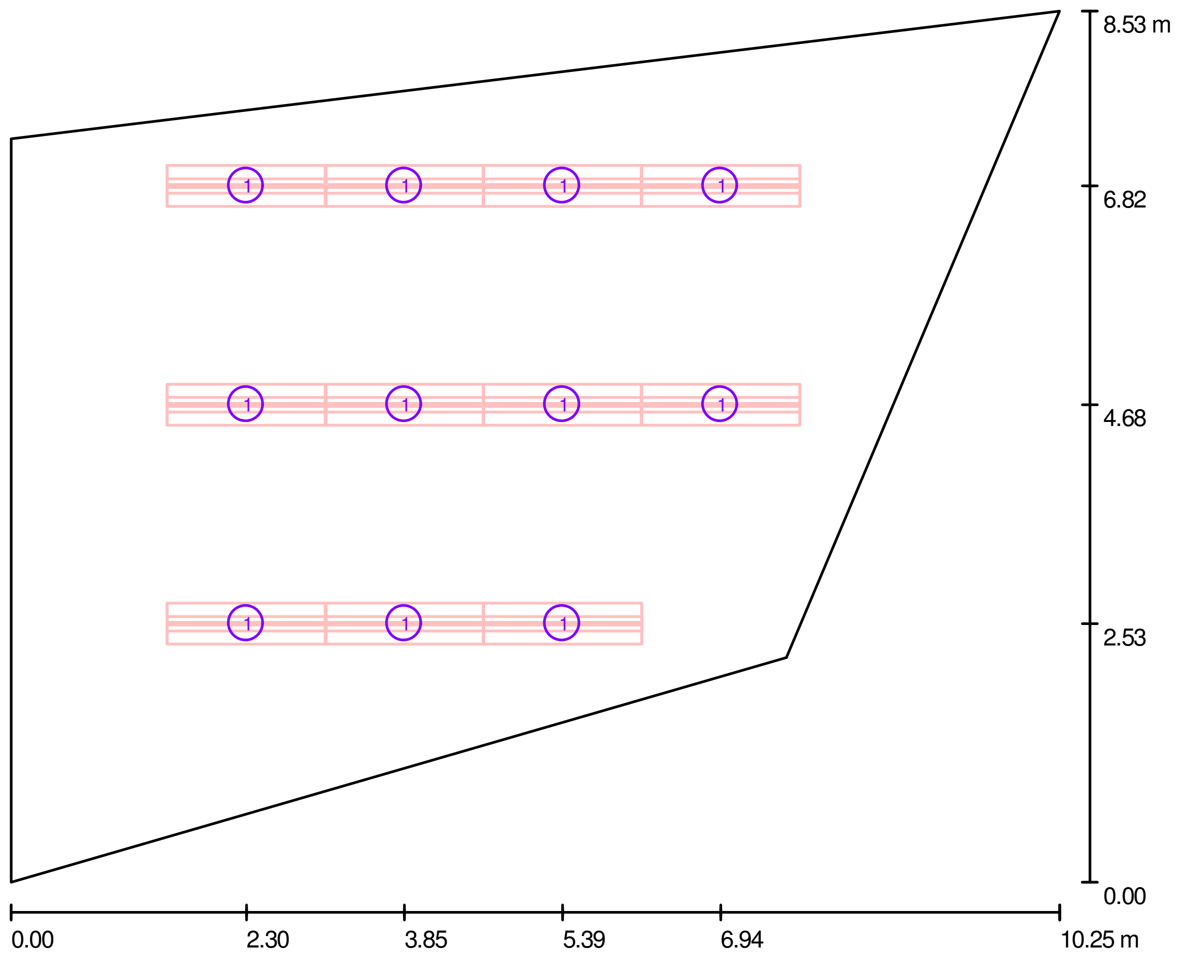
11 Pieces DIAL 27 LZA 2/35W T16 EVG LME
Article No.: 27
Luminous flux (Luminaire): 4705 lm
Luminous flux (Lamps): 6860 lm
Luminaire Wattage: 75.0 W
Luminaire classification according to CIE: 83
CIE flux code: 53 81 91 83 69
Fitting: 2 x T16 35W (Correction Factor 1.000).





Operator
Telephone
Fax
e-Mail

Meeting room / Luminaires (layout plan)



Scale 1 : 74

Luminaire Parts List

No.	Pieces	Designation
1	11	DIAL 27 LZA 2/35W T16 EVG LME

Operator
Telephone
Fax
e-Mail

Meeting room / Photometric Results

Total Luminous Flux: 51755 lm
Total Load: 825.0 W
Light loss factor: 0.80
Boundary Zone: 2.000 m

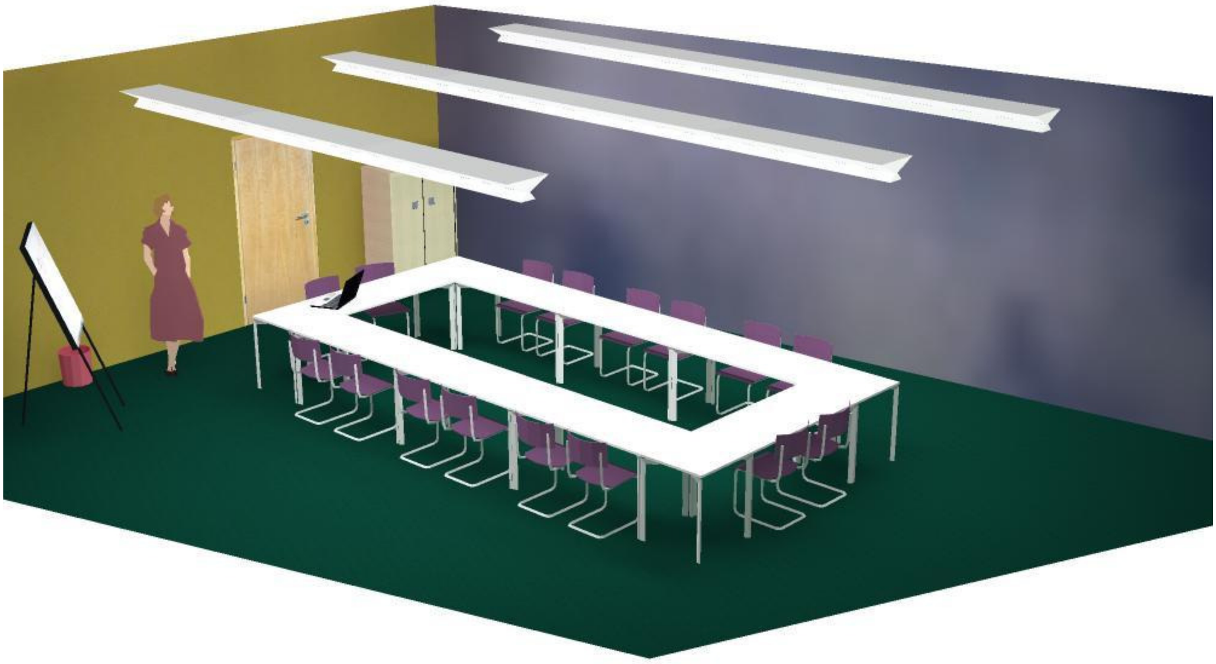
Surface	Average illuminances [lx]			Reflection factor [%]	Average luminance [cd/m²]
	direct	indirect	total		
Plano útil	696	123	820	/	/
Terrazzo	250	66	316	15	15
Plaster Ceiling	105	66	171	70	38
Glass	79	56	135	30	13
Glass	201	73	274	6	5.24
Brick	51	52	104	20	6.61
Glass	179	65	245	30	23

Uniformity on the working plane
u0: 0.694 (1:1)
E_{min} / E_{max}: 0.606 (1:2)

Specific connected load: 14.14 W/m² = 1.72 W/m²/100 lx (Ground area: 58.36 m²)

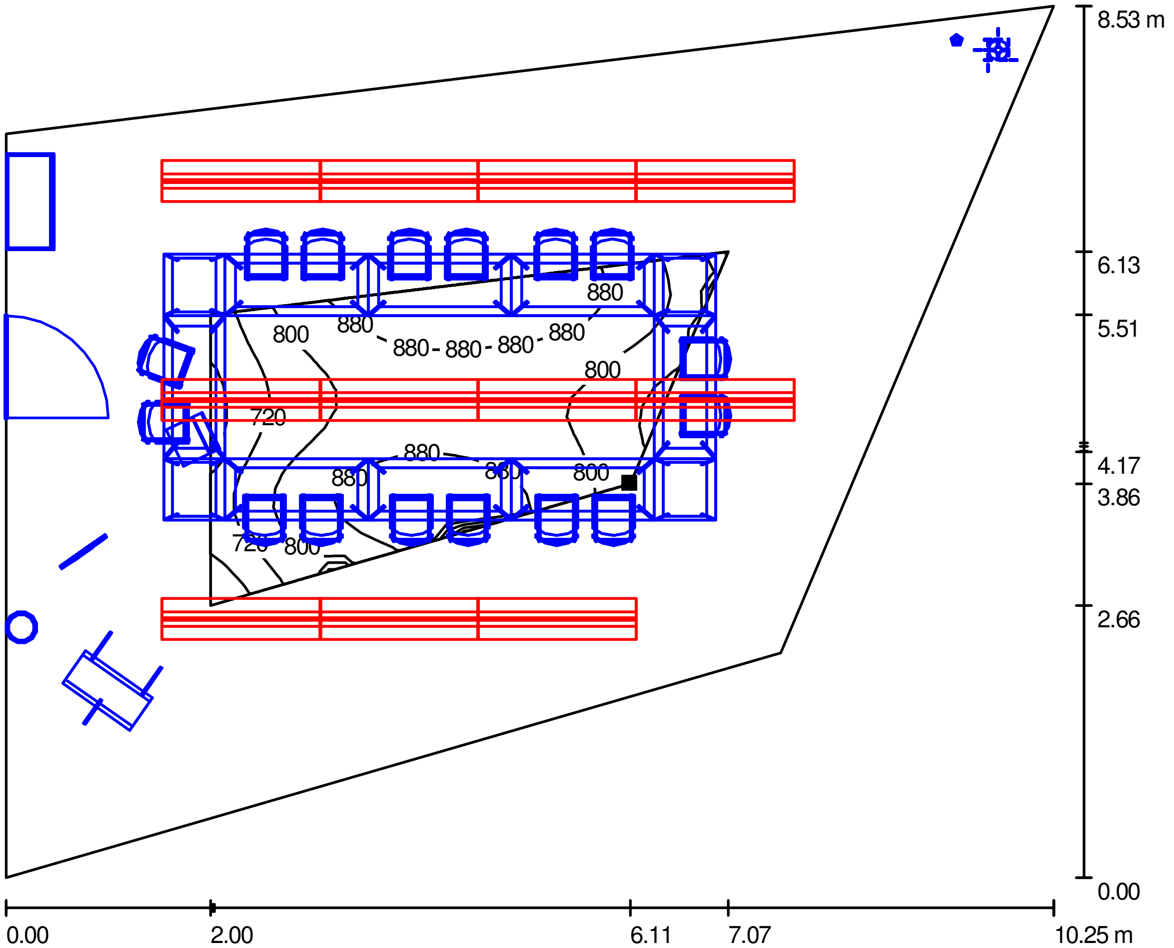
Operator
Telephone
Fax
e-Mail

Meeting room / 3D Rendering



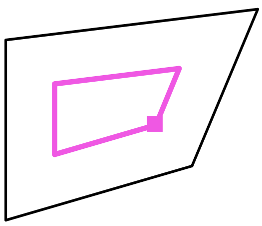
Operator
Telephone
Fax
e-Mail

Meeting room / Plano útil / Isolines (E)



Values in Lux, Scale 1 : 74

Position of surface in room:
Working plane with 2.000 m
Boundary Zone
Marked point:
(6.108 m, 3.855 m, 0.850 m)

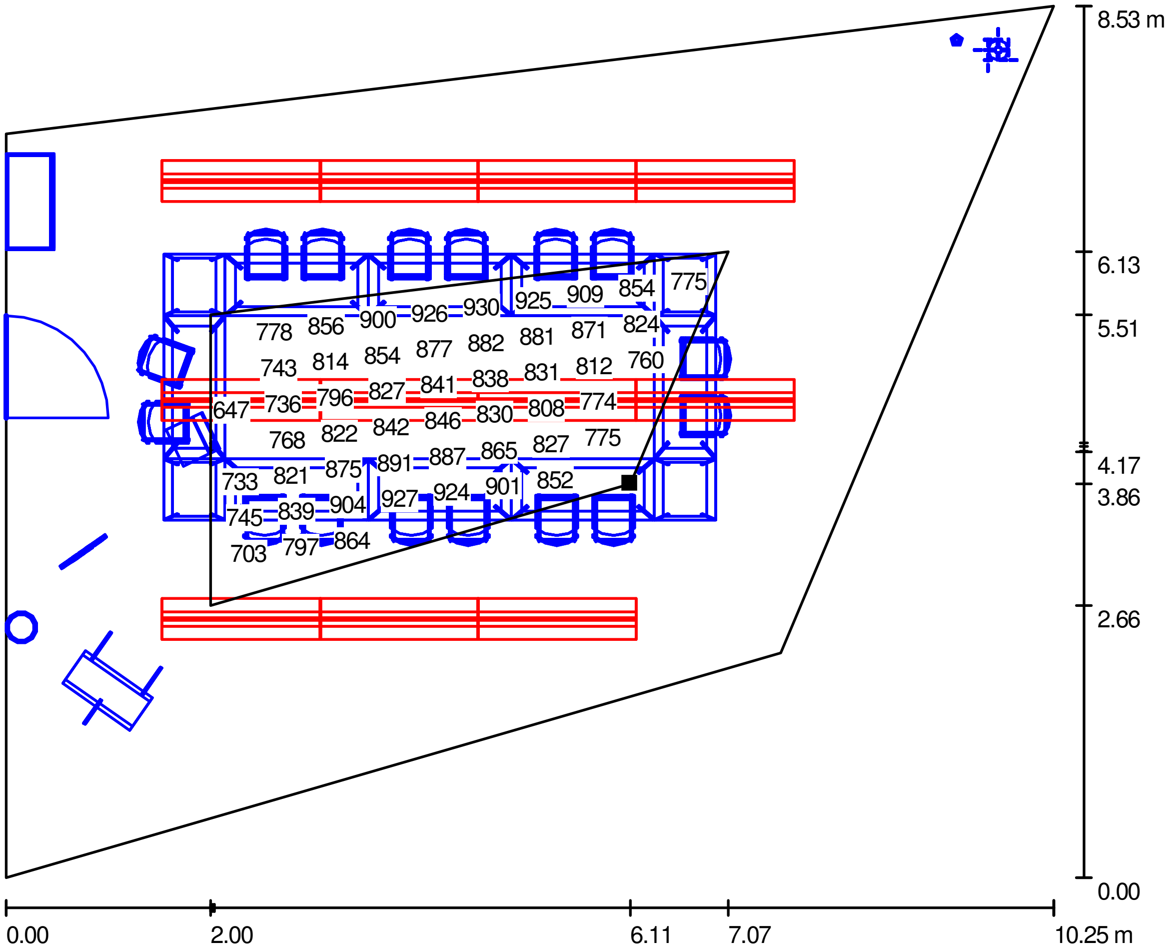


Grid: 32 x 16 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
820	569	938	0.694	0.606

Operator
Telephone
Fax
e-Mail

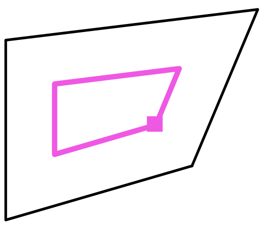
Meeting room / Plano útil / Value Chart (E)



