

# Characteristics of a newly built general hospital in Romania



**IOAN SILVIU DOBOȘI**  
General Manager  
DOSETIMPEX SRL,  
Timișoara, Romania  
[ioansilviu@dosetimpex.ro](mailto:ioansilviu@dosetimpex.ro)



**DRAGOȘ MIHĂILĂ**  
HVAC Design  
Engineer  
DOSETIMPEX SRL,  
Timișoara, Romania  
[dragos@dosetimpex.ro](mailto:dragos@dosetimpex.ro)



**CORNEL DEMETER**  
Electrical Design  
Engineer  
CAPABIL SRL,  
Timișoara, Romania  
[cornel.demeter@capabil.ro](mailto:cornel.demeter@capabil.ro)



**DRAGOȘ BOCAN**  
Architect  
Atelier CAAD SRL,  
Timișoara, Romania  
[dragosbocan@gmail.com](mailto:dragosbocan@gmail.com)



**CRISTINA TĂNASĂ**  
Assistant Professor,  
Ph.D., P.E.  
Politehnica University  
Timisoara,  
DARO PROIECT SRL  
[cristina.tanasa@dar.ro](mailto:cristina.tanasa@dar.ro)

It is well known that the design and execution quality of a construction may dramatically influence the real behavior and performance of a building. This point is even more important for healthcare buildings as they have unique and rigorous criteria from multiple perspectives such as structural, architectural, HVAC and indoor environment quality. This paper presents the case study of Mioveni Hospital building, recently built in southern Romania, and is focused on emphasizing the specific architectural and building installations characteristics and design conditions of such type of building. The case study building has in total eight floors and a built area of approximately 17 448.54 m<sup>2</sup>. The whole process of accomplishing all that means the Mioveni City Hospital, embodied a sustained effort from the design phase to the commissioning phase. From a professional point of view, it was a complete and challenging experience and the final outcome merits all the efforts made in this venture.

## General description

Constructing a hospital of the dimensions and importance of the Mioveni City hospital is by far one of the largest current achievements in the Romanian medical and social environment of the past years. This investment was a challenge for both the recipient and the design teams as well as for construction companies involved in the project. The new hospital building is located at the address of the existing Municipal Hospital “Sfântul

Spiridon” in Mioveni. The city hospital is designed to have a continuous hospitalization capacity of 250 beds. The new hospital also included setting up entirely new medical specialties, such as the one for interventional cardiology fitted with an angiograph. The beneficiary wanted to create a new hospital to accommodate the sections of the old hospital as well as new parts to accommodate diverse and complex medical services for the benefit of the population of Mioveni City.

The design of the hospital was performed following a series of normative acts specific to the hospital construction, as follows:

- NP 015 - 1997 - Design and verification of the hospital construction and of the installations necessary for their application [1];
- ORDER no. 914 of July 26, 2006 - for the approval of the norms regarding the conditions that a hospital must respect in order to obtain authorized sanitary permits for operation [2];

ORDER No. 1096/2016 - regarding the modification and completion of the Order of the Minister of Health no. 914/2006 for the approval of the norms regarding the conditions that a hospital must comply in order to obtain the sanitary authorization of functioning [3].

Considering the limitations imposed by the land, the building was developed vertically with a height regime consisting of basement, ground floor and 6 levels. The plan form of the basement and the ground floor is rectan-

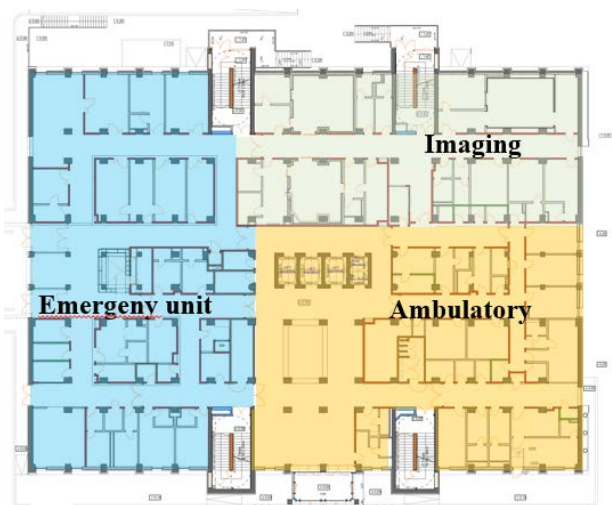
gular and the floors from 1 to 6 have the form of the letter 'H', as it can be seen in **Figure 1** and **Figure 2**. **Table 1** describes the functionality of each floor of the hospital.

