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Abstract

The present report is the report of the first phase * of the energy audit project of Al-Zahra Medical Center *, which has been prepared by Saman Energy Consulting Engineers Company and covers paragraphs 1 to 6, 8, 10 and 11 of the service description of this project.

This report first introduces the complete heating equipment of the engine room, the necessary thermal measurements for each equipment, presents the results and calculates their efficiency, and also estimates the consumption of energy carriers in the engine room of the building in the cold season. It will be observed that the boiler efficiency is equal to 75.83% and the boiler fuel consumption is equal to 439 cubic meters per hour. Also, the boiler efficiency is doubled to 7.81% and its fuel consumption is about 264 cubic meters per hour.

Then the lighting system of the hospital building is examined and the measurement results are given in this section. In this section, the energy consumption index of the building is calculated according to the information of 2010 and 2011, which is estimated at 136.46 kWh per square meter per year. Also, the share of lighting consumption according to the measurements and information collected is about 11%.

Status in the engine room

1-1 Introduction

Al-Zahra Hospital is currently operating with a total area of 27 hectares of infrastructure of 80,000 square meters and 800 active beds and 48 wards and specialized and sub-specialized units and paraclinical units, 43 specialized and sub-specialized clinics and 27 active operating rooms. This hospital has 6 floors that include different departments such as gastrointestinal nephrology, rheumatology, blood and oncology, surgical departments and subspecialty departments.

Al-Zahra Educational and Medical Center is located in Isfahan, near Sofeh Mountain Park, and was inaugurated and put into operation in 1993.

Figure 1_1 shows the hospital building.

1-1 hospital building

1-2 building facilities

1_2_1 Heating, cooling and hot water installations

In the building in question, central heating and cooling system is used for heating and cooling of the building. The process of heat production and transfer in a central heating system is such that the heat necessary to compensate for heat loss of the building by a boiler inside the engine room on water or the steam is mounted and carried by independent pipes to the heat exchangers located in the rooms, such as radiators and independent fan coils. The heat transfer fluid is returned to the boiler after heat exchange in the room to repeat the above cycle. The steps of this operation can be effectively controlled by devices such as thermostats, etc. The central heating system of the building in question includes four steel boilers and heat exchangers of fan type and air conditioner, which will be examined in the following.

For cooling in the building, three absorption chillers are used that provide cold water in the circulation of thermal terminals (fan coil and air conditioner).

Also, to supply hot water to the residents, the steam coming out of the boilers is used so that the hot steam coming out of the boiler is directed by piping into the hot water exchanger (5 coil sources) and in it, it transfers heat to the water and The boiler returns. The heated water is transferred to the building by the piping system for the consumption of the residents.

1-2-1-1 Heating load supply

The central heating equipment of the building is generally presented in the table1-1.

Number	Manufacturer / model	Type of equipment	Number
3	Kewanee	Boiler	1
1	araki		
3	Pars Mashal	Torch	2
1	araki		
8	KSB_Wkln 32/1a 6 Stage	Boiler water supply pump	3
3	Su244_2 B&G Heat Exchanger	Heat exchanger	4
9	KSB_80_250	Water circulation pumps	5
2	1057 (gallon)	Closed expansion source	6
2	Automatic HB_6600_Duplex Culligan	Stiff	7
170	Atmosphere / ventilation	Ground fan coil	8

1096	Atmosphere / ventilation	Ceiling fan coil	9
20	Atmosphere / ventilation	UAC standing unit	10
111	-	Ceiling unit	11
28	Cold maker	air conditioner	12

Table 1-1 heating equipment of the building

Boiler

In the central heating system of this building, four fire tube boilers are used, which provide the desired steam to the heat exchangers and coil sources to produce hot water for the building, as well as the steam required for the use of different parts of the hospital. A burner has been used to burn fuel and generate heat in each of the boilers.

Figure 2_1 and Figure 1_3 show a view of steam boilers.

Figure 1-2 Steam boilers

Figure 1-3 Boiler No. 1 with burner

The specifications of the building heat generating equipment are presented in Table 1-2 and Table 1-3

Table 1-2 Specifications of boilers

Boiler number	Work pressure (PSI)	Capacity (M.B.H)	Model	Name of manufacturer	Type of equipment
2,3,4	150	25106	Kewanee Classic III Unit. No. 750	Kewanee	Steel boiler
1	150	24257	-	araki	Steel boiler
Boiler number	Maximum capacity (Kcal/hr)	Volume of fuel consumed (CFM)	fuel type	Name of manufacturer	Type of equipment
2,3,4	107	523	natural gas	Pars torch	Torch
1	-	-	natural gas	araki	Torch

It should be noted that the burners of the boilers are dual-burners, and in cases where the gas is cut off for any reason, diesel is used for combustion. For this purpose, two 50,000 liter diesel storage tanks are used, which are located next to the engine room.

Also, feed pumps designed for this purpose and pumping water from inside the boiler have been used to supply the required water of boilers when the water level of the boiler decreases.

Table 1_4 shows the specifications of boiler water supply pumps

Table1-4: specifications of boiler water supply pumps

number	rate CFM	head m	RPM	power HP	model	type of equipment
8	7	95	2900	15	KSB_Wkln 32/1a 6 Stage	Boiler water supply pump

Heat exchanger

Heat exchangers are used to exchange heat between two fluids. This motor home uses three steam heat exchangers that supply the hot water required for the fan coils and air conditioners in the hospital building.

Table 1_5 shows the technical specifications of heat exchangers

Table 1-5: technical specifications of heat exchangers

number	Inlet pressure steam (psi)	Water temperature Output (F)	Water temperature Entrance (F)	thermal power BTU/hr	model	type of equipment
3	125	180	175	5,666,965	Su244_2 B&G Heat exchanger	Steam heat exchanger

It is necessary to explain that 2 sets of converters are in orbit around the clock for about 6 to 7 months of the year (depending on the cold weather) and one device is used as a reserve.

Water circulation pumps in the heating system

Centrifugal pumps are used in central heating and cooling systems to compensate for the pressure drop in the piping system. In this type of pump, water pressure and its speed are provided by the centrifugal force of the impeller. The water flow enters in a direction parallel to the impeller axis and exits in a radial direction.

In the mentioned building, 9 centrifugal pumps have been used to supply pressure in the piping system of the central heating facility, which directs the hot water leaving the heat exchangers to the existing fan coils and air conditioners.

It should be noted that in this system, two to three pump devices are always in the circuit and the rest are used as a reservation or alternative.

Figure 1_4 shows a view of water circulation pumps

Figure 1-4:water circulation pumps

Table 1-6 presents the technical specifications of water circulation pumps

Table 1-6: technical specifications of water circulation pumps

number	rate GPM	(m) head	RPM	power HP	model	Type of equipment
9	1100	55	2900	102	KSB_80_250	pump

Expansion tank

In order to stabilize the system pressure, the possibility of water expansion due to increasing temperature in closed systems is used by the expansion source. In this building, two expansion source devices depending on the capacity of 1057 gallons are used for heating.

Stiff

Solutes in circulating water in the central heating system as well as sanitary water with sediment in the walls of pipes as well as in pumps and boilers can be the source of severe damage to building facilities.
When hard water is heated, the formation of sediment crust is much faster, which causes many problems in boilers and water heaters. The formation of sediment in walls and walls causes a lot of damage to heating and cooling facilities, the most important of which is to reduce The efficiency of converters and thus increase energy consumption. To prevent such problems, especially in areas where water is rich in salts, a water hardening device is used.

In this building, two resin hardeners have been used. Resin hardeners, due to ion exchange and removal of solutes and water-soluble stiff in terms of performance compared to magnetic, electronic and ultrasonic descaling, keep the solutes suspended only in water. They are safer, but on the other hand, resin stiffeners require constant and regular backwashing and regeneration operations.

The excavation and reduction operations in resin hardeners with semi-automatic valves are performed by the engine room operator and in resin hardeners with fully automatic valves without the need for an operator and based on a current or time adjustment system.

Table 1_7 shows the specifications of the desired stiff.