Values in Lux, Scale 1 : 74

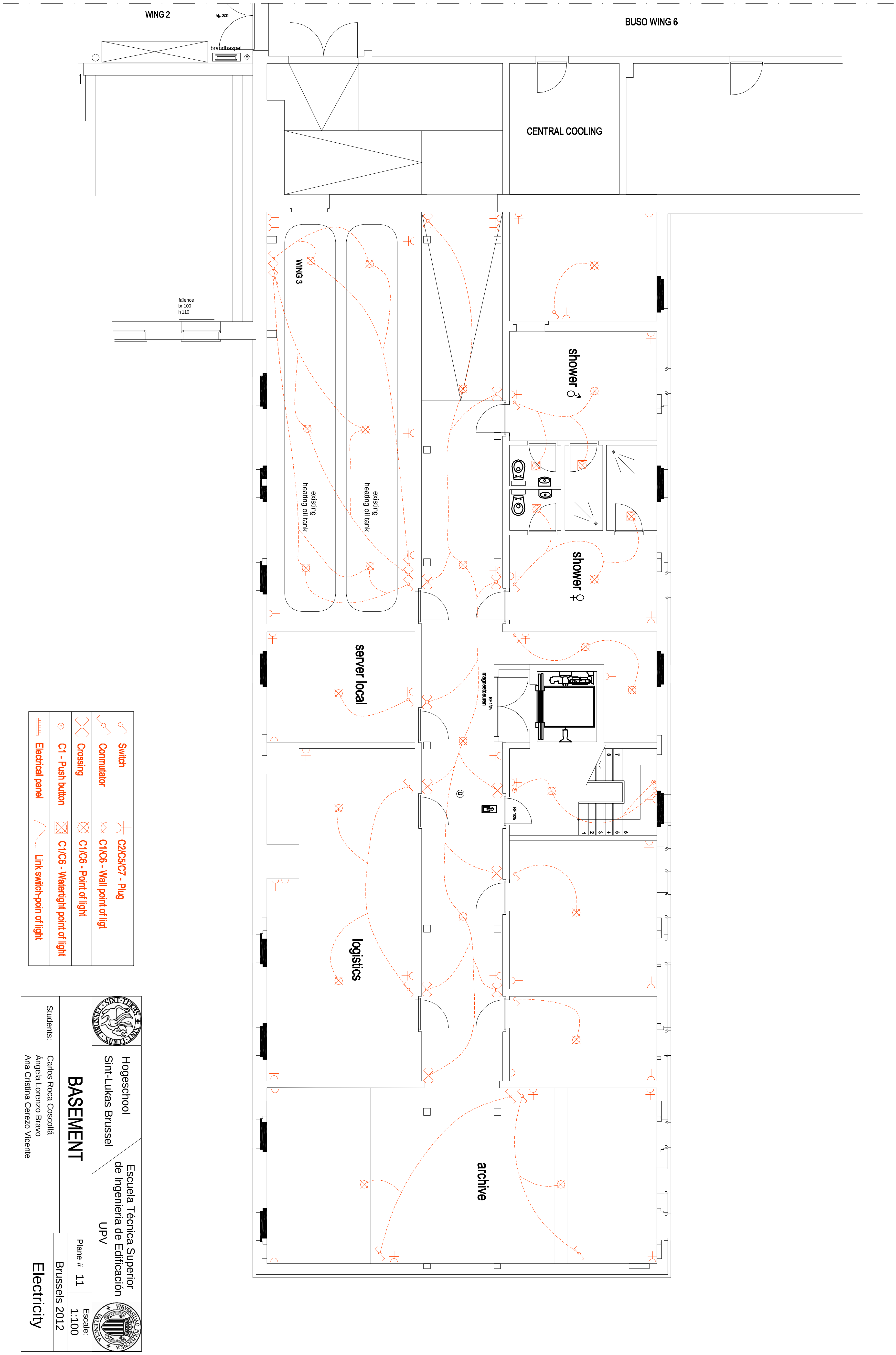
Not all calculated values could be displayed.

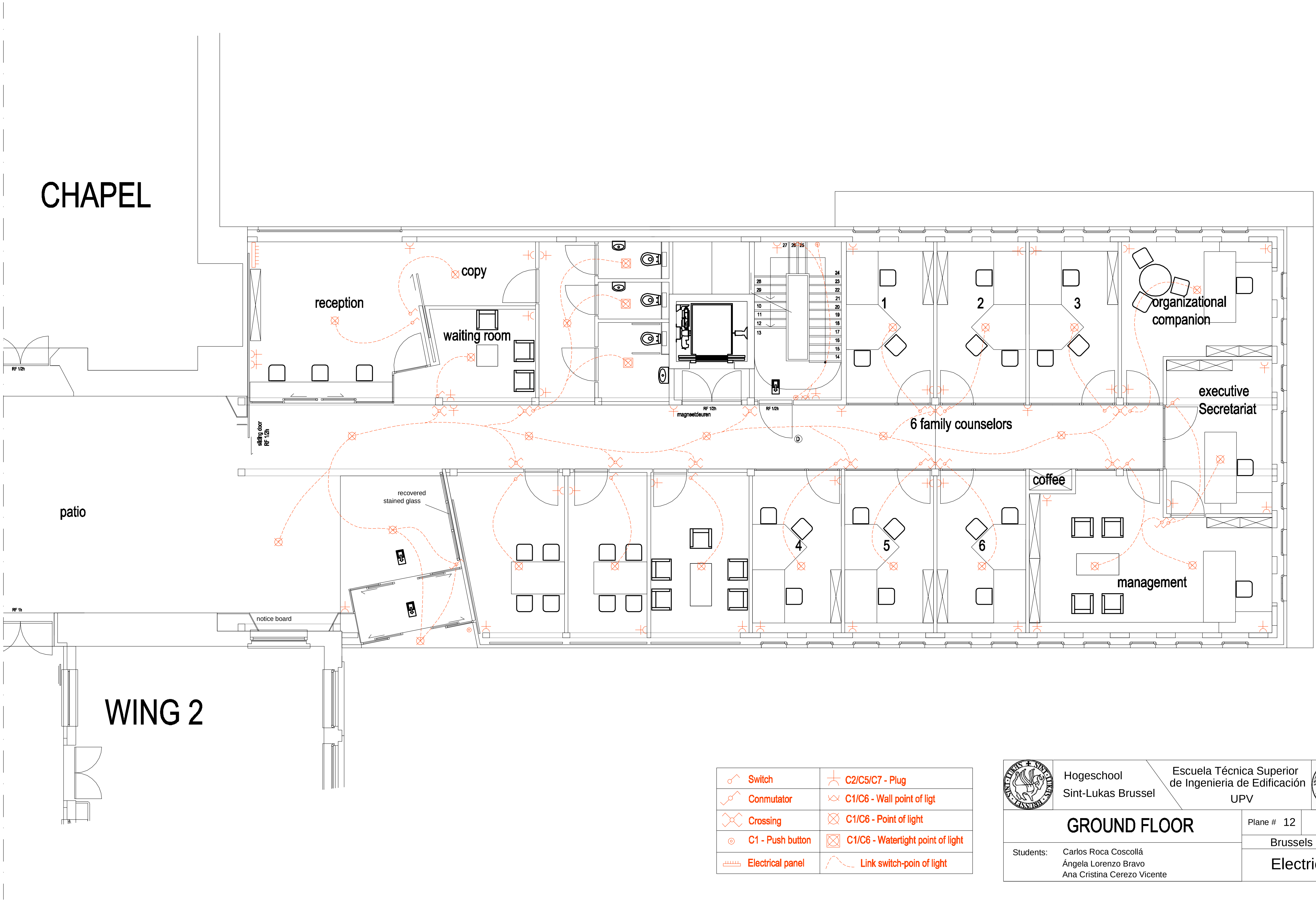
Position of surface in room:
Working plane with 2.000 m
Boundary Zone
Marked point:
(6.108 m, 3.855 m, 0.850 m)



Grid: 32 x 16 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	u0	E_{min} / E_{max}
820	569	938	0.694	0.606


WING 2
brandhaspel
faience
br 100
h 110
BUSO WING 6
CENTRAL COOLING
WING 3
existing heating oil tank
existing heating oil tank
shower ♂
shower ♀
server local
logistics
archive
Switch
Commutator
Crossing
C1 - Push button
Electrical panel
C2/C5/C7 - Plug
C1/C6 - Wall point of ligt
C1/C6 - Point of light
C1/C6 - Waterlight point of light
Link switch-poin of light
Hogeschool
Sint-Lukas Brussel
Escuela Técnica Superior
de Ingeniería de Edificación
UPV
BASEMENT
Students:
Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente
Plane # 11
Escale: 1:100
Brussels 2012
Electricity



Switch	C2/C5/C7 - Plug
Commutator	C1/C6 - Wall point of ligt
Crossing	C1/C6 - Point of light
C1 - Push button	C1/C6 - Watertight point of light
Electrical panel	Link switch-poin of light

Hogeschool
Sint-Lukas Brussel

Escuela Técnica Superior de Ingenieria de Edificación
UPV

GROUND FLOOR

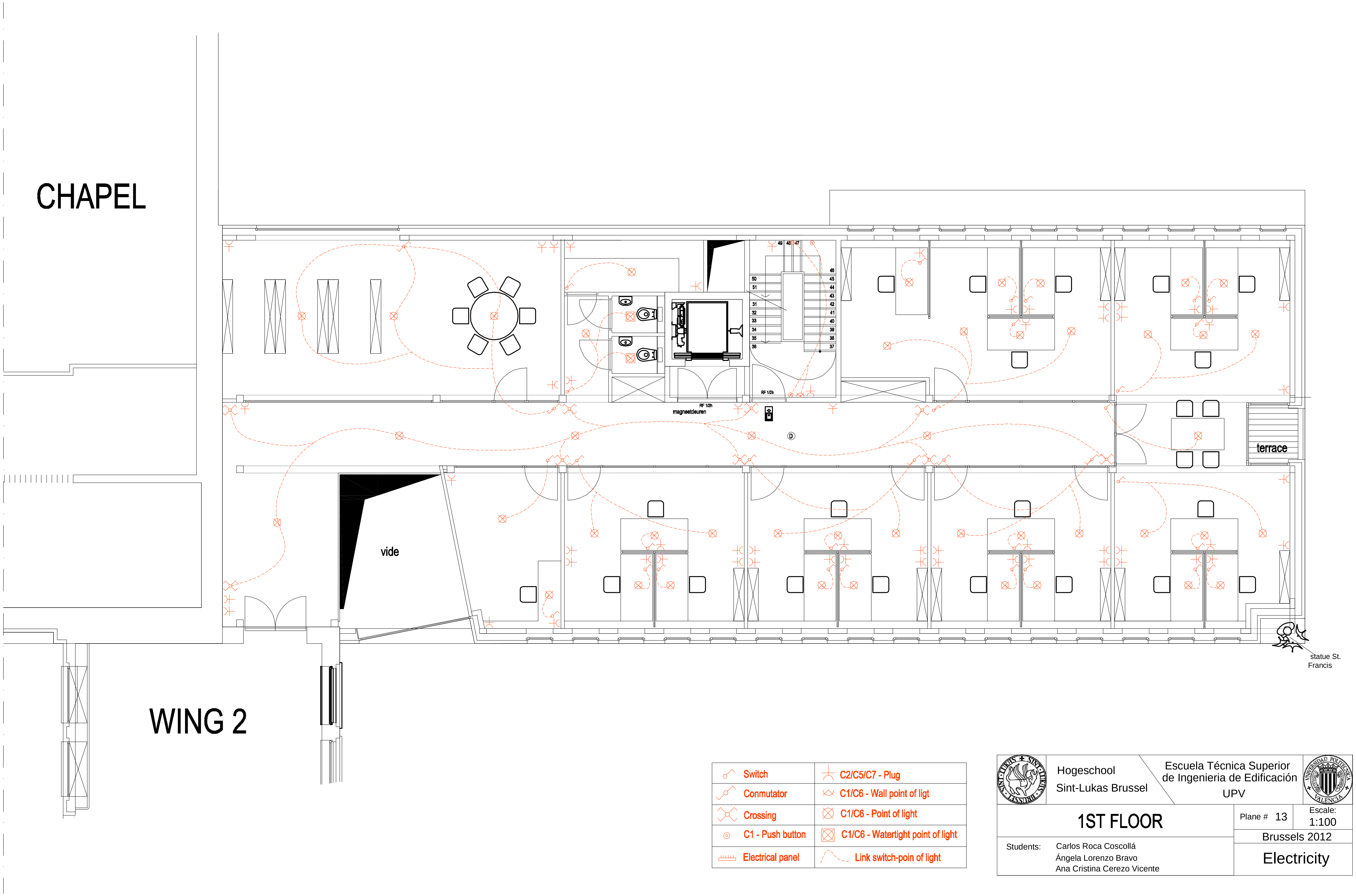
Plane # 12

Escale: 1:100

Brussels 2012

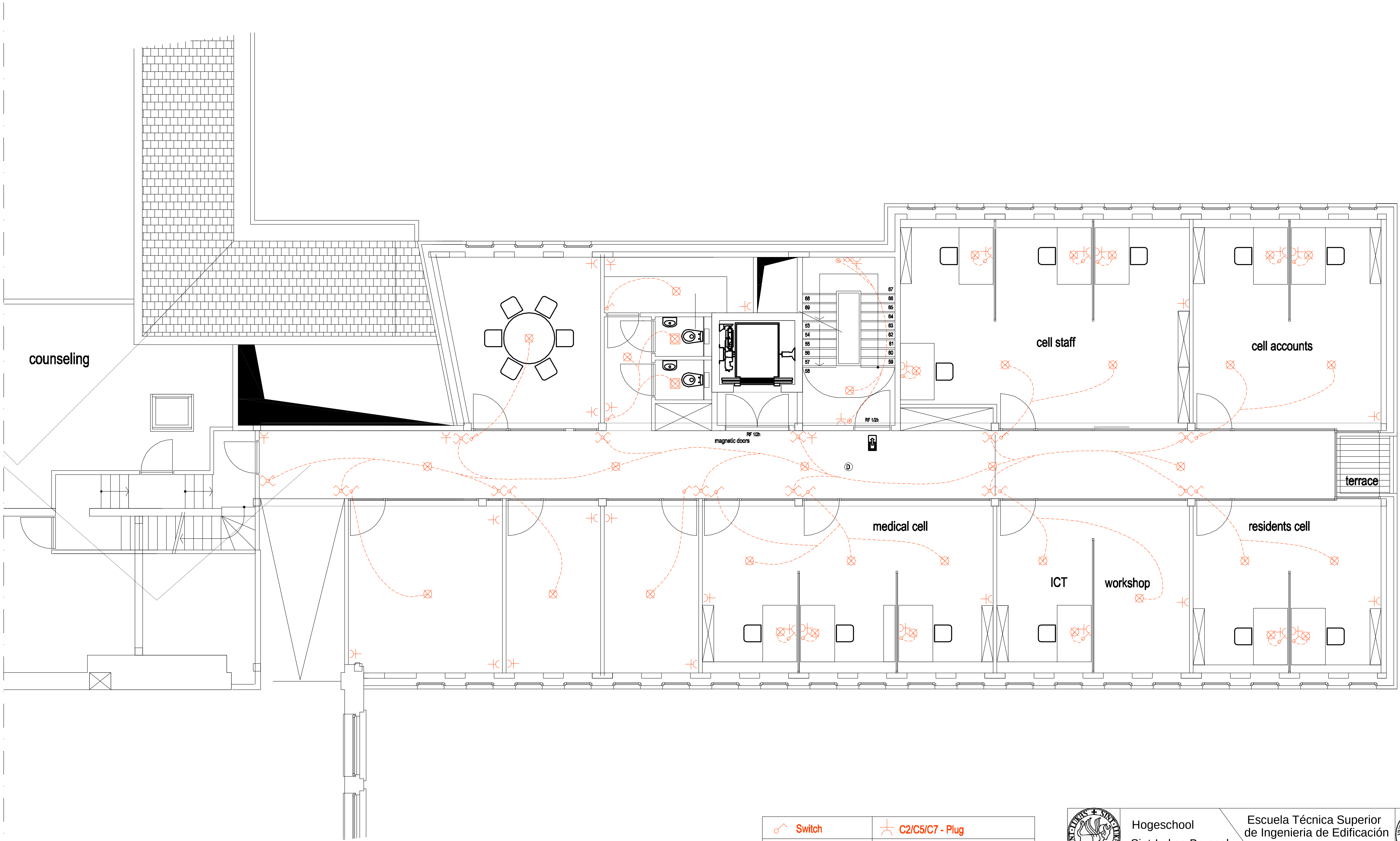
Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente

Electricity



Switch	C2/C5/C7 - Plug
Conmutator	C1/C6 - Wall point of ligt
Crossing	C1/C6 - Point of light
C1 - Push button	C1/C6 - Watertight point of light
Electrical panel	Link switch-poin of light

Hogeschool Sint-Lukas Brussel	Escuela Técnica Superior de Ingenieria de Edificación UPV	
1ST FLOOR	Plane # 13	Escale: 1:100
	Brussels 2012	
Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente	Electricity	



Switch	C2/C5/C7 - Plug
Conmutator	C1/C6 - Wall point of ligt
Crossing	C1/C6 - Point of light
C1 - Push button	C1/C6 - Watertight point of light
Electrical panel	Link switch-poin of light