**Table 1.** Functional layout of the hospital building.

Floor	Functionality	Useful floor area [m <sup>2</sup> ]
Basement	Morgue, Kitchen, Laboratory, Laundry Room	2 448.63
Ground floor	Emergency Unit, Investigations, Ambulatory	2 020.44
1 <sup>st</sup> Floor	Operating Block, Sterilization, Cardiology, Intensive Care	1 936.50
2 <sup>nd</sup> Floor	Maternity, Operating Block and Neonatology	1 721.87
3 <sup>rd</sup> Floor	Gynecology, Pediatrics	1 721.91
4 <sup>th</sup> Floor	Internal medicine	1 719.75
5 <sup>th</sup> Floor	Cardiology, Surgery and Neurology	1 715.93
6 <sup>th</sup> Floor	Pharmacy, Administrative spaces	1 788.46



**Figure 1.** Hospital view.



a) Ground floor



b) First floor

**Figure 2.** Ground floor and first floor plans of the hospital.

## Case studies

The structural system of the building consists of reinforced concrete frames and diaphragms. The floors are made of reinforced concrete and the roof is terrace type. The exterior walls are made of reinforced concrete and masonry, provided with ventilated facade system and 10 cm thick insulation made of basaltic mineral wool. The ground slab was insulated with 10 cm of extruded polystyrene and the roof was isolated with 20 cm of extruded polystyrene. Energy efficient windows have been fitted with aluminium joinery provided with sealing gaskets and triple-glazed windows.

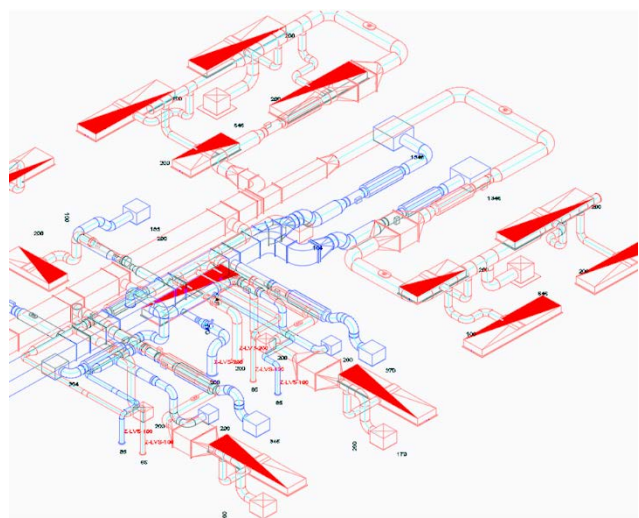
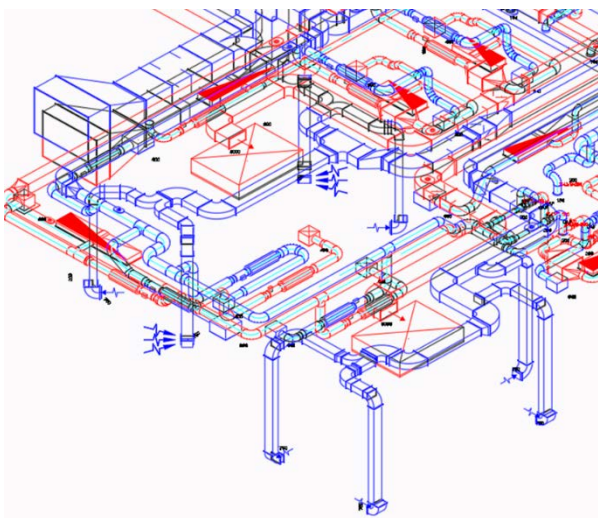
### Building Installations system