Table 1-7: specifications of the existing stiff

number	Maximum capacity (Grain)	model	type	Type of equipment
2	5,356,000	Automatic HB_6600_Duplex Culligan	resin	stiff

Fan coil

Air conditioning systems are divided into several categories based on the type of fluids carrying heat and cold load, including all water, all air and air-water. In the building in question, air conditioning system (all water) is used to provide the required heat and cold space. These systems use fan coil terminals for heat exchange. Heat exchange of this type of thermal terminals with the surrounding environment is in the form of forced heat transfer so that air is passed by blowers on coils containing hot or cold water produced in the engine room and part of the heat and cold in the water. Receives the inside of the coil. Finally, the heated and cooled air is transferred to the space where the terminal is located.

The following table shows the specifications of the thermal terminals in the building.

Table 1-8: specifications of the thermal terminals

number	(CFM)rate	type	Name of manufacturer	Type of equipment	number
12	300	Earth	Ventilation	Fan coil	1
68	400				
34	600				
56	800				
238	300				

354	400	Ceiling	Ventilation	Fan coil	2
365	600				
139	800				
20	3000	standing	Cold maker	Unit UAC	3
65	1200	Ceiling	-	Unit UAC	4
30	2000				
13	3000				
3	4000				

It is necessary to explain that the circulating water piping system for heating and cooling the building is a direct return double pipe and the diameter of the return pipes is the same. In this system, hot and cold water circulates through the pipe and enters the "fan coil" thermal terminal, and after exchanging heat in the fan coil, it returns to the engine of the house through the pipe. Direct return system is used for installations in which heat exchangers such as radiators or fan coils have internal pressure drop or different capacities. All return pipes in this building are of built-in type.

Air handling unit:

Air handling unit (AHU for short) is a device for providing air conditioning and safe with achieving the right temperature and humidity. Air handling unit is one of the main air conditioners that is located in the path of chiller and boiler with air duct.

Table 1_9 shows the specifications of existing Air handling unit.

Table 1-9: the specifications of existing Air handling unit

Covered space m2	Engine power HP	ظرفيت برandدتي BTU/HR	مقدار هوادهي CFM	Name of manufacturer	Name/type of equipment or system	number
1500	10	304533	8430		AUH 101	1
2000	15	456258	12630		AUH 102	2
2600	15	465831	12895		AUH 103	3
1200	5	188572	5220		AUH 104	4
1350	7.5	213678	5915		AUH 105	5
1400	7.5	219098	6065		AUH 106	6
2570	15	553073	15310		AUH 107	7
3500	15	514258	14230		AUH 108	8

1600	7.5	383828	10625		AUH 109	9
2650	10	298946	9955		AUH 201	10
2000	7.5	247297	8235		AUH 202	11
1650	7.5	234234	7800		AUH 203	12
2740	10	298949	9955		AUH 204	13
2100	7.5	262448	7265		AUH 205	14
2700	25	880547	24375		AUH 206	15
2450	15	594798	16465		AUH 207	16
500	10	279598	4935		AUH 208	17
2200	20	594457	11455	Cold maker	AUH 209	18
1550	7.5	298382	6070		AUH 210	19
850	3	112890	3125		AUH 211	20
500	7.5	212418	3725		AUH 212	21
3340	25	615389	17035		AUH 213	22
1900	20	556573	10725		AUH 214	23
1500	7.5	298382	6070		AUH 215	24
3000	7.5	244144	8130		AUH 401	25
3250	7.5	241892	8055		AUH 402	26
3000	7.5	231531	7710		AUH 403	27
3000	7.5	350450	8340		AUH 404	28

In the table above, the covered space is approximately estimated.

Hot water supply

In this system, the hot water consumption of the building is prepared by steam generated in the boiler, inside the coil springs. For this purpose, five coil springs are used, and each of these springs is used periodically and during a year.

Figure 1-5 shows a view of coil sources.

Figure1-5: coil sources

Table 1_10 presents the specifications of hot water sources

Table 1-10 Coil resource specifications

number	hot water rate GPM	Capacity (M.B.H)	tank volume (Gallon)	model	Type of equipment
5	64	3175	3935	Tcs_1236 B&G Tank heater	Coil resource

Also, to compensate for the pressure drop in the hot water piping system, two centrifugal pumps are used, which are located in the return path.

Table 1_11 shows the specifications of hot water pumps.

Table 1-11: specifications of hot water pumps

number	rate GPM	(m) head	RPM	power HP	model	Type of equipment
2	165	27.4	1450	10	KSB_50_315	pump

Chapter 2:

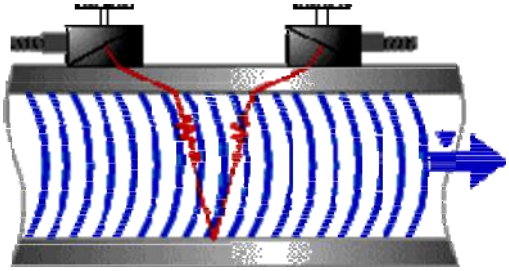
Results of relevant measurements and analyzes

2_1Thermal measurement

2_1_1Dube of water entering the boiler

An ultrasonic flow meter is a device used to measure the velocity of liquids inside a tube using electro sonic waves without the need to cut the tube and make contact with the fluid. The figure opposite shows this device The basis of measuring the device is based on the time difference between sending and receiving electro sonic pulses by two transducers, one in the direction of current and the other in the opposite direction of current.

Transducers alternate between transmitter and receiver. This device has the ability to measure and calculate the following parameters:



- Speed of flow

- Volumetric flow rate

- Flow mass rate

- Heat flow rate

- Average speed sound inside the fluid

In the building in question, the necessary measurements were performed on boilers 1 and 2 for one hour, the results of which are as follows:

-The average flow of water to boiler number one (Araki) is approximately 5.55 cubic meters per hour

-The average flow of water to boiler No. 2 (Kewanee) is approximately 3.45 cubic meters per hour.

Figure 1-2 and Figure 2-3 show the flow chart of water entering the boiler according to the measurement time.