Hogeschool
Sint-Lukas Brussel

Escuela Técnica Superior
de Ingenieria de Edificación
UPV

2ND FLOOR

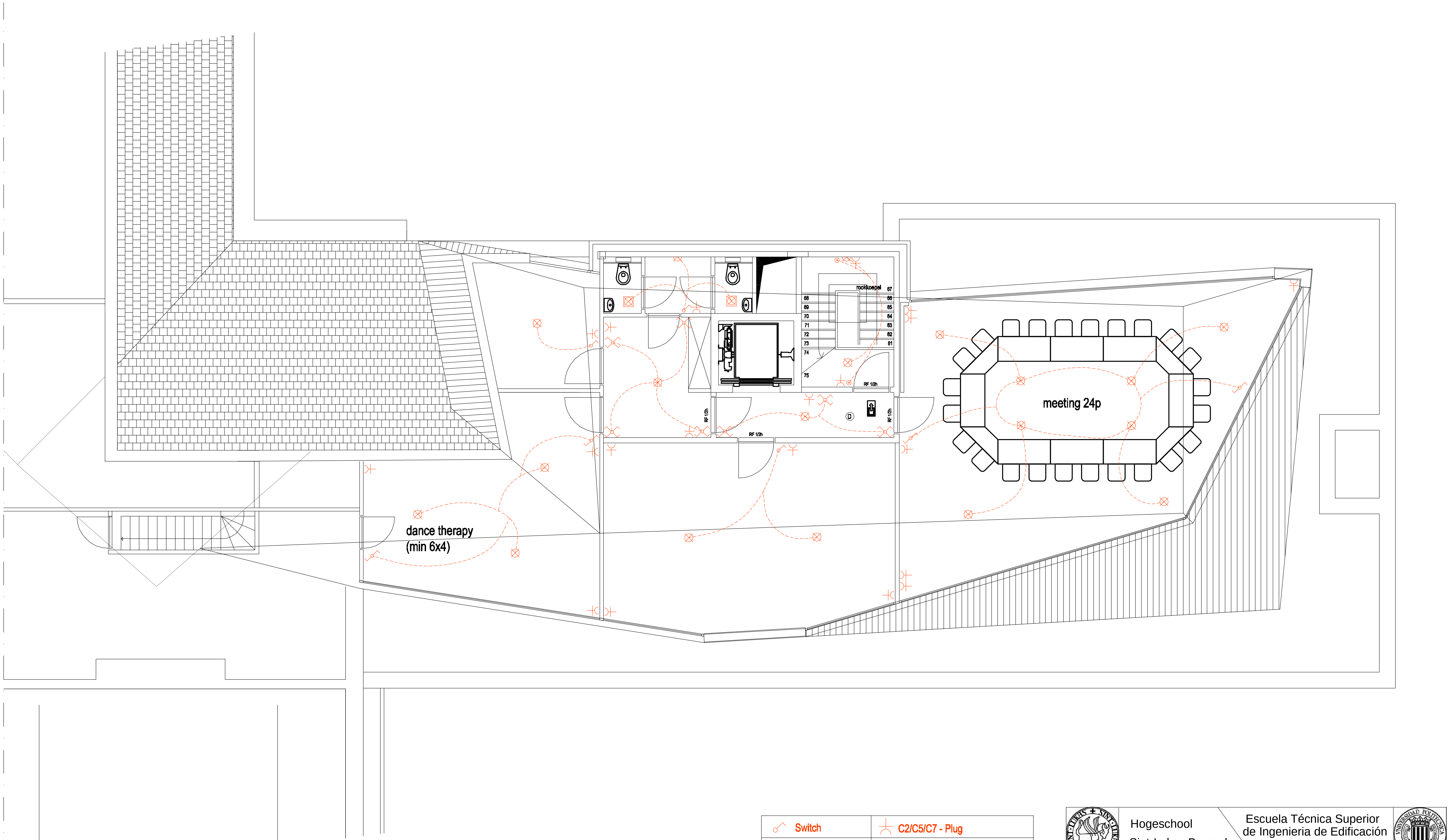
Plane # 14

Escale: 1:100

Brussels 2012

Electricity

Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente



Switch	C2/C5/C7 - Plug
Conmutator	C1/C6 - Wall point of ligt
Crossing	C1/C6 - Point of light
C1 - Push button	C1/C6 - Watertight point of light
Electrical panel	Link switch-poin of light

Hogeschool
Sint-Lukas Brussel

Escuela Técnica Superior
de Ingenieria de Edificación
UPV

3RD FLOOR

Plane # 15

Escale: 1:100

Brussels 2012

Electricity

Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente

Planning, price and quantities and measurement

EXERCISE 1

For calculate the building price and the total duration of the work, first you need a detailed measurement of the elements that are composed the building.

The following table explain the quantities of each material that involved in the construction process and the place where there are, as some materiales are needed to divide if there are on the ground floor or first floor.

CAP 01: EARTHWORKS AND EXCAVATION

ACTIVITY	UD	Quantity	Lenght(m)	widht(m)	thickness(m)	**Total**	
1.01 **Clearing and land clearing**							
	m²	1	11,86	30,25		358,77	m²
1.02 **Basement excavation**							
	m³	1	11,86	30,25	1,75	627,84	m³

CAP 02: FUNDATION

ACTIVITY	UD	Quantity	Lenght(m)	widht(m)	thickness(m)	**Total**	
2.01 **Fundation plate**							
	m³	1	11,86	30,25	0,3	107,63	m³
2.02 **Basement wall**							
	m³	1	11,02	2,05	0,4	9,04	
	m³	2	30,25	2,05	0,4	49,61	
						58,65	m³

CAP 03: STRUCTURE

ACTIVITY	UD	Quantity	Lenght(m)	widht(m)	thickness(m)	**Total**	
3.01 **Pillars Ground Floor**							
	m³	3	1,89	0,14	0,58	0,46	
	m³	5	1,89	0,14	0,54	0,71	
	m³	10	1,89	0,14	0,2	0,53	
	m³	11	1,89	0,2	0,2	0,83	
	m³	3	1,89	0,14	0,6	0,48	
	m³	2	1,89	0,2	0,27	0,20	
						3,22	m³
3.02 **Pillars First Floor**							
	m³	3	4	0,14	0,27	0,45	
	m³	1	4	0,14	0,42	0,24	
	m³	4	4	0,14	0,55	1,23	
	m³	5	4	0,14	0,54	1,51	

		m³	15	4	0,2	0,2	2,40
		m³	1	4	0,14	0,57	0,32
		m³	4	4	0,14	0,2	0,45
		m³	1	4	0,14	0,45	0,25
							6,85 m³
3.03	**Wrough First Floor**						
		m²	1	29,29	11,3		330,98 m²
3.04	**Stairs**						
		m²	2	2,49	4,5		22,41 m²

CAP 04: FACADE AND PARTITIONS

	ACTIVITY	UD	Quantity	Lenght(m)	Widht(m)	Thickness(m)	**Total**
4.01	**Elevator concrete wall**						
		m³	2	5,89	0,57	0,29	1,95
		m³	2	5,89	1,7	0,29	5,81
		m³	1	5,89	2	0,29	3,42
							11,17 m³
4.02	**Facade wall**						
4.02.01	Exterior brick walls						
		m²	1	4,61	5,04		23,23
		m²	1	4,61	22,45		103,49
		m²	1	4,61	29,01		133,74
		m²	1	4,61	11,86		54,67
							315,14 m²
4.02.02	Interior brick walls + insulation						
		m²	1	4,61	4,8		22,13
		m²	1	4,61	22,22		102,43
		m²	1	4,61	28,87		133,09
		m²	1	4,61	11,3		52,09
							309,75 m²
4.03	**interior Partitions**						
4.03.01	Bricks partition Ground Floor						
		m²	10	1,89	4,2		79,38
		m²	2	1,89	2,42		9,15
		m²	1	1,89	11,91		22,51
		m²	1	1,89	24,85		46,97
		m²	1	1,89	9,8		18,52
		m²	3	1,89	0,91		5,16
		m²	1	1,89	0,95		1,80
		m²	1	1,89	0,58		1,10
		m²	1	1,89	1,5		2,84
		m²	1	1,89	0,73		1,38
							188,79 m²

4.03.02 Plastered with gypsum partitions Ground Floor

m²	16	1,89	4,2	127,01
m²	2	1,89	11,91	45,02
m²	2	1,89	24,85	93,93
m²	2	1,89	9,8	37,04
m²	6	1,89	0,91	10,32
m²	2	1,89	0,95	3,59
m²	2	1,89	0,58	2,19
m²	2	1,89	1,5	5,67
m²	2	1,89	0,73	2,76
				327,54 m²

4.03.03 Bricks partition First Floor

m²	16	1,89	4,2	127,01
m²	2	1,89	11,91	45,02
m²	2	1,89	24,85	93,93
m²	2	1,89	9,8	37,04
m²	6	1,89	0,91	10,32
m²	2	1,89	0,95	3,59
m²	2	1,89	0,58	2,19
m²	2	1,89	1,5	5,67
m²	2	1,89	0,73	2,76
				327,54 m²

4.03.04 Plastered with gypsum partitions First Floor

m²	2	4	2,51	20,08
m²	4	4	1,58	25,28
m²	2	4	3	24,00
m²	10	4	4,4	176,00
m²	4	4	1,48	23,68
m²	4	4	1,01	16,16
m²	6	4	1,3	31,20
m²	6	4	3	72,00
m²	1	4	0,6	2,40
m²	6	4	4,6	110,40
m²	6	4	4,4	105,60
m²	2	4	2,7	21,60
m²	2	4	2,17	17,36
				645,76 m²

4.03.05 Partitions aluminum + glass + door

UD	2	4	2,4	2,00
UD	5	4	2,45	5,00
UD	3	4	1,12	3,00
				10,00 UD

CAP 05: JOINERY

ACTIVITY	UD	Quantity	Lenght(m)	Widht(m)	Thickness(m)	**Total**	
5.01 Doors Ground Floor							
5.01.01 Interior wood door							
	UD	8	2	0,83		8,00	UD
5.01.02 Galvanized steel door							
	UD	1	2	0,83		1,00	UD
5.01.03 Bath door							
	UD	4	2	0,83		4,00	UD
5.01.04 Galvanized double steel door							
	UD	1	2	1,6		1,00	UD
5.02 Doors Ground Floor							
5.02.01 Interior wood door							
	UD	4	2	0,83		4,00	UD
5.02.02 Galvanized steel door							
	UD	1	2	0,83		1,00	UD
5.02.03 Bath door							
	UD	3	2	0,83		3,00	UD
5.02.04 Galvanized double steel door							
	UD	1	2	1,6		1,00	UD
5.02.05 Sliding door							
	UD	1	2	1,6		1,00	UD
5.03 PVC Windows Ground Floor							
	UD	9	0,7	0,3		9,00	UD
5.04 PVC Windows First Floor							
	UD	28	0,7	2,5		28,00	UD
	UD	1	1,45	2,5		1,00	UD
	UD	1	4	2,5		1,00	UD

CAP 06:FINISHING

ACTIVITY	UD	Quantity	Lenght(m)	Widht(m)	Thickness(m)	**Total**	
6.01 Walls							
6.01.01 Ceramic tiles Locker Ground Floor							
	m²	4	1,89	4,2		31,75	
	m²	2	1,89	3,1		11,72	
	m²	2	1,89	2,56		9,68	
	m²	6	1,89	2,42		27,44	
	m²	4	1,89	1,16		8,77	
						57,61	m²

6.01.02 Ceramic tiles Locker First Floor

m²	3	4	4,4	52,80	
m²	6	4	2	48,00	
				100,80	m²

6.01.03 Paint Ground Floor

m²	16	1,89	4,2	127,01	
m²	2	1,89	11,91	45,02	
m²	2	1,89	24,85	93,93	
m²	2	1,89	9,8	37,04	
m²	6	1,89	0,91	10,32	
m²	2	1,89	0,95	3,59	
m²	2	1,89	0,58	2,19	
m²	2	1,89	1,5	5,67	
m²	2	1,89	0,73	2,76	
				327,54	m²

4.03.03 Paint Ground Floor

m²	2	4	2,51	20,08	
m²	4	4	1,58	25,28	
m²	2	4	3	24,00	
m²	10	4	4,4	176,00	
m²	4	4	1,48	23,68	
m²	4	4	1,01	16,16	
m²	6	4	1,3	31,20	
m²	6	4	3	72,00	
m²	1	4	0,6	2,40	
m²	6	4	4,6	110,40	
m²	6	4	4,4	105,60	
m²	2	4	2,7	21,60	
m²	2	4	2,17	17,36	
				645,76	m²

6.02 **Floors**

6.02.01 Ceramic tiles Locker Ground Floor

m²	1	48,84	m²

6.02.02 Ceramic toilet First Floor

m²	1	89,90	m²

6.02.03 Terazzo Ground Floor

m²	1	276,06	m²

6.02.04 Terazzo First Floor

m²	1	173,30	m²

6.02.05 Plinth Terrazzo Ground Floor

m²	1	161,44	m²

6.03	**Ceiling**		
6.03.01	Plastered with gypsum in wrough Ground Floor		
	m²	200,14	m²
6.03.02	Suspended ceiling registrable Hall Ground Floor		
	m²	56,64	m²
6.02.03	Suspended ceiling registrableLocker Ground Floor		
	m²	34,67	m²
6.02.04	Paint Ceiling Ground Floor		
	m²	200,14	m²
6.02.05	Plastered with gypsum in wrough First Floor		
	m²	233,71	m²
6.02.06	Suspended ceiling registrable Hall and toilet First Floor		
	m²	56,07	m²
6.02.07	Paint Ceiling First Floor		
	m²	233,71	m²
6.03	**Stairs**		
6.03.01	Stairs Ground Floor		
	UD	1,00	UD
6.03.02	Stairs First Floor		
	UD	1,00	UD

EXCERCISE 2

Each material has different price and time for make. There are many webpage where you can select the elements that are composed the building and make the budget as accurate as possible.

We used www.generadordeprecios.com; here you can choice the characteristics that you want to have the material. You get a table with the €/ud (unit price) and the performance of each element.

For calculate the duration of the activities you have to select the performance worker and calculate with the total measurement material.

Example:

m^2 Exterior sheet facade of ceramic brick for lining.

Exterior sheet cladding facade, 1/2 foot thick factory, triple hollow brick, for coating,33x16x11 cm, received with cement mortar M-5.

Ud	Description	Performance	Price	Amount
Ud	Triple hollow brick, for coating, 33x16x11 cm, according to UNE-EN 771-1.	18,900	0,29	5,48
m^3	Mortar cement CEM II / BP 32.5 N type M-5, made on site with 250 kg/m^3 of cement and a volume ratio 1/6.	0,011	115,30	1,27
kg	Hydrophobic additive for waterproofing mortars.	0,063	1,03	0,06
kg	Steel rebars, UNE-EN 10080 B 500 S, developed and placed on site workshop, severaldiameters	0,800	0,91	0,73
m^2	Ceramic tiles,natural matte finish, according to UNE-EN14411.	0,100	8,00	0,80
h	7 Workers.	0,449	15,67	49,25
h	2 accomplice.	0,225	14,31	6,44
%	Auxiliary means	3,000	64,03	1,28
%	Indirect costs	3,000	65,31	1,93
			TOTAL	67,27

4.02	**Facade wall**					
4.02.01	Exterior brick walls					
		m²	1	4,61	5,04	23,23
		m²	1	4,61	22,45	103,49
		m²	1	4,61	29,01	133,74
		m²	1	4,61	11,86	54,67
						315,14m² total

In this unit Price, we have 7 workers with a performance of 0,449 h/m² and 315,14m² of brick wall.

$$\text{Duration hours} = \frac{Perfomace\ x\ Mesureament}{nº\ Worker}\ ; \quad Durantion\ day = \frac{Durantion\ hours}{8}$$

$$Durantion\ hours = \frac{0.449\ x\ 315{,}14}{7} = \boldsymbol{20, 26\ hours \rightarrow 3\ days}$$

With the duration of the wall, only rest calculates how much all the bricks façade cost:

$$\left.\begin{array}{l}\text{Price: } 67{,}27€/m^2 \\ \text{Quantity: } 315{,}14m^2\end{array}\right\} 67{,}27\ x\ 315{,}14 = 2.199{,}47€$$

The following tables shows the results of calculation of the item and a summary of the quantities of each chapter of the project, including the duration.

Materials performance

1. Earthwork

m² Clearing and land clearing.

Clearing and land clearing to a minimum depth of 25 cm, by mechanical means, removal of excavated materials and cargo truck, not including transportation to an authorized landfill.

Ud	Descomposition	Performance	Price	Amount
h	Wheel loader 85 hp / 1.2 m³	0,015	46,22	0,69
h	2 accomplicer.	0,006	14,31	0,09
%	Medios auxiliares.	2,000	0,78	0,02
%	Costes indirectos.	3,000	0,80	0,02
			Total	0,82

m³ Excavation.

Drain in basement excavation in semi hard clay soil by mechanical means, removal of excavated materials and freight truck.