#### *Ventilation and air conditioning*

The ventilation and air conditioning of the entire hospital is carried out with the help of 18 air handling units (AHU). The sizing and choice of the air handling units was made according to the served spaces and the number of air changes required for each space (according to NP 015 - 1997 and I5 - 2010). The air purity conditions in the rooms of the hospital units imply an adequate level of filtration, which determines the number of filtration stages. All ventilation systems are connected to an energy management and monitoring system - Building Management System. The sizing of the AHUs has been designed to ensure the number of air changes required in the rooms to which each AHU is connected, according to the normative NP 015 [1]. The hospital rooms are classified in 4 classes, which have as main criterion the air purity expressed by the essential requirement in the field that is, lack of germs (asepsis). Air exchanges range from 2 air exchanges per hour for offices, corri-

dors and cabinets, up to 20 air changes per hour for operating rooms. Each of the 5 operating rooms is equipped with an AHU that works without air recirculation, the air introduced will be 100% fresh air. The AHUs in the operating rooms are equipped with intermediate fluid heat recovery, steam humidification, heating and preheating battery, cooling battery, inlet and outlet fans, and will have 2 stages of input filtering. The air supply for the operating rooms is realized through stainless steel filter ceilings with vertical laminar flow, equipped with HEPA 14 Filters. **Figure 3** captures the isometric view of the ventilation system that serves the operating rooms and intensive care area.

The ventilation and air treatment for the areas allocated to the intensive care unit and the operating unit will be carried out with the help of 2 AHUs. The introduction of the air for the intensive care rooms, post / preoperative spaces, the medical washes and the instrument washes are performed by swirl / anemostats, and induction units located in the false ceiling, equipped with HEPA filters 13. The air evacuation is done by swirl anemostats, with 4 directions located in the false ceiling. During periods without activity the fresh air flow in the intensive care rooms will be maintained at 50% of the nominal flow. The design of the ventilation and air conditioning installation of the laboratory area was done according to the National Biosafety Guide for medical laboratories. Each laboratory is equipped with a differential pressure control system with which the depression against the adjacent corridor will be maintained, min 10 Pa. For the evacuation of the vitiated air from the 8 laboratories, there were



**Figure 3.** Isometric view of ventilation system operating rooms and intensive care rooms.

provided swirl grids equipped with HEPA 13 filters, connected to an exhaust fan with the flow rate of 2 740 m<sup>3</sup>/h.

### Heating and cooling systems

The boiler is composed of 3 steel boilers (3 x 900 = 2 700 kW) equipped with dual burners with gas (modulating) and diesel fuel (in two stages). The basic fuel is methane gas, diesel being used as an alternative in case of problems in methane gas supply. The boilers operate in cascade and are controlled by BMS to maintain a constant flow temperature of 70°C ± 1°C. BMS also rotates the basic boiler at a number of operating hours for uniform wear of the equipment. To supply the vital consumers, it is necessary to operate two boilers out of three, one being a reserve. Cooling is provided by 3 chillers (3 x 800 kW = 2 400 kW) mounted on the outside of the building. The chiller compressors are screw type, and their cascade is done through BMS to maintain the primary flow temperature to the value set at 5°C. In order to supply consumers in the situation of extreme summer climatic conditions, it is necessary to operate two chillers out of three, one being

a reserve. The chillers also work during the winter period in free-cooling-free cooling mode.

### Domestic hot water

Domestic hot water preparation (DHW) is done in semi-instantaneous mode with 2 heat exchangers (2 x 300 kW) and 5 storage vessels, boilers 5 x 1 000 l (Figure 4). The main source of thermal energy is a circuit from the boiler - 600 kW - hot water 70/50°C. The secondary source for DHW preparation is solar energy - four fields of 20 flat solar panels each with a surface area of about 2.3 square meters (Figure 5).



Figure 4. Solar panels installed on the roof.