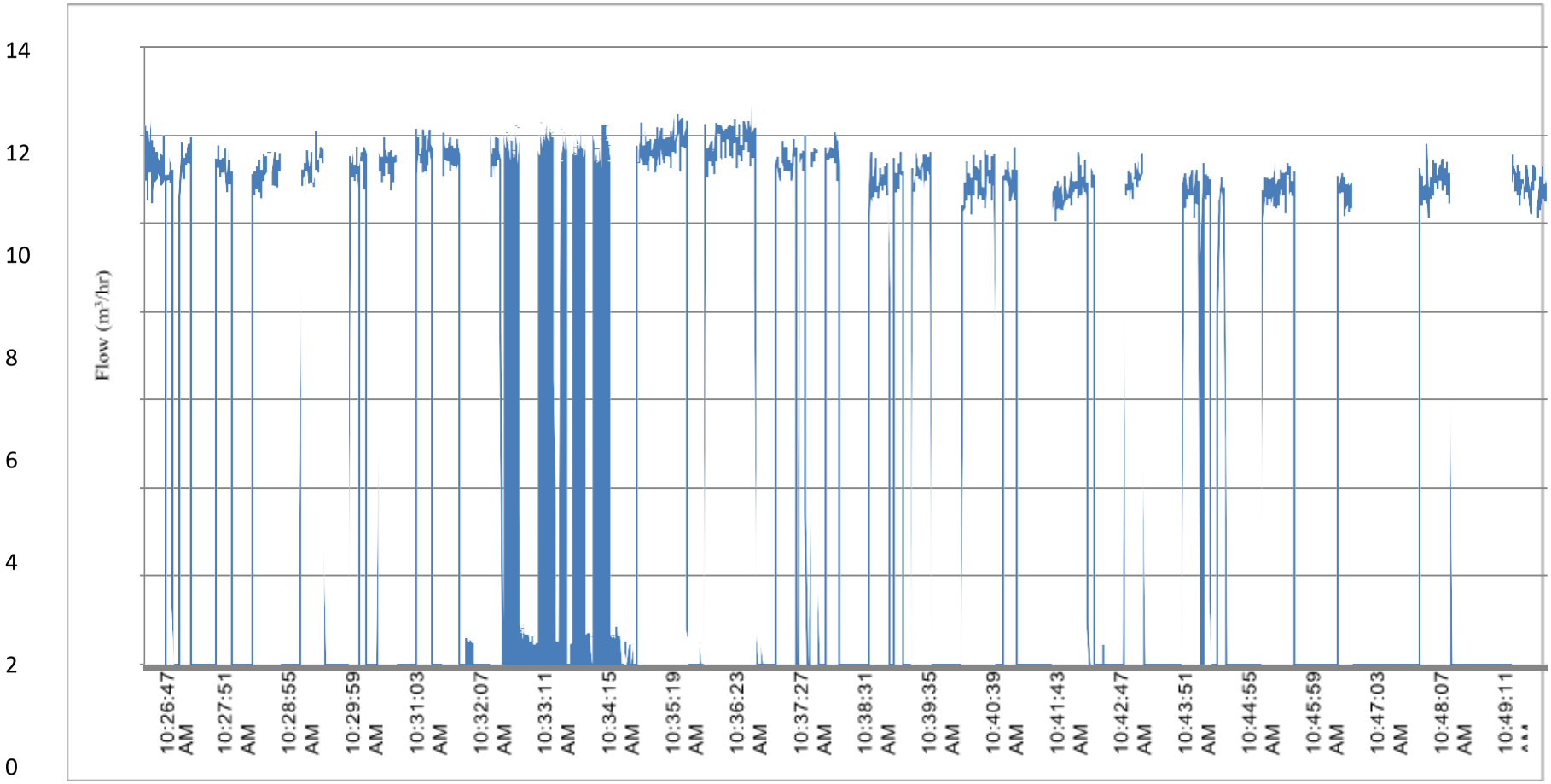


Figure 2-1 Inlet water rate to boiler 1 in terms of measurement time

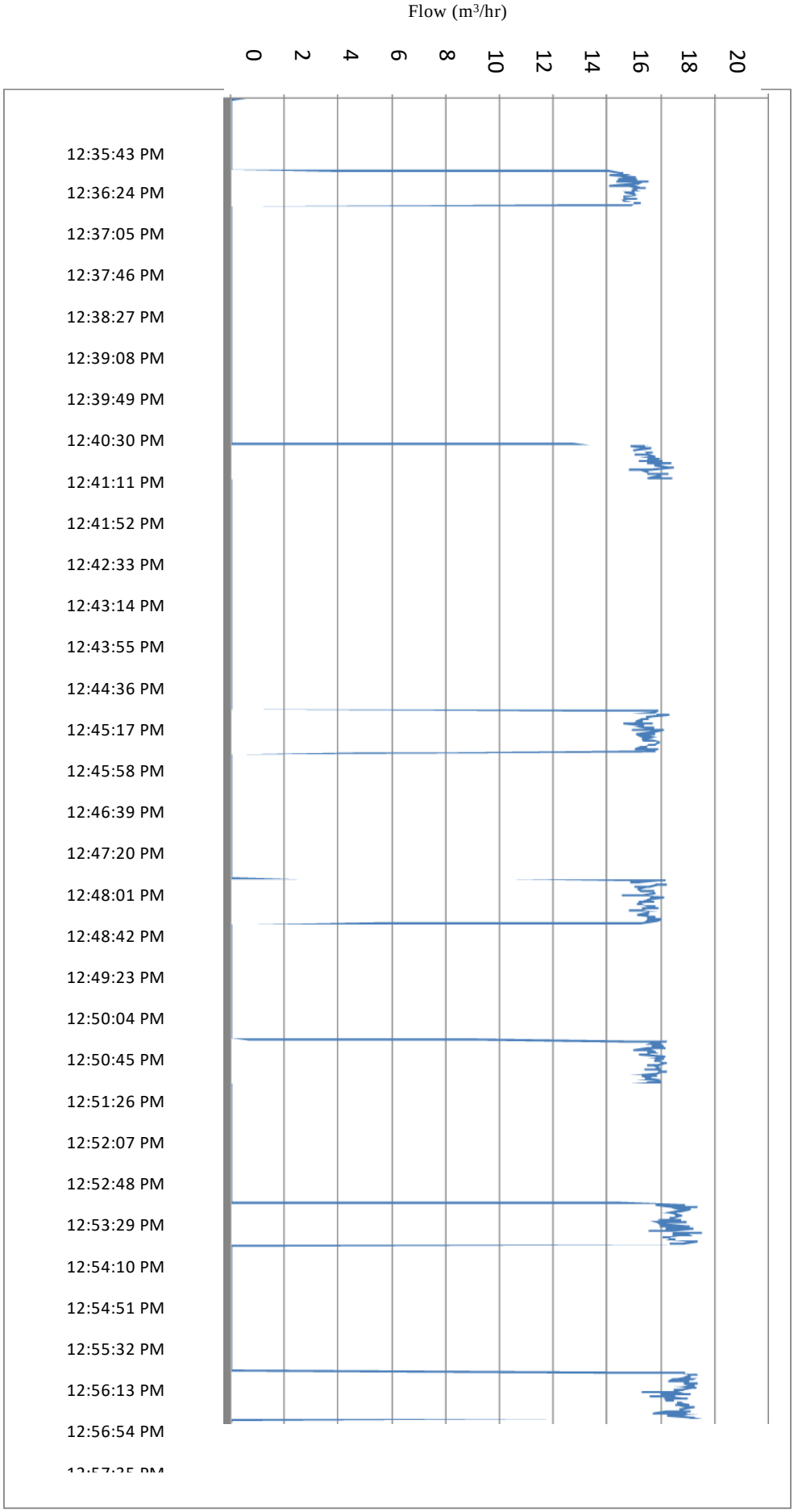


Figure 2-1 Inlet water rate to boiler 2 in terms of measurement time

2_1_2Analysis of smoke coming out of the boiler chimney

Smoke analyzer (Testo 335) is a new generation of smoke analyzers that covers a wide range of work in various industries. This device can be used in combustion systems in power plants, manufacturing boilers and burners, manufacturing industrial plants and even applies to static motors.

This device is equipped with a measuring cell for O2 as a standard cell, in addition to the ability to measure NOX, CO2, CO, SO2 by switching cells or installing other cells. According to the measured parameters, this device has the ability to install various probes. Other applications of this device include:

-Adjustment of various types of industrial burners

-Measurement of concentrations in raw materials and non-toxic gases

-Combustion air test of all types of furnaces

-Calculation of excess air and combustion efficiency

-Gas pressure and velocity test in flue gas and air ducts

-Measurements of cylinder temperature, gas pressure, etc.

The opposite figure shows the Testo 335 smoke analyzer

2_1_2_1Calculation of combustion efficiency of boilers

In order to analyze the fuel consumption situation in the building engine room, the burners should be examined and tested for combustion efficiency.

Measurements were made on the outlet of the building boilers and the results are as follows:

Boiler No. 1 (Araki)

Table 2_1 presents the results of the smoke analysis of boiler number 1

Table 2-1 results of the smoke analysis of boiler number 1

FT °C	O2%	CO ppm	% CO2	AT °C	ExAir %	Effn %
166	8.84	0	6.89	28.9	72.7	90.2

FT: Passing gas temperature in degrees Celsius

O2: Percentage of oxygen content in combustion products

CO: The amount of carbon monoxide particles in the exhaust gases in ppm

CO2: Percentage of carbon dioxide gas measured by the device

AT: Inlet air temperature to the boiler in degrees

Ex.Air: Percentage of excess air

Effn: Combustion efficiency

The combustion efficiency of the boiler itself is a function of the parameters measured in the combustion analysis such as smoke temperature, inlet air temperature and percentage of excess air. The analyzer has calculated the amount of combustion efficiency using the measured parameters

The combustion efficiency for boiler number 1 is calculated to be 90.2% It should be noted that the combustion efficiency of boiler number 1 is desirable Boiler number Kewanee) 2)

Table 2_2 presents the result of the exhaust smoke analysis from number 2

Table2-2: the result of the exhaust smoke analysis from number 2

FT °C	O2%	CO ppm	% CO2	AT °C	ExAir %	Effn %
157.3	12.01	3	5.09	30.1	133.6	88.4

The combustion efficiency for boiler number 2 is equal to 88.4%

It should be noted that the percentage of excess air and volume percentage of oxygen in this boiler is a high number, which has reduced the combustion efficiency and thermal efficiency of the boiler compared to boiler number 1.