Ud	Descomposition	Performance	Price	Amount
h	Wheeled backhoe 75 hp.	0,141	36,98	5,21
h	2 accomplicer.	0,056	14,31	0,80
%	Auxiliary means.	2,000	6,01	0,12
%	Indirect costs.	3,000	6,13	0,18
			TOTAL	6.31

2. Fundation

m³ Fundation Plate

Fundation, HA-25/B/20/IIa produced in central and spills with cupola. Steel UNE-EN 10080 B 500 S, amount 85 kg/m³.

Ud	Descomposition	Performance	Price	Amount
Ud	Rigid plastic spacer, approved for foundations.	5,000	0,12	0,60
kg	Steel rebars, UNE-EN 10080 B 500 S, developed and placed on site workshop, severaldiameters.	85,000	0,91	77,35
m³	ConcreteHA-25/B/20/IIa produced in central and spills with cupola	1,050	72,15	75,76
h	Rule vibrant 3 m.	0,335	4,66	1,56
h	7 Workers.	0,202	15,67	22.15
h	2 accomplice.	0,202	14,31	5,78
%	Auxiliary means.	2,000	183,81	3,23
%	Indirect costs.	3,000	186,02	5,61
			TOTAL	325,61€

m³ Basement wall.

Basement wall, Height <=3 m, HA-25/B/20/IIa produced in central and spills with cupola, steel UNE-EN 10080 B 500 S, 50 kg/m³, thickness 30 cm, metal formwork.

Ud	Description	Performance	Price	Amount
Ud	Rigid plastic spacer, approved for walls.	8,000	0,05	0,40
kg	Steel rebars, UNE-EN 10080 B 500 S, developed on workshop and placed on sitejob, several diameters.	50,000	0,91	45,50
m²	Formwork and demoulding on one side, in walls, modular metal panels up to 3 m high,even pass for installations elements.	3,330	23,88	79,52
m³	HA-25/B/20/IIa concrete made on center and poured with cupola.	1,050	72,15	75,76
h	7 Workers.	0,303	15,67	33.24
h	2 accomplice.	0,303	14,31	8,67
%	Auxiliary means.	2,000	243,09	4,86
%	Indirect costs.	3,000	247,95	7,44
			TOTAL	255,39€

3. Structure

m³ Reinforced concrete pillars.

Rectangular/square reinforced concrete pillars, HA-25/B/20/IIa manufactured in central and bomb disposal, UNE-EN 10080 steel B 500 S, amount 120 kg / m^3, reusable formwork sheet metal up to 3 m in height and 30x30 cm midsection.

Ud	Description	Performance	Price	Amount
Ud	Rigid plastic spacer, approved for pillars.	12,000	0,05	0,60
kg	Steel rebars, UNE-EN 10080 B 500 S, developed on workshop and placed on sitejob, several diameters.	120,000	0,91	109,20
m^2	Mounting and Unmounting formwork for reinforced concrete columns of rectangular or square section, up to 3 m high, built with reusable metal sheets 50x50 cm, even mounting hardware, application of liquid release agent and cleaning plates.	22,222	10,50	233,33
m^3	HA-25/B/20/IIa concrete, made on center and poured with bomb.	1,000	76,80	76,80
h	7 Workers.	0,223	15,67	24,46
h	2 accomplice.	0,111	14,31	3,18
%	Auxiliary means.	2,000	447,51	8,95
%	Indirect costs.	3,000	456,42	13,17
			TOTAL	470,22€

m³ Reinforced concrete pillars.

Rectangular/square reinforced concrete pillars, HA-25/B/20/IIa manufactured in central and bomb disposal, UNE-EN 10080 steel B 500 S, amount 120 kg / m³, reusable formwork sheet metal between 3-4 m. in height and 30x30 cm. midsection.

Ud	Description	Performance	Price	Amount
Ud	Rigid plastic spacer, approved for pillars.	12,000	0,05	0,60
kg	Steel rebars, UNE-EN 10080 B 500 S, developed on workshop and placed on sitejob, several diameters.	120,000	0,91	109,20
m²	Mounting and Unmounting formwork for reinforced concrete columns of rectangular or square section, up to 3 m high, built with reusable metal sheets 50x50 cm, even mounting hardware, application of liquid release agent and cleaning plates.	22,222	10,50	233,33
m³	HA-25/B/20/IIa concrete, made on center and poured with bomb.	1,000	76,80	76,80
h	7 Workers.	0,223	15,67	3,49
h	2 accomplice.	0,111	14,31	1,59
%	Auxiliary means.	2,000	447,51	8,95
%	Indirect costs.	3,000	456,42	13,17
			TOTAL	470,22€

m² **Concrete Staircase.**

Slab stairs and steps of concrete HA-25/B/12/IIa manufactured in Central and bomb disposal, steel UNE-EN 10080 B 500 S, 25 kg/m², e=15 cm, Wood formwork.

Ud	Description	Performance	Price	Amount
m²	Mounting and Unmounting formwork for concret slab with struts, beam supports and phenolic plywood and pine.	1,250	36,75	45,94
m²	Mounting and Unmounting formwork for forming steps in slabs of reinforced concrete staircase seen, with props and phenolic plywood pine.	0,900	20,00	18,00
Ud	Rigid plastic spacer, approved for stairs slab.	3,000	0,07	0,21
kg	Steel rebars, UNE-EN 10080 B 500 S, developed on workshop and placed on sitejob, several diameters.	25,000	0,91	22,75
m³	HA-25/B/20/IIa concrete made on center and poured with bomb.	0,275	78,80	21,67
h	7 Workers.	0,809	15,67	88,74
h	2 accomplice.	0,404	14,31	40,46
%	Auxiliary means.	2,000	237,78	4,76
%	Indirect costs.	3,000	242,53	7,28
			TOTAL	249,81

m² **Wrought unidirectional with beam**.

HA-25/B/20/IIa reinforced concrete structure made in Central and with pump spill; total volume of concrete 0.131 m³ / m² UNE-EN 10080 steel B 500 S with a total amount of 11 kg / m²; unidirectional and horizontal wrought, edge 25 = 20+5 cm; prestressed joist, concrete vault, 60x20x20 cm electro welded mesh 20x20 ME, Ø 5 mm, steel B 500 T 6x2, 20UNE-EN 10080 compression layer, flat beams; plant height of 3 m.

Ud	Description	Performance	Price	Amount
m²	Mounting and Unmounting formwork continuo with struts, metal beam supports and and formwork surface of treated wood reinforced with rods and profiles, in reinforced concrete beams, up to 3 m high.	0,280	34,65	9,70
m²	Mounting and Unmounting formwork system for continuous unidirectional reinforced concrete wrought, up to 3 m in height of plant, composed: struts, metal beam supports and formwork surface of treated wood reinforced with rods and profiles.	0,820	2,70	2,21
Ud	Concrete vault, 60x20x20 cm, including special pieces.	5,625	0,54	3,04
m	Mold expanded polystyrene Mold for the cornice.	0,100	8,81	0,88
m	Prestressed joist T-12, L mean = <4 m, according to UNE-EN 15037-1.	0,165	2,90	0,48
m	Prestressed joist T-12, L mean = 4/5 m, according to UNE-EN 15037-1.	0,908	3,52	3,20
m	Prestressed joist T-12, L mean = 5/6 m, according to UNE-EN 15037-1.	0,495	3,75	1,86
m	Prestressed joist T-12, L mean = <6 m, according to UNE-EN 15037-1.	0,083	4,11	0,34
Ud	Rigid plastic spacer, approved for beams.	0,800	0,07	0,06
kg	Steel rebars, UNE-EN 10080 B 500 S, developed on workshop and placed on sitejob, several diameters.	11,000	0,91	10,01
m²	Electrowelded mesh ME 20x20 Ø 5-5 B 500 T 6x2,20 UNE-EN 10080.	1,100	1,39	1,53
m³	HA-25/B/20/IIa concrete, made on center and poured with bomb.	0,143	76,80	10,98
h	7 Workers.	0,519	15,67	56,92
h	2 accomplice.	0,259	14,31	7,41
%	Auxiliary means.	2,000	105,79	2,17
%	Indirect costs.	3,000	107,91	3,32
			TOTAL	114,12

4. Facade

m² **Exterior sheet facade of ceramic brick for lining.**

Exterior sheet cladding facade, 1/2 foot thick factory, triple hollow brick, 33x16x9cm, received with cement mortar M-5.

Ud	Description	Performance	Price	Amount
Ud	Triple hollow brick, for coating, 33x16x9 cm, according to UNE-EN 771-1.	18,900	0,29	5,48
m³	Mortar cement CEM II / BP 32.5 N type M-5, made on site with 250 kg/m³ of cement and a volume ratio 1/6.	0,011	115,30	1,27
kg	Hydrophobic additive for waterproofing mortars.	0,063	1,03	0,06
kg	Steel rebars, UNE-EN 10080 B 500 S, developed and placed on site workshop, several diameters.	0,800	0,91	0,73
h	7 Workers.	0,449	15,67	49,25
h	2 accomplice.	0,225	14,31	6,44
%	Auxiliary means.	3,000	64,03	1,28
%	Indirect costs.	3,000	65,31	1,93
			TOTAL	67,27

m² Interior sheet facade of brick for lining, with integrated insulation.

Interior sheet facade cladding 7 cm thick. Double hollow brick, large format with expanded polystyrene insulation panel built with glue and plaster received quality B1.

Ud	Description	Performance	Price	Amount
m²	Rigid expanded polystyrene panel, according to UNE-EN 13163, machining right side of 10 mm thick, thermal resistance 0.25 (m K) / W, thermal conductivity 0.036 W / (mK), for expansion joint.	0,024	0,92	0,02
Ud	Double hollow brick, large format expanded polystyrene insulation panel incorporated. Expanded polystyrene insulation composed of 4 cm thick, with smooth surface and lateral half machining wood.	2,872	5,91	16,97
kg	Plastering glue	4,273	0,28	1,20
kg	Plaster glue.	1,423	0,28	0,40
m³	Building plaster paste B1, according to UNE-EN 13279-1.	0,001	78,89	0,08
h	7 Workers.	0,209	15,67	22,92
h	2 accomplice.	0,209	14,31	5,98
%	Auxiliary means.	3,000	47,58	0,95
%	Indirect costs.	3,000	48,53	1,46
			TOTAL	49,98

5. Partitions

m² Interior partition ceramic sheet brick for lining.

Interior partition sheet 7 cm thick, double hollow brick, for coating, 33x16x7 cm, received with cement mortar M-5.

Ud	Description	Performance	Price	Amount
Ud	Double hollow brick, for coating, 33x16x7 cm, according to UNE-EN 771-1.	18,900	0,21	3,97
m³	Mortar cement CEM II / BP 32.5 N type M-5, made on site with 250 kg/m³ of cement and a volume ratio 1/6.	0,006	115,30	0,69
h	7 Workers.	0,354	15,67	38,83
h	2 accomplice.	0,177	14,31	17,73
%	Auxiliary means.	2,000	61,22	1,22
%	Indirect costs.	3,000	62,45	1,87
			TOTAL	64,32

m² Plastered with gypsum paste in vertical wall.

Plastered with gypsum paste in vertical wall.

Ud	Description	Performance	Price	Amount
m³	Gypsum paste YG / L.	0,004	154,61	0,62
h	7 Workers.	0,13	22,12	20,13
h	2 accomplice.	0,065	21.53	2,80
%	Auxiliary means.	2,000	23,55	0,47
%	Indirect costs.	3,000	24,02	0,72
			TOTAL	24,74

Ud Aluminum Enclosure.

Demountable partition screen consists of 4x2, 9 m, prepainted aluminum, glass in the middle of the surface with aluminum prepainted door of 2.10 x0, 90 m, intermediate insulation mineral wool and glass in the top section.

Ud	Description	Performance	Price	Amount
m²	Rabbet blind panel for screens, consisting of two aluminum sheets with intermediate mineral wool insulation thermal conductivity 0.039 w/mk.	3,150	67,80	213,57
m	Profile in "U" for aluminum prepainted screens.	5,900	7,77	45,84
m	Aluminum prepainted baseboard for partitions.	3,000	9,94	29,82
m²	Colorless polished glass, 8 mm. UNE-EN 410 and EN 673.	6,270	30,50	191,24
m	Lacquered aluminum profile for receiving the glass partitions.	19,870	5,83	115,84
Ud	Single door of an aluminum sheet to put in screens, even fittings.	1,000	394,41	394,41
h	7 Workers.	6,072	15,93	677,96
h	2 accomplice.	6,072	14,82	179,97
%	Auxiliary means.	0,002	1847,78	36,96
%	Indirect costs.	0,003	1884,74	56,54
			TOTAL	1941,28

6. Joinery

Doors

Ud Interior Wood door.

Blind door, with one sheet of 200x80, 5x3, 5 cm, chipboard, varnished in the workshopmodel with straight molding, sub-frame 90x35 mm pine, with wood veneer, pine country of 90x20 mm; flashing MDF with wood veneer, pine 70x10 mm.

Ud	Description	Performance	Price	Amount
Ud	Subframe pine, 90x35 mm, for single door with fasteners.	1,000	17,39	17,39
m	Rebate of MDF with wooden veneer, 90x20 mm, painted in the workshop.	5,100	3,71	18,92
m	Flashing MDF with wood veneer, 70x20mm, painted in the workshop.	10,400	1,61	16,74
Ud	Blind pass gate country, 203x82, 5x3, 5cm, with chipboard with straight trim, varnished in the workshop. According to UNE 56803.	1,000	72,00	72,00
Ud	Hinge of 100x58 mm, shot in black gloss brass, interior door.	3,000	0,74	2,22
Ud	Brass screws 21/35 mm.	18,000	0,06	1,08
Ud	Mortise lock, front, accessories and screws arrached to inner door, according to UNE-EN 12209.	1,000	11,29	11,29
Ud	Set long handle and brass coat gloss black, basic series, inner door.	1,000	8,12	8,12
h	7 Workers.	0,909	15,93	101,86
h	2 accomplice.	0,909	14,82	26,94
%	Auxiliary means.	2,000	276,07	5,52
%	Indirect costs.	3,000	281,59	8,45
			TOTAL	290,04

Ud Interior Wood door for bathroom

Shower and toilet door blind, with one sheet of 200x83, 5x3, 5 cm, smooth masonite, varnished in a workshop, subrame 90x35 cm pine; rebates MDF with wooden veneerof sapele 90x20 mm; flashing MDF, veneered wood of 70x10 mm.

Ud	Description	Performance	Price	Amount
Ud	Pine Wood subframe, 90x35 cm, for single door with fasteners.	1,000	17,39	17,39
m	Rebate of MDF with wood veneer, 90x20 mm, painted in the workshop.	5,100	3,27	16,68
m	Flashing MDF with wood veneer, 70x10 mm, painted in the workshop.	10,400	1,29	13,42
Ud	Doors blind, of 203x82, 5x3, 5cm, with smooth Masonite, painted in the workshop. According UNE- 56803	1,000	66,89	66,89
Ud	Hinge of 100x58 mm, shot in black brass shine, interior passage door.	3,000	0,74	2,22
Ud	Brass screws 21/35 mm.	18,000	0,06	1,08
Ud	Mortise lock, front, accessories and screws attached to door step, according to UNE-EN 12209.	1,000	11,29	11,29
Ud	Set long handle and brass coat gloss black, basic series, inner door step.	1,000	8,12	8,12
h	7 Workers.	0,909	15,93	101,36
h	2 accomplice.	0,909	14,82	26,94
%	Auxiliary means.	2,000	265,39	5,31
%	Indirect costs.	3,000	270,70	8,12
			TOTAL	278.82

Ud Pass gate two galvanized Steel sheets.

Pass gate two galvanized steel sheets 1840x2045 mm light and step height, galvanized finish.

Ud	Description	Performance	Price	Amount
Ud	Pass gate two sheets of 38 mm thick, 1840x2045 mm light and step height, formed bytwo galvanized steel sheets, galvanized 0.5 mm thick folded, assembled and mounted, with intermediate chamber filled with polyurethane, on galvanized steel frame 1.5 mm thick clawed anchor work, including hinges welded to frame and riveted to the blade, embedded lock closure to a point, brass cylinder and key, shields and colored nylon handles black.	1,000	225,63	225,63
h	7 Workers.	0,303	15,92	33,77
h	1 accomplice.	0,303	14,76	8,94
%	Auxiliary means.	2,000	268,34	5,37
%	Indirect costs.	3,000	273,71	8,21
			TOTAL	281,92

Ud Pass galvanized Steel door.

Pass galvanized steel sheet door, 900x200 mm light and step height, galvanized finish.