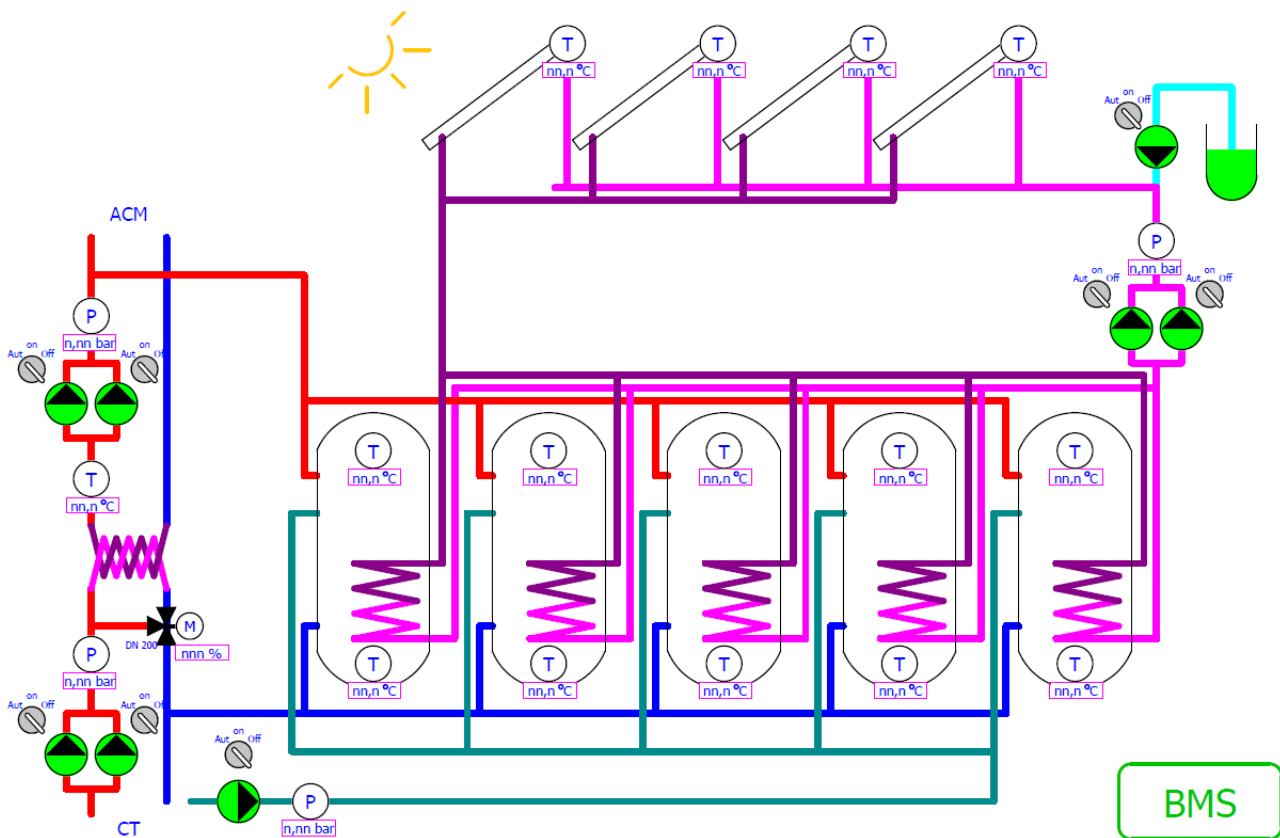


Figure 5. DHW control scheme

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They are mounted on the cover of the main building (over the 6th floor) with the orientation of SV and inclination of 45°. The captured thermal energy is transported in the coils of the 2 boilers. The thermal power of the solar system in peak mode is about 150 kW (maximum temperature 130°C).

### Electrical engineering

The main source of electricity is the National Energy Network. The supply is made through a medium voltage connection point, powered by two lines from National Energy Network and a transformer station with two units of 2 000 kVA, 20 / 0.4 kV, which are 100% mutually reserved. The transformers are located in the basement of the main building. The backup source consists of two 1 250 kVA generator sets, which automatically start after a maximum of 15 seconds and run in parallel. The generators are equipped with a synchronization panel that will allow them to operate in parallel. The generator sets are located in the basement of the main building. The backup source with an interruption time of maximum 0.5 seconds will consist of two uninterruptible power supplies of 250 kVA each, connected to an external bypass. Energy-efficient LED-type luminaires were used for lighting.