Thermal imaging of heating equipment

Thermo graphic analysis, also known as thermography, thermo vision, and thermal imaging, has a wide range of applications, and with the use of thermo graphic cameras, all defects that lead to changes in the surface temperature distribution pattern can be identified.

It is shown in the figure 2-3of the mentioned device

In this building, some of the building's heating equipment, some fittings and water and steam transfer pipes have been photographed by the above device, which will be presented below.

Figure 2-3: Thermal imaging device testo875

Boiler number one (Araki)

In the following figures, the image taken by the above device from boiler number 1 is shown. It should be noted that each color represents a specific temperature, which is shown in the table next to the figure

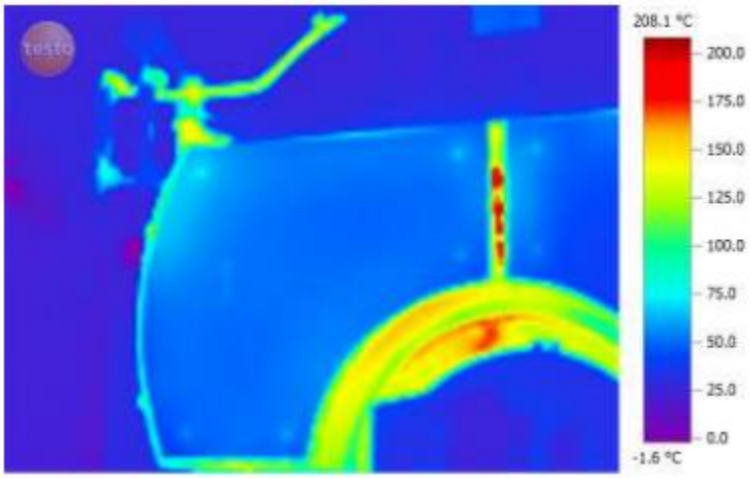


Figure 2-4: Thermal image of the boiler body "Facing view"

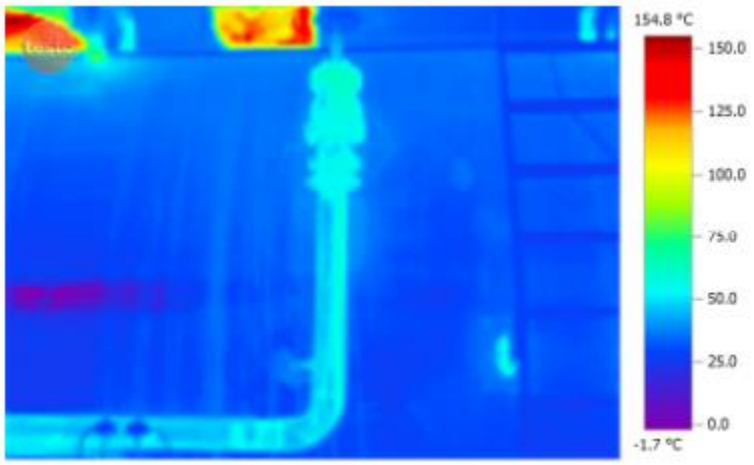


Figure 2-5: Thermal image of the boiler body and water entering the boiler

According to the shape and form of the average temperature of the walls of boiler No. 1 is calculated to be approximately equal to 32 degrees Celsius. Also, the average temperature of the water entering the boiler is equal to 50 degrees Celsius.

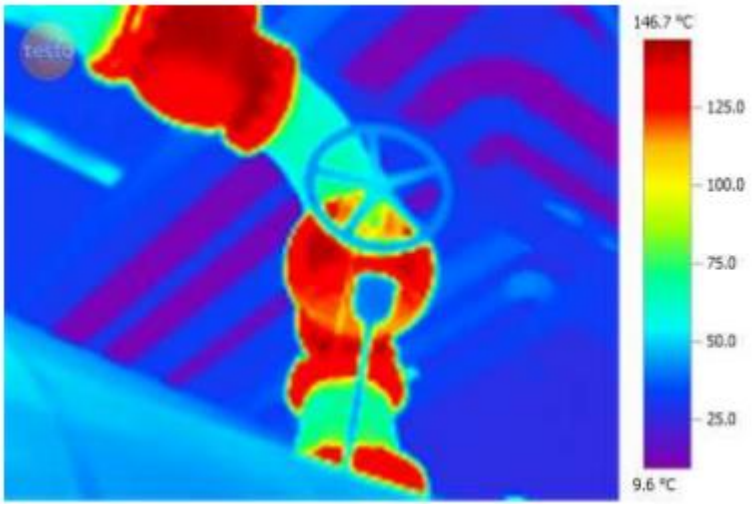


Figure 2-6:Thermal image of steam transfer pipes in boiler 1

As you can see in the figure, the lack of insulation in the joints has caused heat loss in these areas.

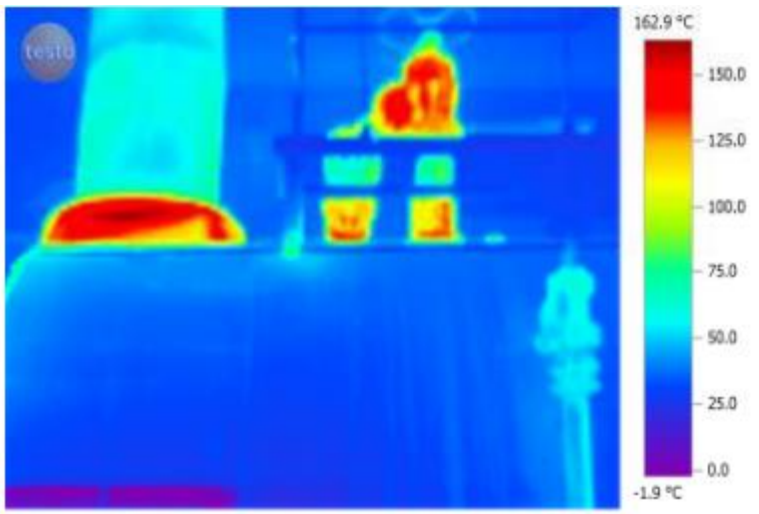


Figure 2-7: Thermal image of boiler chimney 1

Boiler 2”kenawee”:

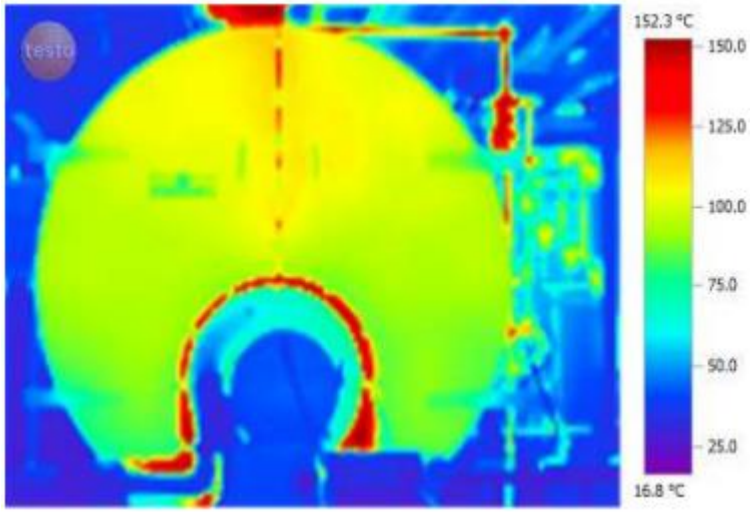


Figure 3-8: Thermal image of boiler body 2

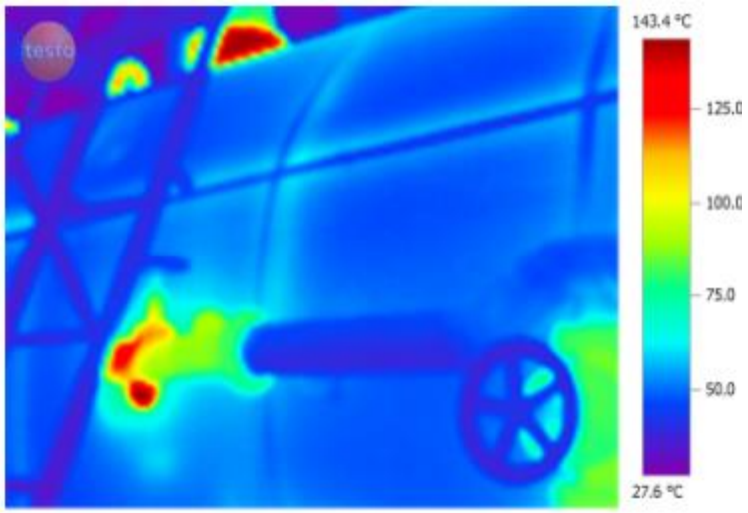


Figure 2-9: Thermal image of the water entering the boiler

According to Figure 2-8 and Figure 2-9, the average calculated temperature for the body of boiler 2 is about 54 degrees Celsius and the inlet water temperature to the boiler is calculated as 84 degrees Celsius.