Ud	Description	Performance	Price	Amount
Ud	A pass door of sheet 38 mm thick, 700x1945 mm light and step heigh, consist two galvanized steel sheets, galvanized 0.5 mm thick folded, assembled and mounted, with intermediate chamber filled with polyurethane, on galvanized steel frame 1.5 mm thick clawed anchor work, including hinges welded to frame and riveted to the blade, embedded lock closure to a point, brass cylinder and key, shield and colored nylon handles black.	1,000	75,26	75,26
h	7 Workers.	0,202	15,92	22,51
h	2 accomplice.	0,202	14,76	5,96
%	Auxiliary means.	2,000	103,73	2,07
%	Indirect costs.	3,000	105,81	3,17
			TOTAL	108,98

Ud Interior Sliding Wood door.

Step sliding door for dual partition with hollow, blind, a sheet of 203x185x3, 5cm, direct chipboard, painted in the workshop, straight trim model; precerco pinecountry of 120x35 mm MDF rebates , with wood veneer, pine country of 120x20 mm; flashing MDF with wood veneer, pine country of 70x10 mm.

Ud	Description	Performance	Price	Amount
Ud	Subframe of pine wood, 120x35 mm, for single door with fasteners.	2,000	23,47	46,94
m	Rebate of MDF with wood veneer, 120x20 mm, painted in the workshop.	10,200	4,55	46,41
Ud	Hanging fittings, sliding door kit.	1,000	7,75	7,75
m	Flashing MDF with wood veneer, 70x10 mm, painted in the workshop.	10,400	1,61	16,74
Ud	Blind pass gate pine, 203x185x3, 5 cm, particle board with a straight molding, painted in the workshop. According to UNE 56803.	1,000	72,00	72,00
Ud	Handle with handle for closing aluminum core set, sliding door step for inside.	1,000	25,40	25,40
m	Double aluminum sliding door track.	1,100	8,83	9,71
h	7 Workers.	1,212	15,93	135,15
h	2 accomplice.	1,212	14,82	35,92
%	Auxiliary means.	2,000	396,03	7,92
%	Indirect costs.	3,000	403,95	12,12
			TOTAL	416,07

Windows

Ud PVC exterior window

PVC window sash-tilt, size 70x30 cm, with sub-frame.

Ud	Description	Performance	Price	Amount
Ud	PVC window sash-tilt, size 70x30 cm, profiles with a smooth finish and white, with galvanized steel cleats, handle and hardware dichromate, not compact, UNE-EN 14351-1.	1,000	152,11	162,11
m	Sub frame for PVC exterior carpentry.	4,000	6,25	25,00
Ud	Cartridge neutral silicone caulk to seal exterior carpentry.	0,200	3,13	0,63
h	7 Workers.	1,668	15,92	185,88
h	2 accomplice.	0,834	14,76	24,62
%	Auxiliary means.	2,000	388,24	7,76
%	Indirect costs.	3,000	396,00	11,88
			TOTAL	407,88

Ud PVC exterior window

PVC window sliding two sheets of thickness 74 mm, dimensions 1450x2500 mm, with sub-frame.

Ud	Description	Performance	Price	Amount
Ud	PVC window sliding two sheets of thickness 74 mm, dimensions 2,3x1,4m, profiles with a smooth finish and white, with galvanized steel cleats, handle and hinges dichromate, UNE-EN 14351-1.	1,000	320,43	320,43
m	Subframe for PVC exterior carpentry.	7,400	6,25	46,25
Ud	Cartridge neutral silicone caulk to seal exterior carpentry.	0,200	3,13	0,63
h	7 Workers	1,359	15,92	151,45
h	2 accomplice	0,679	14,76	20,04
%	Auxiliary means	2,000	538,80	10,78
%	Indirect costs	3,000	549,57	16,49
			TOTAL	566,06

Ud PVC exterior Windows

Fixed window size 700x250 mm PVC, with sub-frame.

Ud	Description	Performance	Price	Amount
Ud	Fixed window size 700x250 mm PVC, profiles with a smooth finish and white, with galvanized steel internal reinforcements, according to UNE-EN 14351-1.	1,000	45,95	45,95
m	Sub-frame for PVC exterior carpentry.	3,200	6,25	20,00
Ud	Cartridge neutral silicone caulk to seal exterior carpentry.	0,200	3,13	0,63
h	7 Workers.	1,668	15,92	185,88
h	2 accomplice.	0,834	14,76	24,62
%	Auxiliary means.	2,000	277,08	5,54
%	Indirect costs.	3,000	282,62	8,48
			TOTAL	291,10

Ud **PVC exterior Windows**

Fixed window size 4000x2000 mm PVC, with sub-frame.

Ud	Description	Performance	Price	Amount
Ud	Fixed window size of 4000x2000 mm PVC, profiles with a smooth finish and white, with galvanized steel internal reinforcements, according to UNE-EN 14351-1.	1,000	370,94	370,94
m	Sub-frame for PVC exterior carpentry.	8,000	6,25	50,00
Ud	Cartridge neutral silicone caulk to seal exterior carpentry.	0,200	3,13	0,63
h	7 Workers.	1,301	15,92	144,98
h	2 accomplice.	0,650	14,76	19,19
%	Auxiliary means.	2,000	585,74	11,71
%	Indirect costs.	3,000	597,45	17,92
			TOTAL	615,38

7. Finishing

Walls

m² Tiled interior support in bricks surface.

Tiling with smooth tile, 1/0/-/-, 15x15 cm, 8 € / m², ready to bevel the pieces, placed on a support surface brick interior walls, using cement mortar M-5, without joints (separation between 1.5 and 3 mm), with corners of PVC.

Ud	Description	Performance	Price	Amount
m^3	Mortar cement CEM II / BP 32.5 N type M-5, made on site with 250 kg / m^3 of cement and a volume ratio 1/6.	0,030	115,30	3,46
m	PVC recoil tiled corners.	0,500	1,32	0,66
m^2	Smooth tile ceramic tile 1/0/-/-, 15x15 cm, 8.00€/m² , according to UNE-EN 14411.	1,050	8,00	8,40
m^3	White cement grout BL X 22.5.	0,001	157,00	0,16
h	7 Workers.	0,501	15,67	54,95
h	2 accomplice.	0,501	14,70	14,73
%	Auxiliary means.	2,000	82,36	1,65
%	Indirect costs.	3,000	84,01	2,52
			TOTAL	86,53

m² Plastic paint on interior walls of plaster.

Plastic paint with smooth texture, white, matte finish on interior vertical surface of cement mortar base coat and two coats of finish (yield: 0.125 l / m each hand).

Ud	Description	Performance	Price	Amount
l	Aqueous acrylic emulsion binder surface as colorless, shiny finish, applied by brush and roller.	0,180	10,04	1,81
l	Plastic paint for interior in aqueous dispersion, washable, type II according to UNE48243, permeable to water vapor, white, matte finish, applied by brush, roller or spray.	0,250	5,72	1,43
h	7 Workers.	0,152	15,67	16,67
h	2 accomplice.	0,182	14,70	5,35
%	Auxiliary means.	2,000	25,26	0,51
%	Indirect costs.	3,000	25,77	0,77
			TOTAL	26,54

FLOOR FINISHING

m²   Ceramic tile flooring laid with adhesive.

Flooring Tile, glazed stoneware, 25x25 cm, 8 € / m², received exclusive use tile adhesive for interior, gray and grouted with white grout to minimum joint (between 1.5 and 3 mm), colored with the same color as the pieces.

Ud	Description	Performance	Price	Amount
kg	Cementitious adhesive for indoor use only, gray colour.	3,000	0,22	0,66
m²	Tile glazed stoneware 25x25 cm, 8.00€/m², acoording to UNE-EN 14411.	1,050	8,00	8,40
kg	White cement BL-22, 5 X, paving, according UNE 80305.	1,000	0,14	0,14
m³	White grout BL X 22.5.	0,001	157,00	0,16
h	7 Workers.	0,405	15,67	44,42
h	2 accomplice.	0,202	14,70	5,94
%	Auxiliary means.	2,000	59,72	1,19
%	Indirect costs.	3,000	60,91	1,83
			TOTAL	62,74

m²   Terrazzo flooring.

Terrazzo flooring micrograin (less than or equal to 6 mm) classified normal use for indoor, 40x40cm, ivory, blow pot placed on a bed of cement mortar M-5, with sand and grouted with cement grout BL-V 22.5 white colored with the same color as the tiles.

Ud	Description	Performance	Price	Amount
m³	Mortar cement CEM II / BP 32.5 N type M-5, made on site with 250 kg / m³ of cement and a volume ratio 1/6.	0,032	115,30	3,69
m²	Indoor terrazzo tile, normal use, micrograin (less than or equal to 6mm), nominal format 40x40 cm, Ivory, with a first polishing factory, polishing and final polishing work, according to UNE-EN 13748-1.	1,050	8,39	8,81
kg	White cement BL-22, 5 X, paving, according to UNE 80305.	1,000	0,14	0,14
kg	Color or borated for terrazzo tile flooring.	0,500	0,68	0,34
h	7 Workers.	0,192	15,67	21,06
h	2 accomplice.	0,192	14,70	5,65
%	Auxiliary means.	2,000	39,68	0,79
%	Indirect costs.	3,000	40,48	1,21
			TOTAL	41,69

m Terrazzo skirting.

Terrazzo skirting lowered micrograin (less than or equal to 6 mm), Ivory Indoor 40x7cm, 220-degree polishing.

Ud	Description	Performance	Price	Amount
kg	Cementitious adhesive for laying terrazzo flooring.	0,015	0,45	0,01
m	Terrazzo skirting lowered micrograin (less than or equal to 6 mm), color Ivory, interior,40x7 cm, 220-degree polishing.	1,050	1,50	1,58
m³	White grout BL X 22.5	0,001	157,00	0,16
h	7 Workers.	0,184	15,67	20,18
h	2 accomplice.	0,184	15,67	5,77
%	Auxiliary means.	2,000	27,69	0,55
%	Indirect costs.	3,000	28,24	0,85
			TOTAL	29,09

CEILING FINISHING

m² Registrable false ceiling plaster boards.

Registrable decorative false ceiling consisting of smooth plates plasterboard finish, uncoated, of 1200x600x9, 5 mm, with visible profiling.

Ud	Description	Performance	Price	Amount
Ud	Plug and screw fixation 5x27.	0,840	0,06	0,05
Ud	Hang rod.	0,840	0,46	0,39
Ud	Hang suspended ceilings.	0,840	0,89	0,75
Ud	Insurance for fixing hang in suspended ceilings.	0,840	0,14	0,12
Ud	Top connection to secure the rod to hang in suspended to hang in suspended ceilings.	0,840	1,08	0,91
m	Primary profile 24x38x3700 mm, galvanized steel, according to UNE-EN 13964.	0,840	0,87	0,73
m	Secondary Profile 24x32x600mm, galvanized steel, according to UNE-EN13964.	0,840	0,87	0,73
m	Secondary Profile 24x32x600mm, galvanized steel, according to UNE-EN13964.	1,670	0,87	1,45
m	25x25x3000 mm angular profile, galvanized steel, according to UNE-EN 13964.	0,400	0,73	0,29
m²	Plasterboard smooth plate finish, uncoated, of 1200x600x9, 5 mm for suspended ceilings, according to UNE-EN 13964.	1,050	4,03	4,23
h	7 Workers.	0,232	16,18	26,28
h	2 Accomplice.	0,232	14,70	6,82

%	Auxiliary means.	2,000	42,74	0,85
%	Indirect costs.	3,000	43,60	1,31
			TOTAL	44,91

m² **Plastic paint on interior walls of plaster.**

Plastic paint with smooth texture, white, matte finish on horizontal and vertical interior walls of plaster base coat and two coats of finish (yield: 0.125 l / m each hand).

Ud	Description	Performance	Price	Amount
l	Aqueous acrylic emulsion binder surfaces as colorless, shiny finish, applied by brush,roller or spray.	0,180	10,04	1,81
l	Plastic paint for interior in aqueous dispersion, washable, type II according to UNE48243, permeable to water vapor, white, matte finish, applied by brush, roller or spray.	0,250	5,72	1,43
h	7 Workers.	0,456	15,67	50,02
h	2 Accomplice.	0,456	14,70	13,41
%	Auxiliary means.	2,000	66,66	1,33
%	Indirect costs.	3,000	68,00	2,04
			TOTAL	70,04

m² **Plastered with gypsum paste vertical facing.**

Plastered with gypsum paste vertical facing.

Ud	Description	Performance	Price	Amount
m^3	Gypsum paste YG/L.	0,004	154,61	0,62
h	7 Workers.	0,13	22,12	20,13
h	2 Accomplice.	0,065	21,51	2,80
%	Auxiliary means.	2,000	23,54	0,47
%	Indirect costs.	3,000	24,01	0,72
			TOTAL	24,74

STAIRS FINISHING

Ud Staircase cladding with ceramic elements. Ground floor.

Lining three straight staircase with intermediate plateaus with 13 steps of 90 cm wide, lined with glazed stoneware pieces. Received with cement mortar M-5 and grouting with mortar, CG1, for minimum joint (between 1.5 and 3 mm) with the same tone of the pieces.

Ud	Description	Performance	Price	Amount
m	Footprint for step glazed stoneware, 8.00 € / m.	11,700	8,00	93,60
m	Step riser for glazed stoneware, 8.00 € / m.	11,700	8,00	93,60
m	Plinth glazed stoneware ceramic, 420x180 mm, 5.00 € / m.	5,460	5,00	27,30
m²	Glazed stoneware tile, 8.00 € / m², according to UNE-EN 14411.	1,701	8,00	13,61
m	Glazed stoneware ceramic baseboard, 7 cm, 3€/m.	3,600	3,00	10,80
m	Profile gasket type PVC PVC-step Pro 25 "BUTECH" white finish, 7 mm high, to top edge of stairs paved with ceramic tiles.	11,700	12,36	144,61
m³	Mortar cement CEM II / BP 32.5 N type M-5, made on site with 250 kg / m³ of cement and a volume ratio 1/6.	0,180	115,30	20,75
m³	Sand 0 to 5 mm in diameter.	0,030	12,02	0,36
kg	Cementitious grout, CG1, for minimum joint between 1.5 and 3 mm, according to UNE-EN 13888.	1,170	0,70	0,82
h	7 Workers.	1,862	15,93	207,63
h	2 Accomplice.	1,862	14,82	55,19
%	Auxiliary means.	2,000	668,27	13,37
%	Indirect costs.	3,000	681,64	20,45
			TOTAL	702,09

Ud Staircase cladding with ceramic elements. First floor.

Lining three straight staircase with intermediate plateaus with 23 steps of 90 cm wide, lined with glazed stoneware pieces. Received with cement mortar M-5 and grouting with mortar, CG1, for minimum joint (between 1.5-3 mm) with the same tone of the pieces.

Ud	Description	Performance	Price	Amount
m	Footprint for step glazed stoneware, 8.00 € / m.	20,700	8,00	165,60
m	Step riser for glazed stoneware, 8.00 € / m.	20,700	8,00	165,60
m	Plinth glazed stoneware ceramic, 420x180 mm, 5.00 € / m.	9,660	5,00	48,30
m^2	Glazed stoneware tile, 8 €/m^2, according to UNE-EN 1441.	1,701	8,00	13,61
m	Glazed stoneware ceramic baseboard, 7 cm, 3 €/m.	3,600	3,00	10,80
m	Profile gasket type PVC PVC-step Pro 25 "BUTECH" white finish, 7 mm high, to top edge of stairs paved with ceramic tiles.	20,700	12,36	255,85
m^3	Mortar cement CEM II / BP 32.5 N type M-5, made on site with 250 kg / m^3 of cement and a volume ratio 1/6.	0,280	115,30	32,28
m^3	Sand 0 to 5 mm in diameter.	0,030	12,02	0,36
kg	Cementitious grout, CG1, for minimum joint between 1.5 and 3 mm, according to UNE-EN 13888.	2,070	0,70	1,45
h	7 Workers.	3,299	15,93	367,87
h	2 Accomplice.	3,299	14,82	97,68
%	Auxiliary means.	2,000	1686,78	33,74
%	Indirect costs.	3,000	1720,51	51,62
			TOTAL	1772,13

Table duration/performance

This is a table that relates the duration and measure calculations of all the parts of the Ground and First Floor.
There are uderlined the activities for make the duration network of the fist floor for ejercice 3.