### Building Management System (BMS)

The hospital is equipped with a building management system (BMS) to ensure the automatic operation, control and supervision of heating, ventilation, air conditioning and lighting systems. The BMS maintains the pressure difference between the clean or polluting rooms and the adjacent ones, the control of the lighting system and the electrical distribution boards. The design of the BMS was made on the

basis of data on heating, ventilation and air conditioning, lighting installations and architecture of the building. BMS is an efficient tool in optimizing energy consumption. Its parameters must be set in such a way as to ensure the designed operating parameters (temperatures, lighting level, pressures, etc.), with a minimum energy consumption of the installations. To illustrate the interface of the BMS system, print screen images are presented in **Figures 6 and 7**.

### Energy certification of the hospital

The energy certificate was prepared according to the Methodology of Calculating the Energy Performance of Buildings MC001-2006 [4]. The analysis of the energy certificate shows the classification of the building in class A of energy performance. **Figure 8** shows an extract from the Certificate of Energy Performance of the hospital from which the early mentioned classification results. The fact that this hospital was classified in the energy performance class A, shows that in addition to the functional, architectural, structural design and hospital design concerns of the hospital, the designers have given importance and energy efficiency of the hospital so that the operating costs of the building related to energy consumption should be as small as possible.

### Discussion

The whole process of accomplishing everything that means the Mioveni City Hospital represented a sustained effort of all those involved from the design phase to the commissioning phase. It was a complete and challenging experience from a professional point of view, but the satisfaction of the final result deserves

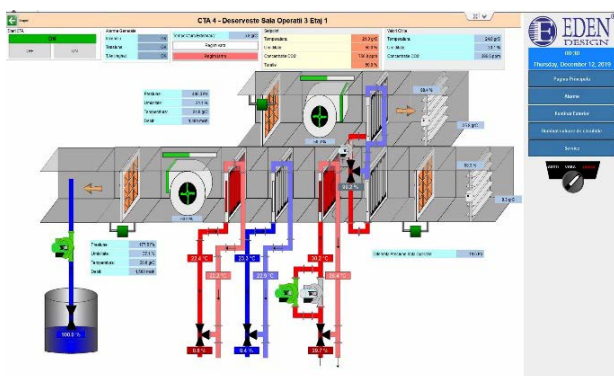


Figure 6. BMS – CTA 4 control panel.

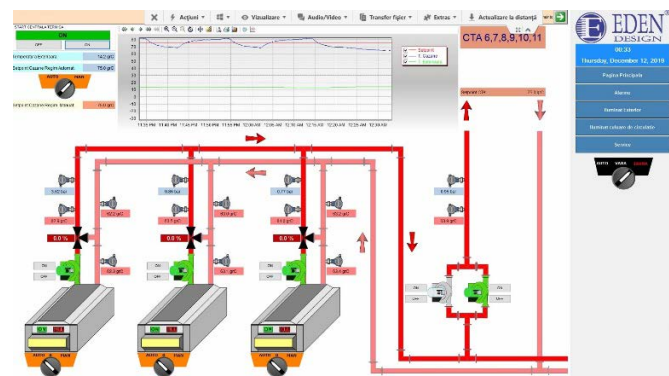


Figure 7. BMS – control panel of heating plant.