Heat exchanger: The image of heat exchangers is shown in Figure 10-2

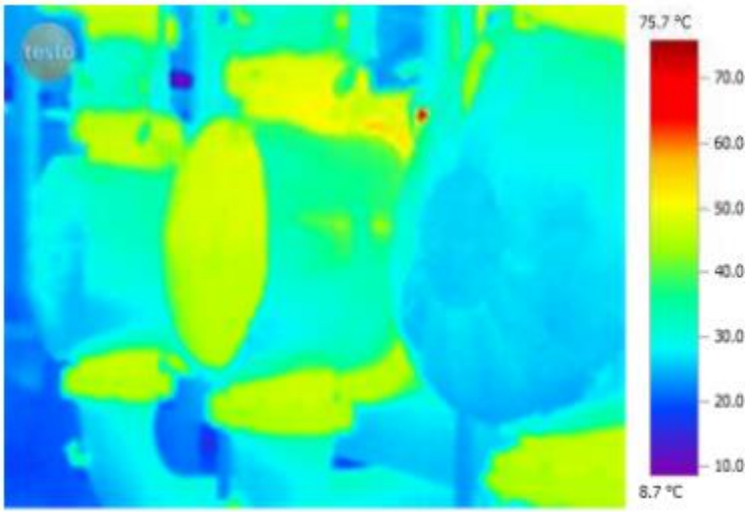


Figure 2-10: Thermal image of heat exchangers

DE aerator

The thermal image taken from the DE aerator is shown in the figure2-11

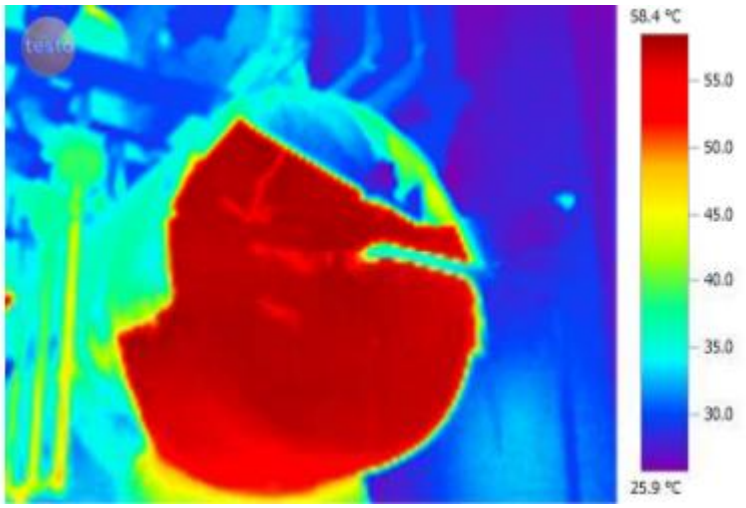


Figure 2-11: thermal image of de aerator

As shown in the figure2-11, the insulation of the DE aerator is not suitable and needs to be repaired

2-2Energy consumption analysis and efficiency of building steam boilers

At this stage, according to the measurements made before, the existing boilers can be examined in terms of energy consumption and efficiency. The required measurements were performed on boilers 1 and 2 and the results are presented in the table2-3

boiler 2	Boiler1	measurement
49	47	Area of boiler walls adjacent to air(m2)
54	32	Medium temperature of boiler walls(C°)
26	22.2	Ambient air temperature (C°)
0	1	Area of uninsulated points on the boiler surface(m2)
0	110	Insulated point temperature at boiler level(C°)
84	50	Inlet water temperature to the boiler(C°)
4.5	5.17	Inlet water pressure to the boiler(bar)
3.45	5.55	Inlet water rate to the boiler (M3/hr)
4.5	5.17	Steam outlet pressure from the boiler(bar)
12.01	8.84	Volumetric percentage of oxygen in combustion products (%)
157.3	166	The temperature of the gas passing through the chimney(C°)

PHAST [process heating and assessment survey tool] software is used to investigate the waste in the boiler and also to calculate its efficiency. PHAST software is provided by the US Department of Energy "DOE"[US department of energy] and is used to simulate different types of furnaces. Using this software, the performance of the furnace in different simulation conditions and the amount of losses and efficiency are calculated. One of the capabilities of PHAST software is simulation and analysis of energy consumption in the boiler. This software analyzes Boyle based on the calculation of the necessary parameters presented in Table 2-3

2-2-1Boiler Analysis No. 1

Boiler No. 1 was simulated and tested by the software, the results of which are as follows. Figure 1 shows the Sanki Boiler 1 diagram 2-12:

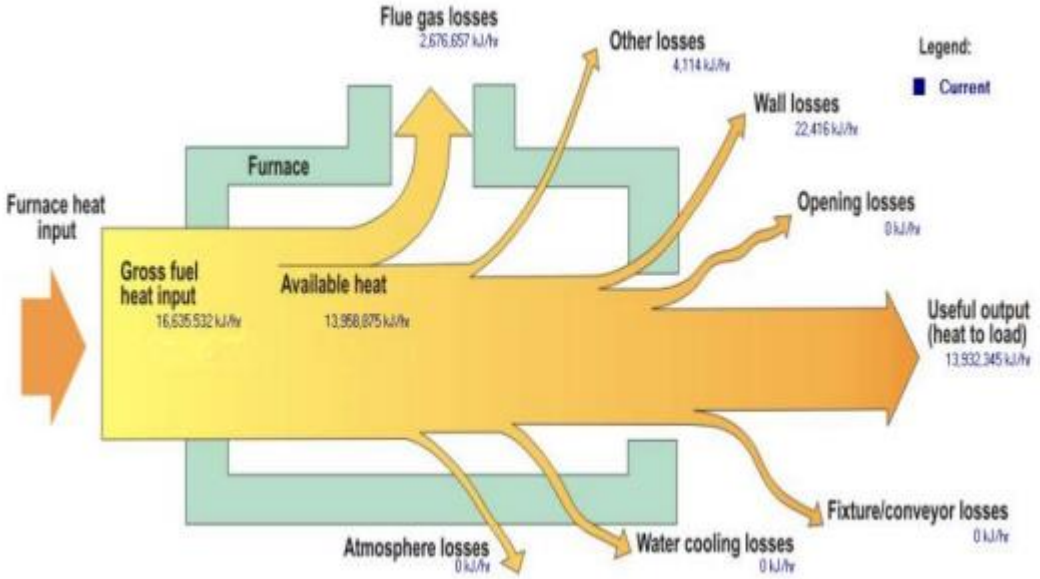


Figure 2-12: Sanki Boiler Diagram No. 1

The total thermal energy from the combustion of the inlet fuel

Heat loss due to smoke coming out of the boiler

Heat dissipation of uninsulated boiler valves

Boiler body heat loss

Useful energy output from the boiler

Based on the simulation results of "Figure 2-12" on boiler number 1, the boiler energy losses can be investigated and the boiler thermal efficiency can be calculated.

In Figure 2-13 and Table 2-4, the distribution of thermal energy as well as the percentage of energy losses from boiler No. 1 can be investigated.