CAP 01: EARTHWORKS AND EXCAVATION

	ACTIVITY	RESOURCES	PRODUCTION	MEASURE	UD	DURATION(h)	DURATION (days)	PRICE(€/UD)	TOTAL
1.01	Clearing and land clearing	wheel loaded	0,02	358,77	m²	5,38	1	0,83	297,78 €
		2 accomplices	0,02						
1.02	Basement excavation	wheel backhoe	0,14	627,84	m³	12,56	2	6,31	3.961,67 €
		2 accomplices	0,14						
									4.259,45 €

CAP 02: FUNDATION

	ACTIVITY	RESOURCES	PRODUCTION	MEASURE	UD	DURATION(ho	DURATION (días)	PRICE(€/UD)	TOTAL
2.01	Fundation plate	7 worker	0,20	107,63	m³	3,08	1	325,61	35.045,40 €
		2 accomplices	0,20						
2.02	Basement wall	7 worker	0,30	58,65	m³	2,51	1	255,39	14.978,62 €
		2 accomplices	0,30						
									50.024,03 €

CAP 03: STRUCTURE

	ACTIVITY	RESOURCES	PRODUCTION	MEASURE	UD	DURATION(ho	DURATION (días)	PRICE(€/UD)	TOTAL
3.01	Pillars Ground Floor	7 worker	0,22	3,22	m³	0,71	1	470,22	1.514,11 €
		2 accomplices	0,11						
3.02	Pillars First Floor	7 worker	0,22	6,85	m³	1,51	1	470,22	3.221,01 €
		2 accomplices	0,11						
3.03	Wrough first floor part 1	7 worker	0,52	165,49	m²	12,27	2	114,12	18.885,72 €
		2 accomplices	0,29						
3.04	Wrough first floor part 2	7 worker	0,52	165,49	m²	12,27	2	114,12	18.885,72 €
		2 accomplices	0,29						

3.05	Stairs	7 worker	0,80	22,41	m²	2,56	1	249,81	5.598,24 €
		2 accomplices	0,40						
3.06	Elevator wall	7 worker	0,30	11,17	m³	0,48	1	255,39	2.852,71 €
		2 accomplices	0,30						
									50.957,50 €

CAP 04: FACADE AND PARTITIONS

	ACTIVITY	RESOURCES	PRODUCTION	MEASURE	UD	DURATION(ho	DURATION (días)	PRICE(€/UD)	TOTAL
4.01	WALL								
4.01.01	Exterior wall of bricks Part 1	7 worker	0,45	165,60	m²	10,65	2	67,27	11.139,91 €
		2 accomplices	0,22						
4.01.01	Exterior wall of bricks Part 2	7 worker	0,45	149,54	m²	9,61	2	67,27	10.059,56 €
		2 accomplices	0,22						
4.01.02	Interior wall+insulation	7 worker	0,21	309,75	m²	9,29	2	49,98	15.481,31 €
		2 accomplices	0,21						
4.02	PARTITION								
4.02.01	Partitions of bricks Ground Floor	7 worker	0,35	188,89	m²	9,44	2	64,32	12.149,40 €
		2 accomplices	0,35						
4.02.02	Plastered with gypsum in partitions	7 worker	0,13	327,54	m²	6,08	1	24,74	8.103,34 €
		2 accomplices	0,07						
4.02.03	Partitions of bricks Firts floor	7 worker	0,35	365,68	m²	18,28	3	64,32	23.520,54 €
		2 accomplices	0,35						
4.02.04	Plastered with gypsum in partitions	7 worker	0,13	645,76	m²	11,99	2	32,09	20.722,44 €
		2 accomplices	0,07						
4.02.05	Partitions aluminium + glass + door	7 worker	6,07	10	Ud	8,67	2	1941,98	19.419,80 €
		2 accomplices	6,07						
									109.456,38 €

CAP 05: JOINERY

	ACTIVITY	RESOURCES	PRODUCTION	MEASURE	UD	DURATION(ho	DURATION (días)	PRICE(€/UD)	TOTAL
5.01	DOORS GROUND FLOOR								
5.01.01	Interior wood door	7 worker	0,90	8	Ud	1,03	1	290,04	2.320,32 €
		2 accomplices	0,90						
5.01.02	Galvanized steel door	7 worker	0,20	1	Ud	0,03	1	85,58	85,58 €
		2 accomplices	0,20						
5.01.03	Bath door	7 worker	0,90	4	Ud	0,51	1	173,39	693,56 €
		2 accomplices	0,90						
5.01.04	Galvanized steel double door	7 worker	0,30	1	Ud	0,04	1	246,81	246,81 €
		2 accomplices	0,30						
5.02	DOORS FIRST FLOOR								
5.02.01	Interior wood door	7 worker	0,90	4	Ud	0,51	1	184,6	738,40 €
		2 accomplices	0,90						
5.02.02	Galvanized steel door	7 worker	0,20	1	Ud	0,03	1	108,98	108,98 €
		2 accomplices	0,20						
5.02.03	Bath door First Floor	7 worker	0,90	3	Ud	0,39	1	278,82	836,46 €
		2 accomplices	0,90						
5.02.04	Galvanized steel double door	7 worker	0,30	1	Ud	0,04	1	281,92	281,92 €
		2 accomplices	0,30						
5.02.05	Sliding door	7 worker	1,20	1	Ud	0,17	1	416,07	416,07 €
		2 accomplices	1,20						
5.03	WINDOWS GROUND FLOOR								
5.03.01	Ground Floor small PVC Window 0,7x0,3m	7 worker	1,68	9	Ud	2,16	1	407,88	3.670,92 €
		2 accomplices	0,83						
5.04	WINDOWS FIRST FLOOR								
5.04.01	First Floor PVC Window 0,7x2,5m	7 worker	1,66	28	Ud	6,64	1	291,1	8.150,80 €
		2 accomplices	0,82						
5.04.02	First Floor PVC Window 1,45x2,5m	7 worker	1,35	1	Ud	0,19	1	566,06	566,06 €
		2 accomplices	0,67						
5.04.03	First Floor PVC Window 4x2,5m	7 worker	1,35	1	Ud	0,19	1	615,18	615,18 €
		2 accomplices	0,67						
									18.731,06 €

CAP 06: FINISHING

	ACTIVITY	RESOURCES	PRODUCTION	MEASURE	UD	DURATION(ho	DURATION (días)	PRICE(€/UD)	TOTAL
6.01	WALLS								
6.01.01	Ceramic tiles Locker Ground floor	7 worker	0,50	80,7	m²	5,76	1	86,53	6.982,97 €
		2 accomplices	0,50						
6.01.02	Paint Ground Floor	7 worker	0,15	327,54	m²	7,02	1	26,54	8.692,91 €
		2 accomplices	0,18						
6.01.03	Ceramic tiles toilet First floor	7 worker	0,50	42,4	m²	3,03	1	125,21	5.308,90 €
		2 accomplices	0,50						
6.01.04	Paint First Floor	7 worker	0,46	645,76	m²	42,07	6	40,59	26.211,40 €
		2 accomplices	0,46						
6.02	FLOOR								
6.02.01	Ceramic tiles Locker Ground floor	7 worker	0,40	48,84	m²	2,79	1	62,74	3.064,22 €
		2 accomplices	0,20						
6.02.02	Ceramic tiles toilet First Floor	7 worker	0,40	89,9	m²	5,14	1	62,74	5.640,33 €
		2 accomplices	0,20						
6.02.03	Terrazzo Ground Floor	7 worker	0,19	276,6	m	7,51	1	41,69	11.531,45 €
		2 accomplices	0,19						
6.02.04	Terrazzo First Floor	7 worker	0,19	289,78	m	7,87	1	41,69	12.080,93 €
		2 accomplices	0,19						
6.02.05	Plinth Terrazzo Ground Floor	7 worker	0,18	173,3	lm	4,46	1	29,09	5.041,30 €
		2 accomplices	0,18						
6.02.06	Plinth Terrazzo First Floor	7 worker	0,18	161,64	lm	4,16	1	29,09	4.702,11 €
		2 accomplices	0,18						
6.03	CEILING								
6.03.01	Plastered with gypsum in wrough Ground Floor	7 worker	0,13	200,14	m²	3,72	1		0,00 €
		2 accomplices	0,07						
6.03.02	Suspended ceiling registrable hall Ground Floor	7 worker	0,23	56,64	m²	1,86	1	44,91	2.543,70 €
		2 accomplices	0,23						
6.03.03	Ceiling falso techo registrable bathroom Ground Floor	7 worker	0,23	34,67	m²	1,14	1	44,91	1.557,03 €
		2 accomplices	0,23						
6.03.04	Paint Ground Floor	7 worker	0,46	200,14	m²	13,04	2	70,4	14.089,86 €
		2 accomplices	0,46						

6.03.05	Plaster Ceiling Ground Floor	7 worker	0,46	233,71	m²	15,22	2	24,74	5.781,99 €
		2 accomplices	0,46						
6.03.06	Suspended ceiling registrable hall First Floor	7 worker	0,23	56,07	m²	1,84	1	44,91	2.518,10 €
		2 accomplices	0,23						
6.03.07	Paint First Floor	7 worker	0,46	233,71	m²	15,22	2	70,4	16.453,18 €
		2 accomplices	0,46						

6.04 STAIRS

6.04.01	Ceramic coating stairs Ground Floor	7 worker	1,86	1	UD	0,27	1	1025,61	1.025,61 €
		2 accomplices	1,86						
6.04.02	Ceramic coating stairs First Floor	7 worker	1,86	1	UD	0,27	1	1772	1.772,13 €
		2 accomplices	1,86						
									134.998,12 €

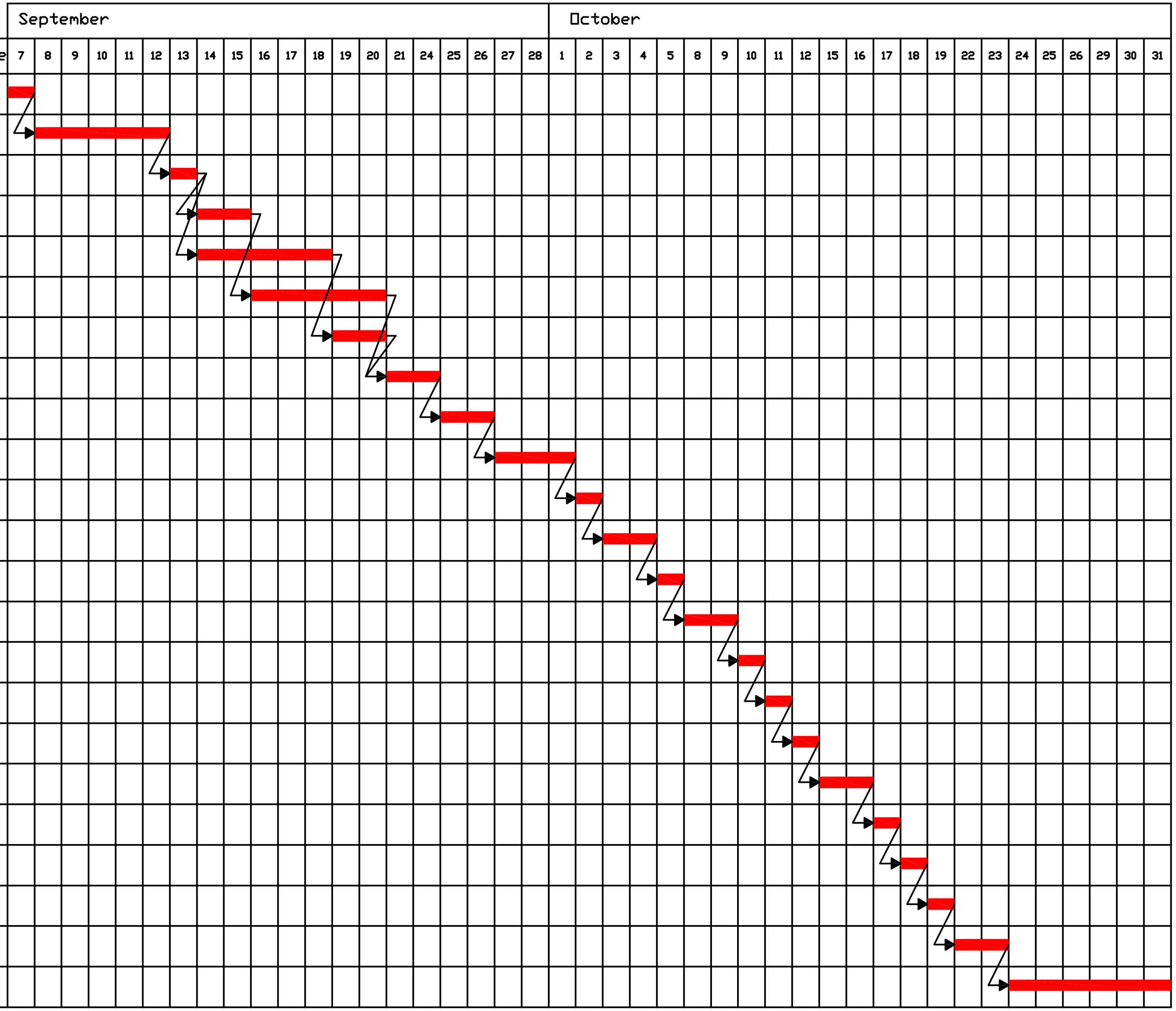
SUMMARY

CODE	CHAPTER	PRICE UD
CH 1	EARTHWORK AND EXCAVATION	4.259,45 €
CH 2	FUNDATION	50.024,03 €
CH 3	STRUCTURE	50.957,50 €
CH 4	WALLS AND PARTITIONS	109.456,38 €
CH 5	FINISHING	134.998,12 €
CH 6	JOINERY	18.731,06 €
	TOTAL	368.426,54 €

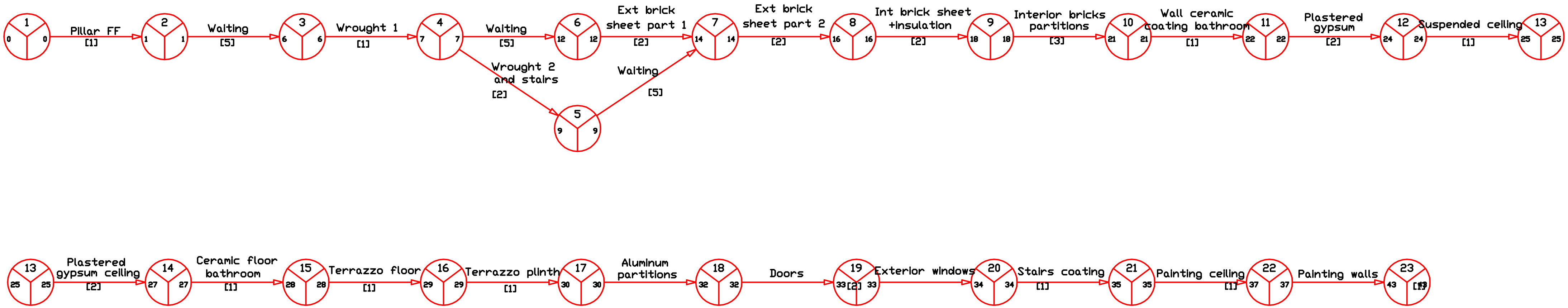
EXERCISE 3

3.1.Gantt

Number	Code	Duration	Clearance
1	Pillar FF	1,00	0,00
2	Waiting	5,00	0,00
3	Wrought 1	1,00	0,00
4	Wrought 2 and stairs	2,00	0,00
5	Waiting wrought 1	5,00	0,00
6	Waiting wrought 2	5,00	0,00
7	Exterior brick sheet part 1	2,00	0,00
8	Exterior brick sheet part 2	2,00	0,00
9	Interior brick sheet+insulation	2,00	0,00
10	Bricks partitions	3,00	0,00
11	Ceramic coating bathroom	1,00	0,00
12	Plastered gypsum	2,00	0,00
13	Suspended ceiling	1,00	0,00
14	Pastered gypsum ceiling	2,00	0,00
15	Ceramic floor bathroom	1,00	0,00
16	Terrazzo floor	1,00	0,00
17	Terrazzo plinth	1,00	0,00
18	Aluminum partitions	2,00	0,00
19	Doors	1,00	0,00
20	Exterior windows	1,00	0,00
21	Stairs coating	1,00	0,00
22	Painting ceiling	2,00	0,00
23	Painting walls	6,00	0,00



3.2. Network



Pillar FF
[1]
Waiting
[5]
Wrought 1
[1]
Waiting
[5]
Wrought 2
and stairs
[2]
Ext brick
sheet part 1
[2]
Waiting
[5]
Ext brick
sheet part 2
[2]
Int brick sheet
+insulation
[2]
Interior bricks
partitions
[3]
Wall ceramic
coating bathroom
[1]
Plastered
gypsum
[2]
Suspended ceiling
[1]
Plastered
gypsum ceiling
[2]
Ceramic floor
bathroom
[1]
Terrazzo floor
[1]
Terrazzo plinth
[1]
Aluminum
partitions
Doors
[2]
Exterior windows
Stairs coating
[1]
Painting ceiling
[1]
Painting walls

Fire Evacuation

Memory fire evacuation

1. Evacuation of occupants

1.1. Calculation of the occupation

In case of fire or other emergency, it must ensure that all people in the building can exit without problems abroad.