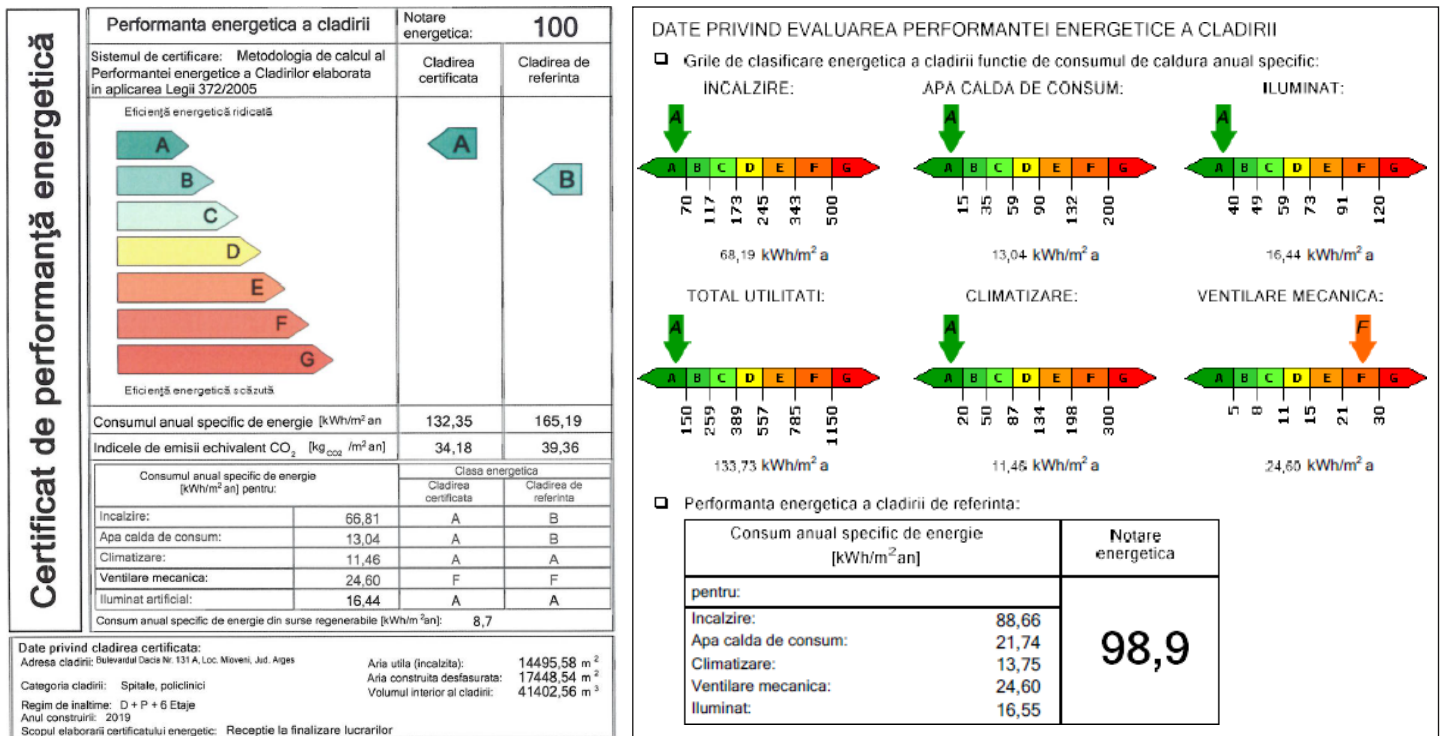


Figure 8. Energy performance certificate of the building.

all the efforts made in this project. Within the project of Mioveni Hospital new concepts were and are promoted: digitalization and medical computerization with the possibility of remote monitoring of patients; BIM - Building Information Modeling - modeling the building from the design phase to the operation and maintenance phase. Mioveni City Hospital is one of the few new hospitals built in

Romania in the last 30 years. In other words, the design and construction of new hospitals in the Romanian public sector currently very rare activities. And from this perspective, Mioveni Hospital is a unique building project at the moment and can be regarded as a reference building for the further development of the built environment in the Romanian health sector. ■

## References

- [1] Indicative NP 015 – Regulations regarding the Design and verification of hospital constructions and their related installations, Institute of Design, Research and Calculation Technique in Construction - IPCT, 1997.
- [2] ORDER no. 914 of July 26, 2006 (updated) for approving the norms regarding the conditions that a hospital must fulfil in order to obtain the sanitary authorization to operate.
- [3] Order no. 1096/2016 regarding the modification and completion of the Order of the Minister of Health no. 914/2006 for approving the norms regarding the conditions that a hospital must fulfil in order to obtain the sanitary authorization to operate.
- [4] Mc 001/2006 - Methodology for calculating the energy performance of buildings.