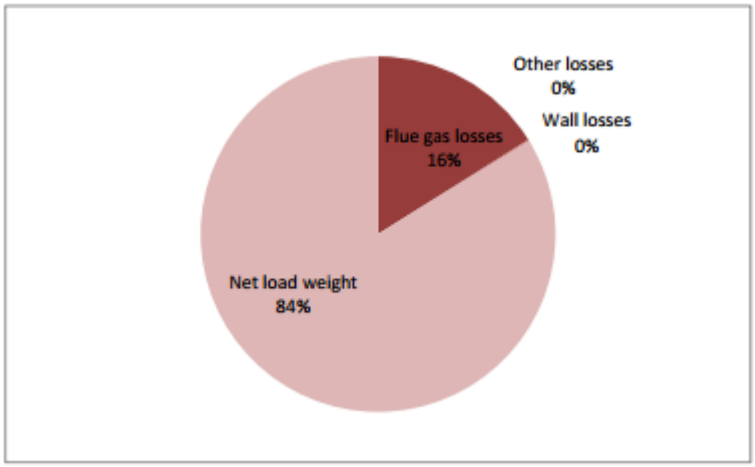


Figure 2-13: Distribution of thermal energy in boiler number 1

Table 3-4: Thermal energy distribution in boiler number 1

Area Of Heat Consumption	Heat Distribution (kj/hr)	Percentage
Net load weight	13,932,345	83.75
Flue gas losses	2,676,657	16.09
Other losses	4,114	0.002
Wall losses	22,416	0.13
Total	16,635,532	100

According to the results simulated with the help of PHAST software, smoke losses account for about 16% of the total energy waste of boiler 1. Also, the efficiency of this boiler is calculated by the software based on the ratio of output energy to total energy equal to 75.83%.

Based on the above results and also the lack of a separate gas meter for the engine room, the fuel consumption of this boiler can be calculated as follows.

The thermal energy from the combustion of the incoming fuel is estimated at 16635532kj / hr "equivalent to 4621kw". Considering the calorific value of the gas equal to 9077kcal / m3, the fuel consumption of this boiler is calculated to be about 439 cubic meters per hour.

Boiler Analysis No. 2

The simulation results on Boiler 2 are as follows.

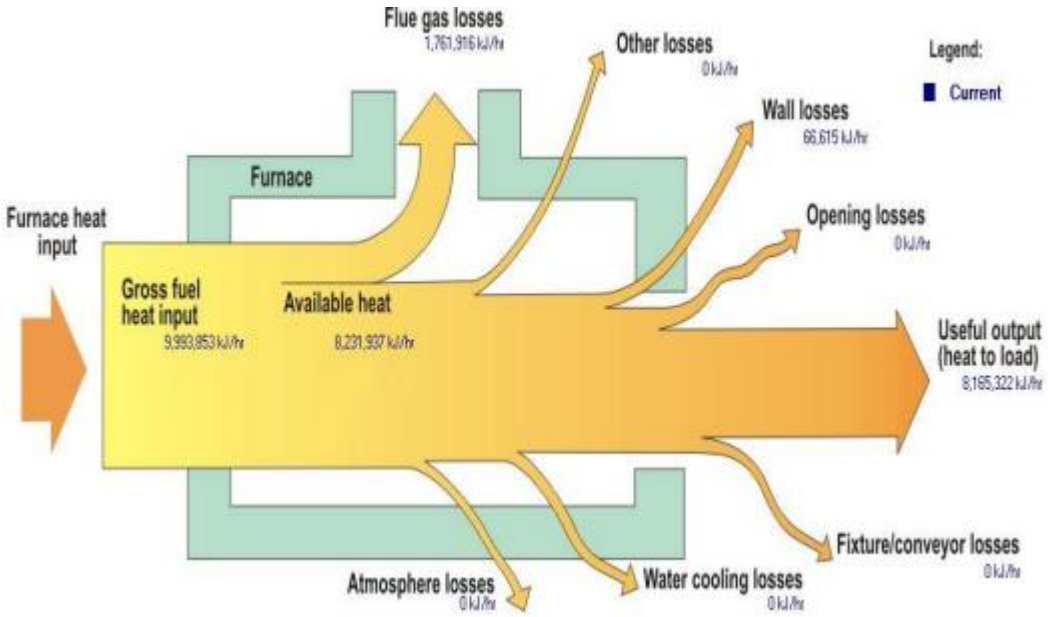


Figure 2-14: Sanki Boiler No. 2 Diagram

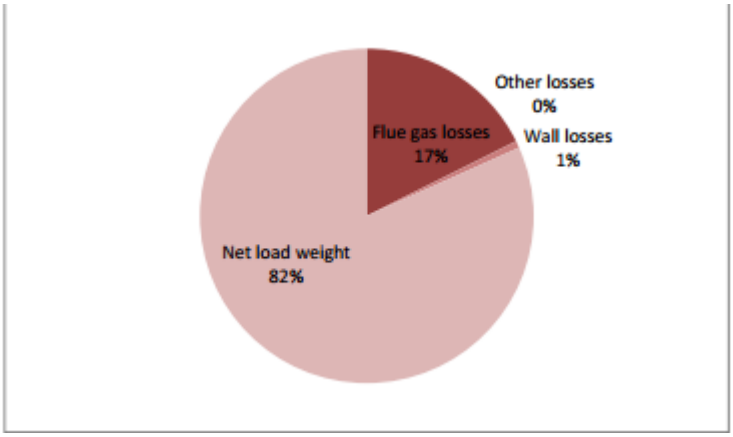


Figure 2-15: Thermal energy distribution in boiler number 2

Table 2-5: Thermal energy distribution in boiler number 2

Area Of Heat Consumption	Heat Distribution (kj/hr)	Percentage
Net load weight	8,165,322	81.7
Flue gas losses	1,761,916	17.63
Other losses	0	0
Wall losses	66,615	0.66
Total	9,993,853	100

As you can see, the efficiency obtained for boiler number 2 is 7.81%. The thermal energy from the combustion of the inlet fuel to the boiler is estimated at 9993853 kj / hr "equivalent to 2776 kw" considering the gas thermal energy equal to 9077kca / m3, the fuel consumption of this boiler is 264 Cubic meters per hour is obtained

2-3Electrical measurements

Due to the lack of a separate meter for the engine room of this building, it is necessary to measure the amount of electricity consumption in a period of time.The engine room is fed by three separate feeders, which are measured by portable electric devices in this engine room.

To measure on different feeders and calculate the specific energy consumption, an electric power analyzer has been used. The device can measure various electrical parameters such as voltage, power factor, active and reactive power, etc. at desired intervals and To register

The following figure2-16 shows a view of the measuring device

Figure2-16

Due to the type of panel and panel switches of some equipment, it is not possible to measure with metrel devices, so on such equipment’s "including a number of air conditioners and fan coils" electrical measurement is done instantly by Hioki three-phase clamp meter device it Is. Shown in figure 2-17

Figure2-17

2-4:Summary of measurement results

In the following, the results of the measurements performed in the two parts of the measurement with the Metrel power analyzer and the Hioki three-phase clamp meter are summarized.

2-4-1: Measurement with metrel device

Each of the input feeders of Al-Zahra Hospital engine room was measured in a period of 24 hours. The following is a summary of the measurement results of each feeder in Table 2-6 to Table 2-8.

Also, the power consumption graph of each of the 3 feeders is shown separately in Figure 2-18 to Figure 2-20.

Measuring equipment				Voltage level(V)	Feeder name	row
Power factor	Average power consumption(KW)	end	start			
0.81	49.3	90/12/22	90/12/21	380	Incoming	1