1- To calculate the occupation should be the occupation density values listed in the table 2.1 of the core document of fire safety in terms of the usable area of each zone

2- For the purposes of determining the occupation, must take into account the simultaneous or alternative use of the different areas of a building, considering the regime of activities and intended use for it.
For a school has an occupation of 5 person per m². The wing building has a surface of 320m² each plant.

Occupation = 320/5= **64 persons per plant**.

1.2. Number of departures and length of the evacuation routes

- Table 3.1 shows the number of outputs that should be in each case at least as well as the length of the evacuation routes to them.

- There is an emergency exit plan, since the maximum occupancy is lower door 100 people (68 people) and downward evacuation height of the plant under consideration do not exceed 28 m. (Total building height 15m)

- The length of the discharge is less than 25m (see drawings).

1.3. Dimensioning of the means of escape

1- The dimensioning of the elements evacuation should be performed according to what is indicated in Table 4.1.

- Doors and access:

$$Widht \geq \frac{Occupants}{200} \geq 0.80m \qquad W = \frac{64}{200} = 0.32 \rightarrow \mathbf{0.80m}$$

- Halls and ramps:

$$Widht \geq \frac{Occupants}{200} \geq 1m \qquad W = \frac{64}{200} = 0.32 \rightarrow \mathbf{1m}$$

- No protected stairs:

  Evacuation descending

$$Widht \geq \frac{Occupants}{160} \qquad W = \frac{64}{160} = 0.4m \rightarrow \mathbf{0.80}\boldsymbol{m}$$

  - Evacuation ascending

$$Widht \geq \frac{Occupants}{160 - 10height} \qquad W = \frac{64}{160 - 10x10} = 1.06m \rightarrow \mathbf{1}\boldsymbol{m}$$

1.4. Stairs protection

Table 5.1 shows the protective conditions to be met for escape stairways.

For teaching purposes, in buildings of height h <15m is not necessary to protect the stairs, both upstream and downstream evacuation.

1.5. Doors along escape routes

1- The doors provided as output of plant or building and the planned evacuation will be folding with vertical axis of rotation and locking system, or will not act while there is activity in the areas to evacuate, or consist of a device quick and easy opening from the side which comes from this evacuation, without using a key and without which act on more than one mechanism. The above conditions do not apply in the case of automatic doors.

2- Will open in the sense that all the evacuation exit planned for more than 50 occupants of the room or space in which it is located.

3- The automatic main doors of the hall have a system in case of power failure or in case of emergency signal, fulfill the following conditions, except in the closed position secure:

- The door remains open, or allow its opening casement in the direction of evacuation by simply pushing a total force of not more than 220 N.

Automatic pedestrian doors shall be subject to mandatory maintenance conditions in accordance with standard UNE-EN 12635:2002 + A1: 2009.

1.6. Marking of means of escape

- The use evacuation signals defined in the UNE 23034:1988, based on the following criteria:

a) The outputs of premises, plant or building will have a sign labeled "EXIT".

b) The signal labeled "Emergency Exit" should be used in all scheduled departure exclusive use in an emergency.

c) provide signals indicative of direction of the routes, visible from all sources of escape from the failure to receive directly the outputs or signals indicative.

e) In these tours, along with the doors other than exit and deceptive in the evacuation signal should be provided with the label "No Exit" in easily visible but never on the leaves of the doors.

f) The signs shall be provided consistent with the allocation of occupants that is attempted at each output, as provided in Chapter 4 of this Section.

g) The routes available (see definition in Annex A of DB SUA) for individuals with disabilities leading to a refuge, a sector of fire routing provided for evacuation of disabled people, or one out of the building is accessible signaled by the signals provided in the preceding paragraphs a), b), c) and d) accompanied by the SIA (International Symbol of Accessibility for mobility). When such accessible routes leading to a refuge or a sector of fire routing provided for evacuation of people with disabilities, will also be accompanied by the label "safe haven".

h) The surface areas of refuge shall be marked by different colors on the pavement and the label "safe haven" accompanied by the SIA placed on a wall adjacent to the area.

- Signals are visible even in case of power failure to the normal lighting.

1.7. Fire smoke control

1- You must install a smoke control system capable of ensuring fire control during the evacuation of occupants, so that it can be carried out safely.

2- The design, calculation, installation and system maintenance is performed according to UNE 23584:2008, IEC 23585:2004 and EN 12101-6:2006.

2. Fire protection facilities

2.1. Provision of fire protection facilities

1- The building must have the equipment and fire protection facilities listed in Table 1.1. The design, implementation, commissioning and maintenance of these facilities and their materials, components and equipment complies with the "Regulations for Fire Protection Facilities".

- Portable fire extinguishers: 1 every 15 m in length. Total 3 extinguishers per floor.

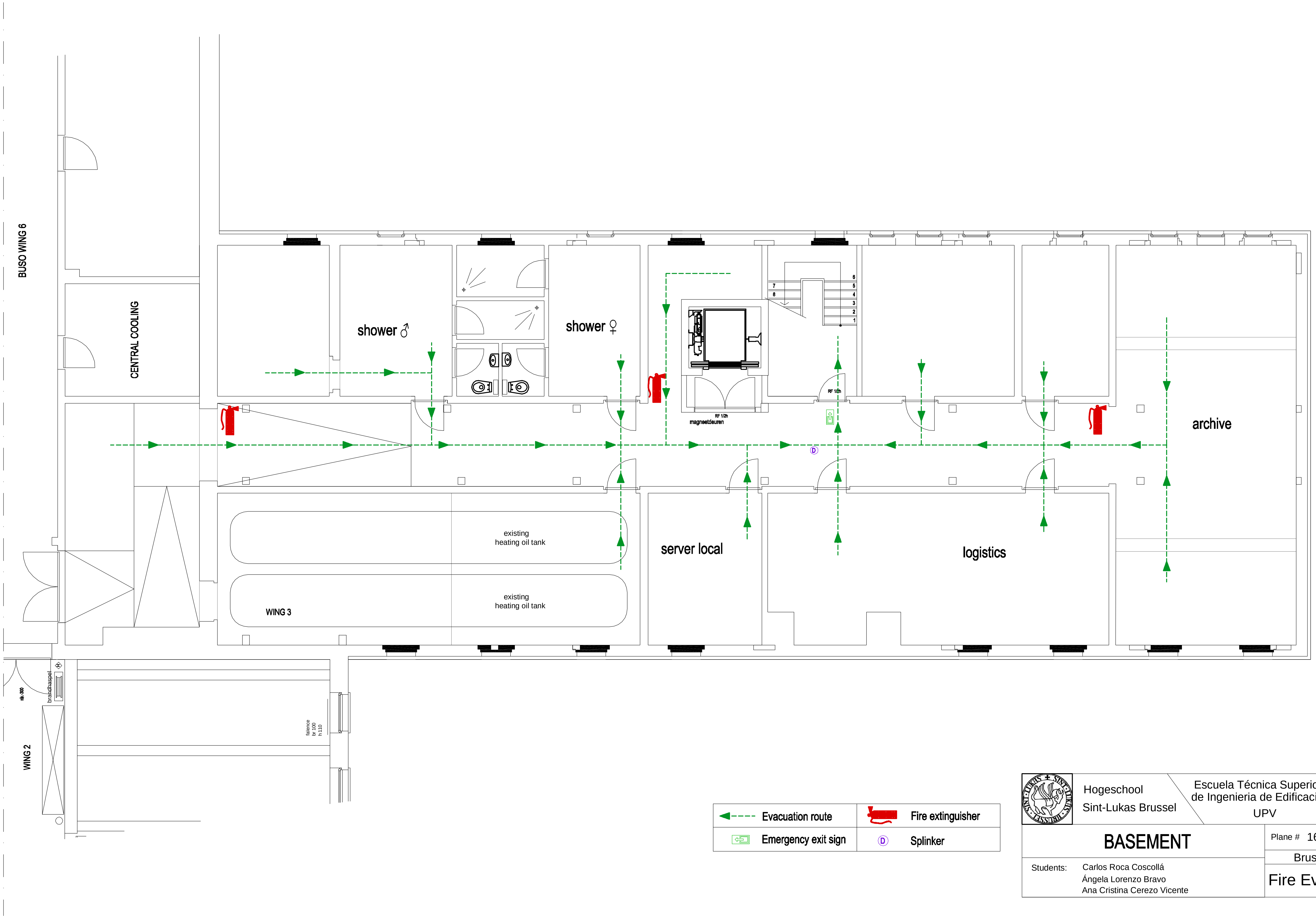
- Alarm system: if the surface is placed is greater than 1000m ^{2}. The project is only in the construction of a wing, so if we only its surface is not necessary. Conversely, if one takes into account all the building exceeds the 1.000m ^{2}, so that should be put.

- Fire Alarm Systems: One in every hallway on each floor.

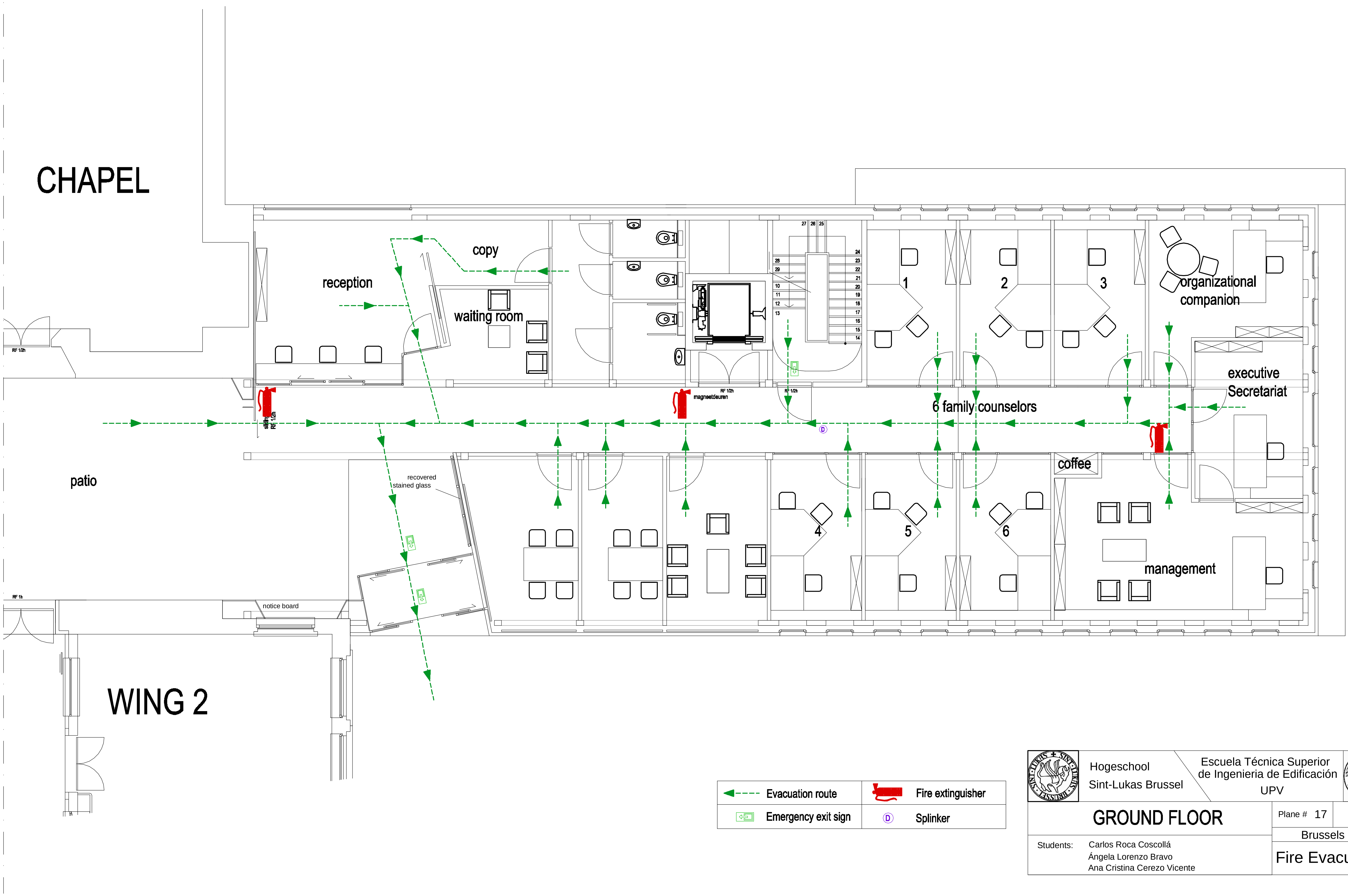
2.2. Signaling manual installations of fire protection

1 The fire protection means of manual operation should be signaled by signals defined in the UNE 23033-1. The size is 420 x 420 mm because the viewing distance is between 10 and 20 m, depending on where the occupants are.

2 The signs will be visible even in case of power failure to the normal lighting. Are photoluminescent at complying with the requirements in the UNE 23035-1:2003, UNE23035-2: 2003 and EN 23035-4:2003 and its maintenance is carried out in accordance with the provisions of the UNE 23035-3:2003.



Hogeschool Sint-Lukas Brussel	Escuela Técnica Superior de Ingenieria de Edificación UPV
BASEMENT	Plane # 16 / Escale: 1:100
	Brussels 2012
Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente	Fire Evacuation