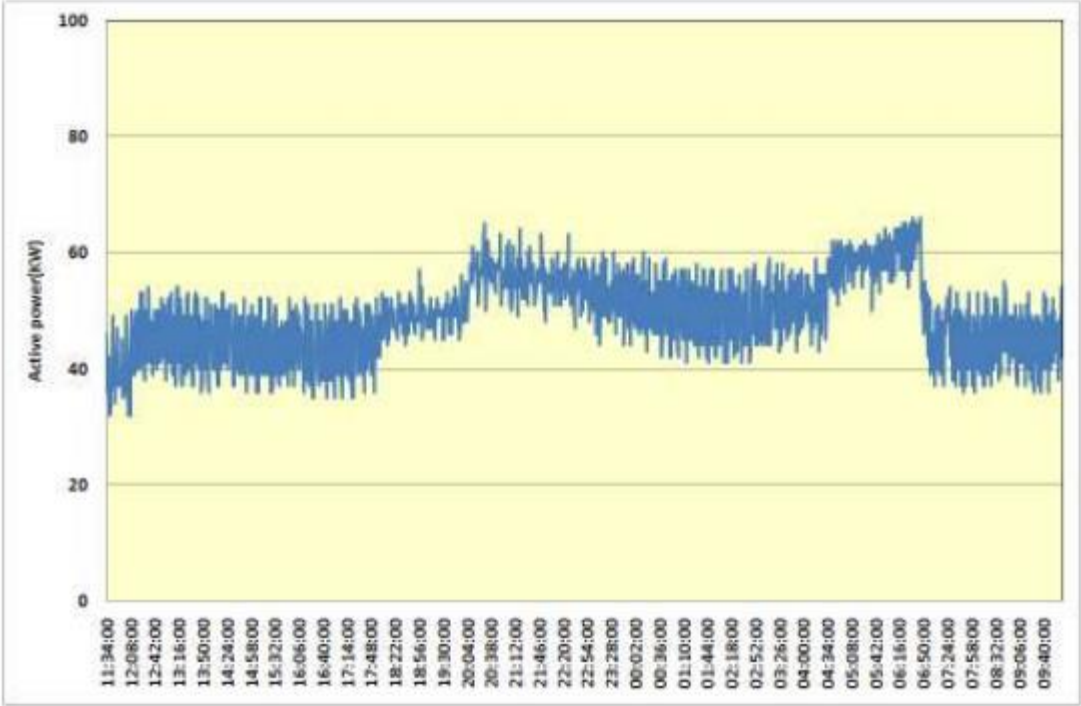


Figure 2-18

Figure 2-18 shows the power consumption of feeder 1 of the motor input of the house in 24 hours. The average power consumption in the measurement period is about 50 kW. Also, the power factor of this feeder is equal to 0.81.

Table 2-7 presents the measurement results on feeder 2.

Measuring equipment				Voltage level (V)	Feeder name	row
Power factor	Average power consumption (KW)	end	start			
0.88	27.27	90/12/22	90/12/21	380	Incoming	1

Table 2-7

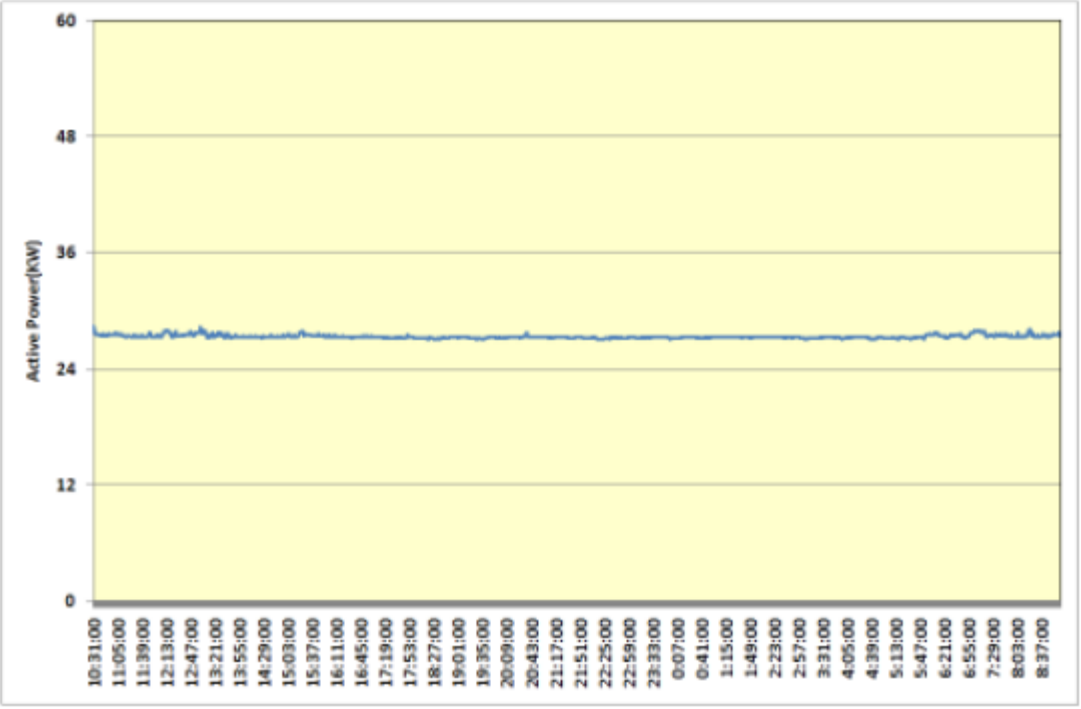


Figure 2-19

As shown in Figure 2-19, the average electrical power of the feeder was about 27 kW, which has the same behavior. Also, the power factor is equal to 88 percent

Table 2-8 measures for fiber 3

Measuring equipment				Voltage level (V)	Feeder name	row
Power factor	Average power consumption (KW)	end	start			
0.84	27.45	90/12/22	90/12/21	380	Incoming	1

Table 2-8

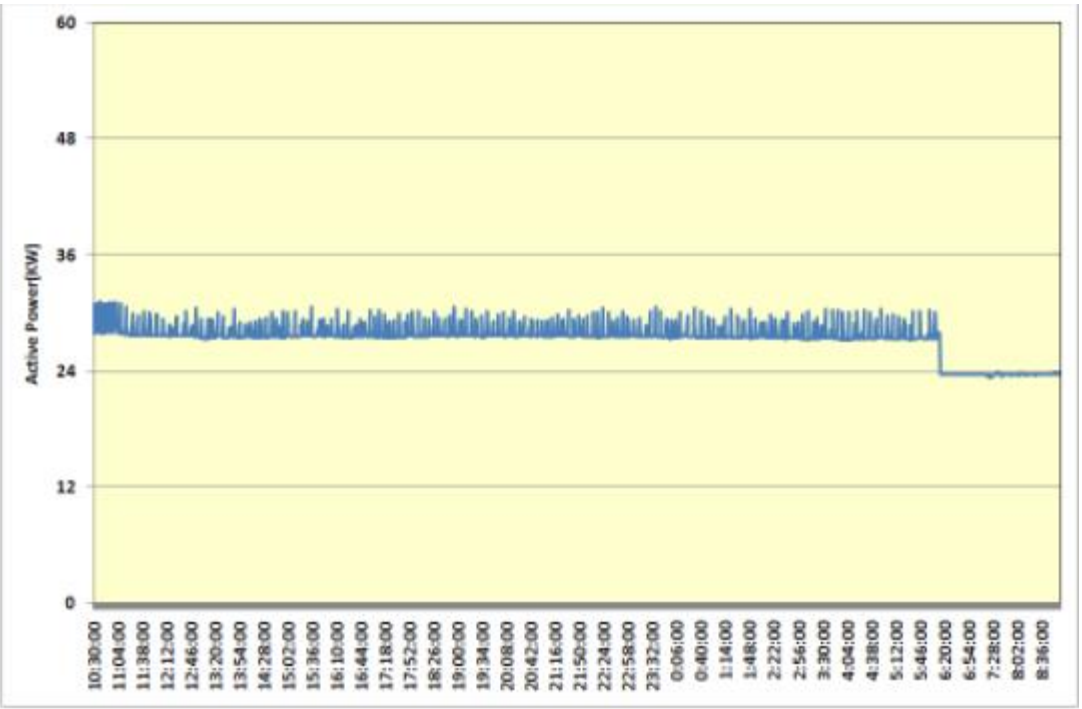


Figure 2-20

The average power consumption is about 27 kW and shows a power factor of 0.84

Considering that the total input power of the engine room is obtained from the sum of these three feeders, then the total input power can be obtained from the set of electrical power of 3 feeders, which can be considered based on this issue, the average electrical input power of the engine room is about 104 KB. Took. The graph of the average input power consumption of the entire engine room will be as shown in Figure 2-21