Evacuation route	Fire extinguisher
Emergency exit sign	Splinker

Hogeschool Sint-Lukas Brussel

Escuela Técnica Superior de Ingenieria de Edificación UPV

GROUND FLOOR

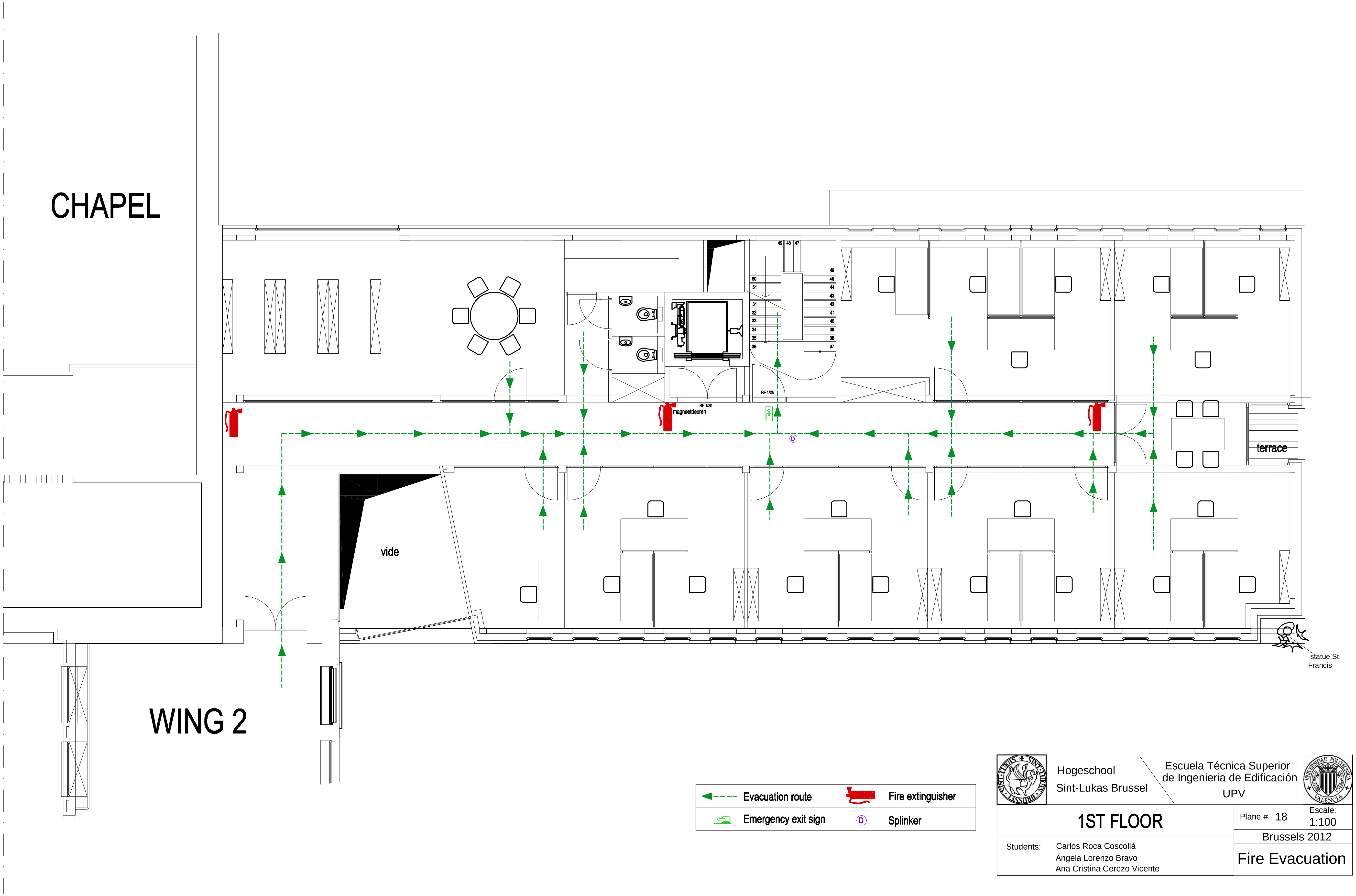
Plane # 17

Escale: 1:100

Brussels 2012

Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente

Fire Evacuation



Evacuation route	Fire extinguisher
Emergency exit sign	Splinker

Hogeschool Sint-Lukas Brussel

Escuela Técnica Superior de Ingenieria de Edificación UPV

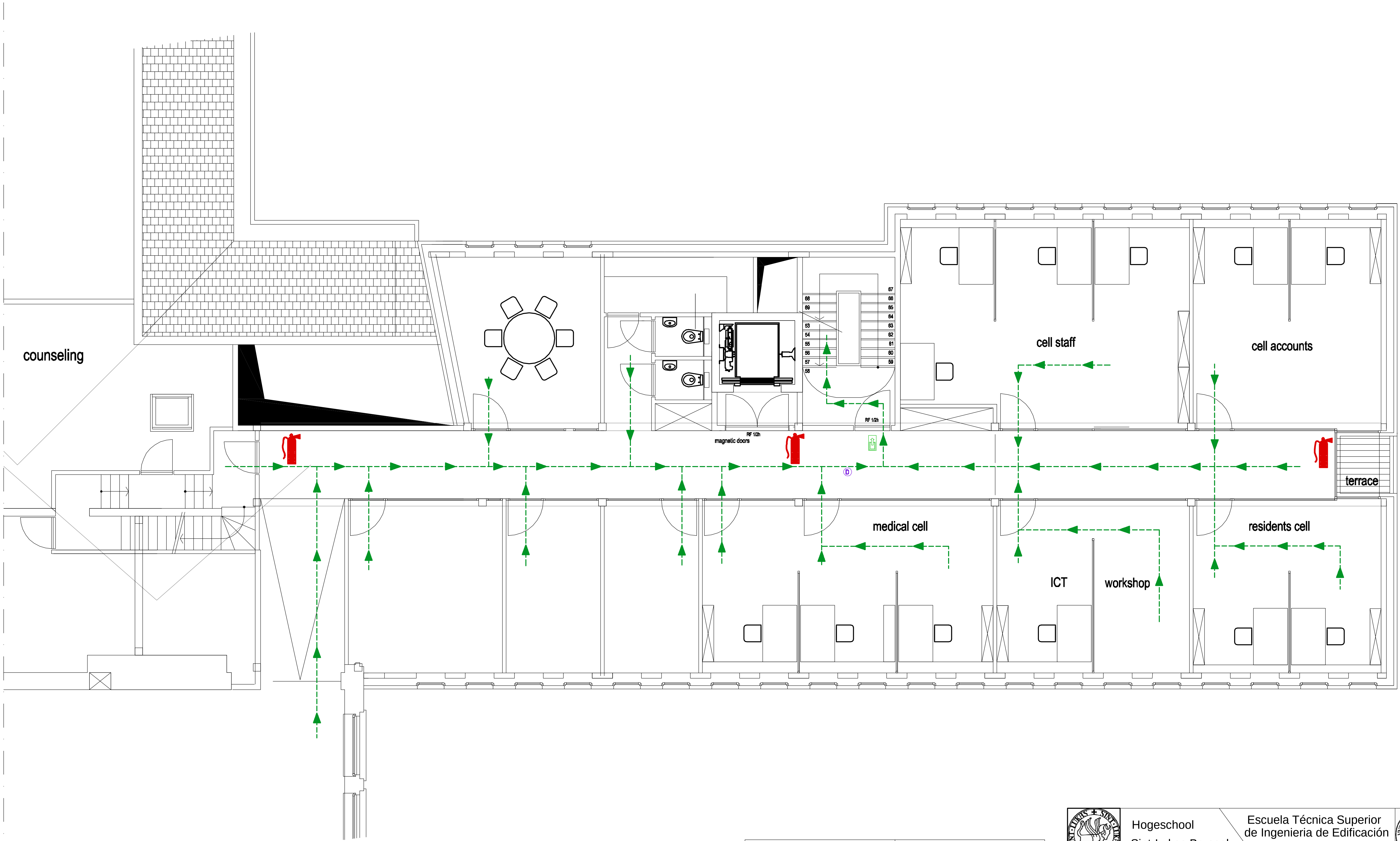
1ST FLOOR

Plane # 18 | Escale: 1:100

Brussels 2012

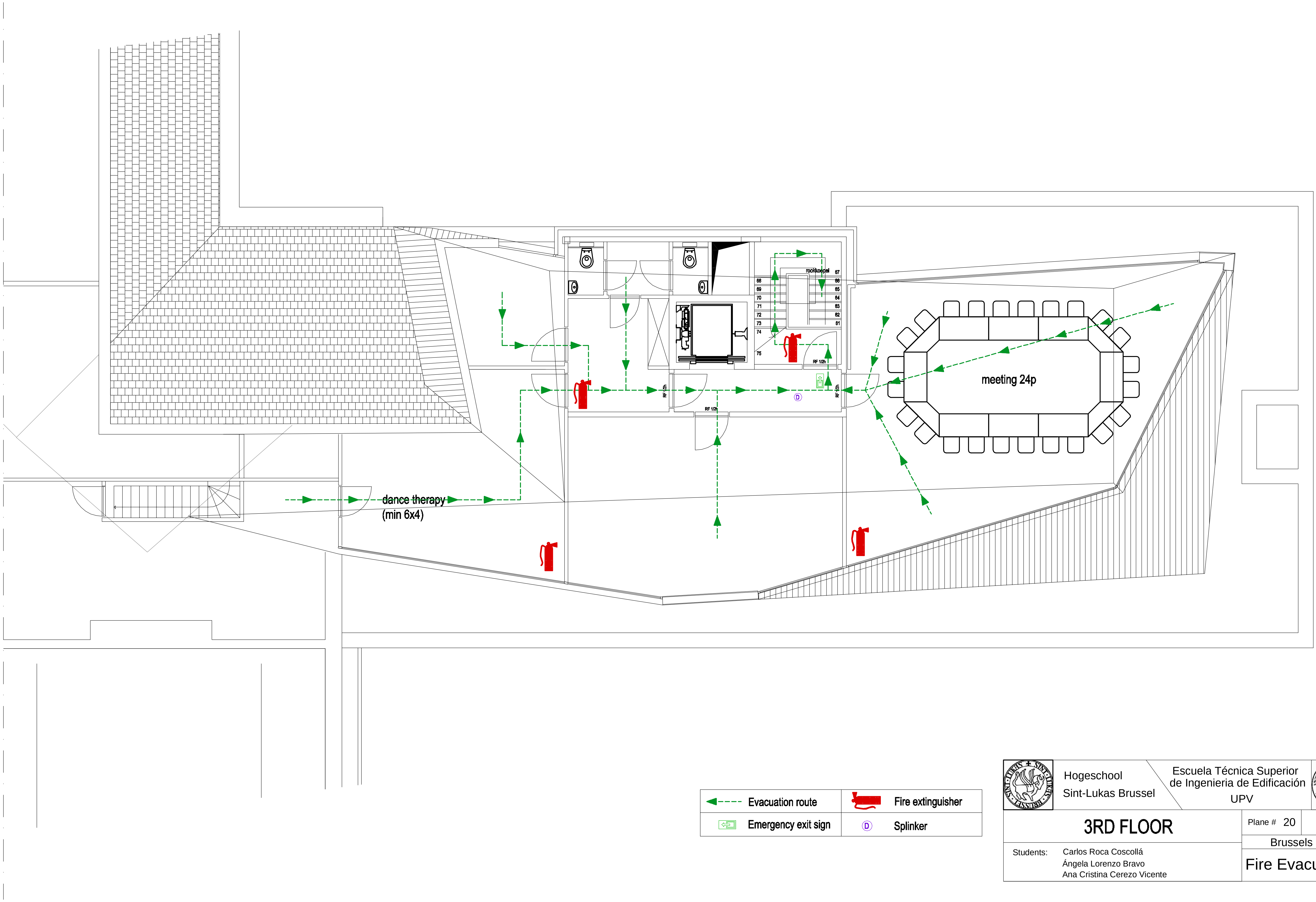
Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente

Fire Evacuation



Evacuation route	Fire extinguisher
Emergency exit sign	Splinker

Hogeschool Sint-Lukas Brussel	Escuela Técnica Superior de Ingenieria de Edificación UPV
2ND FLOOR	Plane # 19 — Escale: 1:100
Students: Carlos Roca Coscollá, Ángela Lorenzo Bravo, Ana Cristina Cerezo Vicente	Brussels 2012 — Fire Evacuation



Evacuation route		Fire extinguisher	
Emergency exit sign		Splinker	

Hogeschool Sint-Lukas Brussel

Escuela Técnica Superior de Ingenieria de Edificación UPV

3RD FLOOR

Plane # 20

Escale: 1:100

Brussels 2012

Fire Evacuation

Students: Carlos Roca Coscollá
Ángela Lorenzo Bravo
Ana Cristina Cerezo Vicente

Structure

Structure

1. Charges that affect the structure

1.1. Surcharge of use:

In administrative buildings: **2 kN/m^2**

1.2. Wind action:

qe = qb · ce · cp

Where:

qb = Dynamic pressure of wind. It used to be 0,5 kN/m^2

ce = Coefficient of exposition. In urban buildings with less than 8 floors we can adopt 2,0.

cp = Coefficient of pressure. In our case it is 0,8.

qe= 0,5 · 2,0 · 0,8 = 0,8 kN/m^2

1.3. Snow charge.

qn = μ · s_k

μ = Coefficient of form of the roof. In our case is 2,0.

S_k = Charge of the snow in an horizontal ground. In our case we can adopt 0,7 kN/ m^2.

qn= 2· 0,7 = 1,4 kN/m^2

1.4. Own weight of the structure.

Unidirectional wrought: 4 kN/m^2

Roof of slite tiles: 2 kN/m^2

Single sheet of double hollow brick: 3 kN/m^2

2. Application of the matrix method.

We know, that we should use this method to obtain the reactions and the moments in the points 26 and 27 to calculate the beam and the pillar, but we're not used to this complicated structures and we're not able to solve the system. We're going to solve the porch obtaining the reactions in the supports.

3. Sizing of a beam.

Characteristics of the concrete and the steel.

Concrete : HA – 25 → fcd = 16,7 kN/cm^2

$\gamma c = 1,5$

Steel: B-400 S → fyd = 34,78 kN/cm^2

$\gamma s = 1,15$

3.1. Longitudinal reinforcement.

To calculate the longitudinal reinforcement, we should know the concrete section of the beam.

Then we should calculate the limit moment that our concrete section can support.

Depending on the moment that we have obtained when we calculate the reactions in the beam, we're going to have a kind of flexion.

If the Limit moment is higher than the moment obtained is that our section can support this moment without the help of the longitudinal reinforcement.

If the Limit moment is lower than the moment obtained, is that our section of concrete is not able to afford the moment and we have to put in the reinforcement.

In both of the cases we are going to put this longitudinal reinforcement, because of the safety.

To obtain the section of steel that we need in our section of concrete, after knowing the moment applied in the structure and the limit moment that our section can support we have to apply the following equations:

$Md = Mlim + Us_2 (d-d_2)$

We have to substitute with the data obtained before and find U_{s2}.

Once we have U_{s2}, we have to obtain As_2, that is the section of the superior longitudinal reinforcement. We obtain that dividing Us_2 by the fyk (characteristic elastic limit of the steel).

After having Us_2 we have to obtain As_1. We do that putting all the charges in equilibrium and we obtain Us_1. To have the section of steel of the inferior longitudinal reinforcement we have to divide Us_1 by the fyk of the steel.

When we have all the areas of the different kinds of reinforcement, we have to obtain the number of bars of steel that we have to have and their diameter. That would depend on our criteria and the minimum number of bars asked by the norm.

3.2. Transversal reinforcement.

To calculate this reinforcement we have to obtain the tractions and compressions that our structure is supporting.

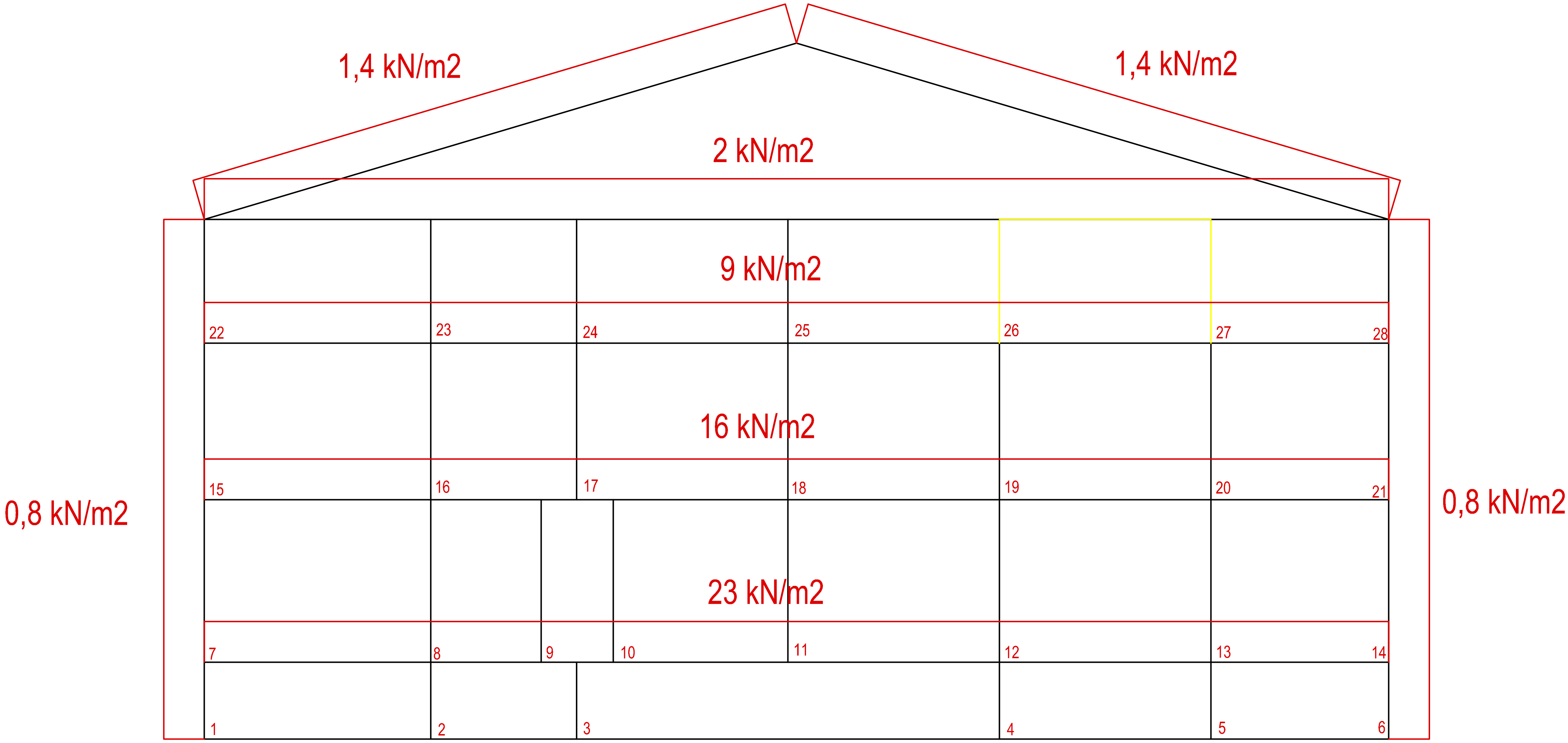
When we know the tractions, we have to apply an equation to have the charges in equilibrium and like that find the area of steel that we have to put in the section.

4. Sizing of a pilar.

To size a pilar, we have to use the same method if we were calculating a beam. We have to take into account the slenderness and the buckling.

5. Sizing of a piece of wrought.

In Spain, we have a different kind of wrought than in Belgium. It has always the same thickness and the same components. To size it we have to find the moment that our structure has to afford, and after that we have to go and look in the catalog of the manufacturers of pretessed beams, and find the pretessed beam that can support this moment.


1,4 kN/m2
1,4 kN/m2
2 kN/m2
9 kN/m2
22
23
24
25
26
27
28
16 kN/m2
15
16
17
18
19
20
21
0,8 kN/m2
0,8 kN/m2
23 kN/m2
7
8
9
10
11
12
13
14
1
2
3
4
5
6