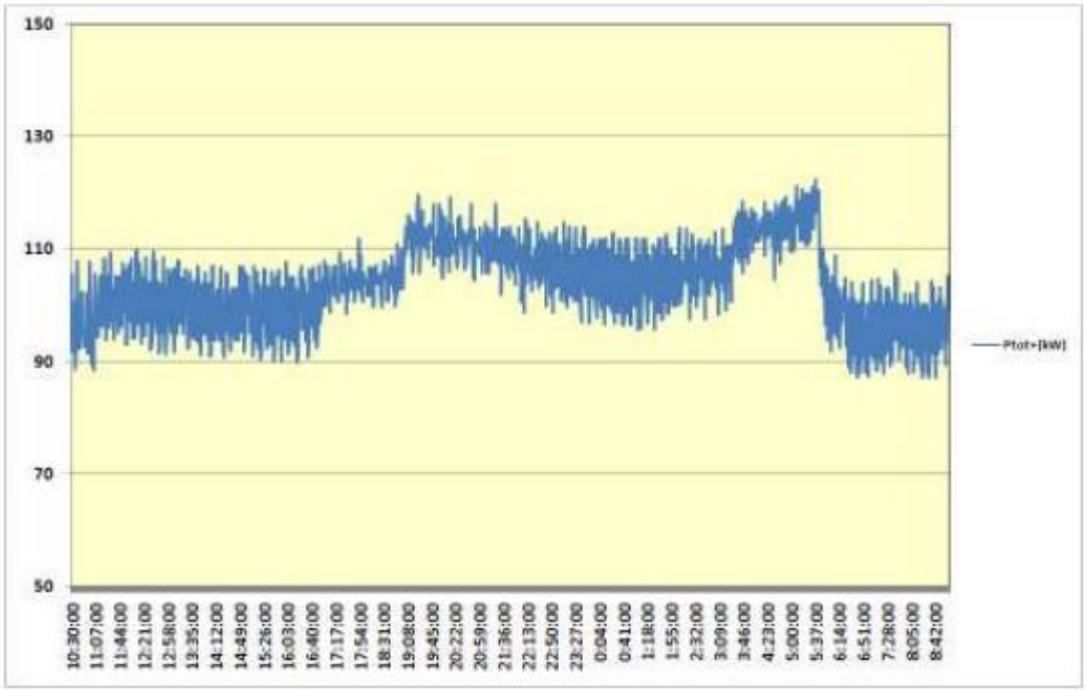


Figure 2-21

Of course, it should be noted that this consumption is in five months of the cold season of the year, which can change with the change of weather conditions.

2-4-2 Instant measurement with hioki device

In instantaneous measurements in a short period of time, several measurements are made on the desired equipment and finally the average power consumption of the equipment is obtained. A summary of the measurement results on the two air conditioner and fan coil equipment is shown in Table 2-9

Power factor	Average power consumption (kW	Line voltage (V)	Equipment name	row
۵/۰	۸	۸۷۳	AHU 901	۱
۶۵/۰	۲/۷	۲۸۳	AHU 801	۲
۸۶/۰	۷۴/۰	۱۸۳	Fan coil 301	۳
۳۴/۰	۵۲/۱	۱۸۳	Fan coil G-21	۴
۴۶/۰	۴۱/۱	۰۸۳	Fan coil 402	۵
۸۸/۰	۸۳/۰	۱۸۳	Fan coil 804	۶

Table 2-19

Third chapter

Collecting lighting information for Al-Zahra Hospital building

3-1 Hospital building

Al-Zahra Hospital is powered by the post of the University of Isfahan, which is powered by a 6.6 kW bus load transformer with a conversion factor of 6.6 kW. The bus load has a total of 8 transformers with a conversion ratio of 6.6 kW to 400 volts, two of which transformers power the hospital lighting parts and the other 6 transformers are used for other applications such as powering motors, fans, etc.

3-2 Introduction of measuring devices

3-2-1 Measuring the input power of buildings

The device used to measure the input power in the building is the metrel brand power analyzer. The device is able to measure and record various electrical parameters such as: voltage, current, active and reactive power, power factor, etc. at desired intervals.

3-2-2 Measuring the light intensity of "lux" buildings

The device intended for this purpose is a lux meter, hioki brand.The device includes a light intensity sensor and a display and can measure the brightness anywhere.

3-3Provide the measurement method used

3-3-1 Power input of buildings

- Purpose of measurement: The purpose of this measurement is to obtain the power consumption diagram of the desired building, which can be used to examine peak consumption times, minimum consumption times and other power consumption behaviors.

-Measurement time: The measurement time is about 20 hours, when the data is recorded at intervals of 15 seconds

-How to measure:

Three current clamps are used to measure three-phase currents and four voltage clamps are used to measure fuzzy and linear voltages. The measuring device is installed on the power supply cable of the building and by adjusting the device and checking the accuracy of the numbers on its monitor, the device is started to measure and record information.

3-3-2 Lux light intensity of buildings

- Purpose of measurement:

The purpose of this measurement is to determine the secondary light intensity of different spaces of the hospital building

- Measurement time: Due to the constant lux, if there is no change in brightness, the measurement is done by the lux meter in an instant.

-How to measure:

By a lux meter in non-matched rooms, the light intensity is measured at several points and their average is considered as the average light intensity of that place. It should be noted that according to the standard, the lux meter should be placed on the work surface and measurements should be made. The number of lux measuring points for each space is obtained from the following equation.

H: Lighting height up to the work surface L-W: and room width number of size points

$$RI = (L \times W) / H \times (L+W)$$

The number of points is calculated based on RI according to the table below

RI	Minimum points
Less than 1	9
Between 1 -2	16
Between 2-3	25
More than 3	36

It should be noted that the distance from the measuring points to the wall is half the distance of the measuring points from each other in each direction.

3-4 Lighting statistics including lamps and frames and physical conditions of the environment

Statistics related to the physical characteristics of the environment, including the dimensions and color of the surfaces and lighting on the second floor of the Al-Zahra Hospital building are given as an example in Table 3-1. It should be noted that the statistics of basement, ground floor, first floor, third floor, 4th floor, fifth floor, 6th floor are given in Appendix 1.

window		Surface color			Dimensions of the room "meters"			Room usage	Room code	Row
Doesn't have	have	Wall	ceiling	Floor	Height	Width	length			
ENT department and vascular surgery										
*		White stone	Green camphor	Cream flooring	2.2	2.7	10.29	Entrance hallway	L1	1
*		White stone	Green camphor	Cream flooring	-	-	-	Nurse station	S1	2
*		White stone	Green camphor	Cream flooring	2.2	2.35	45.53	Corridor section	L2	3
	*	white	white	Cream flooring	3.2	3.4	6.7	"South" patient room	R1-R12	4
	*	white	white	Cream flooring	3.2	3.32	6.5	Room of the day	R13	5
	*	white	white	Cream flooring	3.2	3	3.1	Nurse Room	R14	6
*		white	white	Cream flooring	3.2	3.4	3.6	examination room	R15	7
	*	white	white	Cream flooring	3.2	3	3.7	Other rooms	R16	8
*		White stone	Green camphor	White stone	3.2,2.2	7.5	8.5	lobby	B1	9
Intern and Resident Pavilion "Brothers"										
*		White stone	Green camphor	Yellow flooring	2.2	2.7	10.3	Entrance hallway	L3	10
*		White stone	Green camphor	Yellow flooring	2.2	2	46.7	Corridor pavilion	L4	11
	*	White stone	white	Yellow flooring	3.2	3.3	6.5	Room of the day	R17	12
	*	White stone	white	Yellow flooring	3.2	3.4	6.7	Rest room	R18-R28	13
	*	White stone	white	Yellow flooring	3.2	3	3.7	Rest room	R29,R30	14

Plastic Surgery Department										
*		White stone	Green camphor	Yellow flooring	2.2	2.7	10.3	Entrance hallway	L5	15
*		White stone	Green camphor	Yellow flooring	-	-	-	Nurse Room	S2	16
*		White stone	Green camphor	Yellow flooring	2.2	2.3	21.2	Corridor section	L6	17
	*	White stone	white	Yellow flooring	3.2	3.3	6.7	“north" patient room	R31-R36	18
	*	White stone	white	Yellow flooring	3.2	3	3.7	"South" patient room	R37,R38	19
*		White stone	white	Yellow flooring	3.2	3.3	3.5	examination room	R39	20
	*	White stone	white	Yellow flooring	3.2	3	3.1	Nurse Room	R40	21
*		White stone	Green camphor	White atone	3.2,2.2	7.5	8.5	lobby	B4	22
Organ transplant section										
*		White stone	Green camphor	Yellow flooring	2.2	2.6	36.5	Entrance hallway	L7	23
*		White stone	Green camphor	Yellow flooring	-	-	-	Nurse station	S3	24
*		White stone	Green camphor	Yellow flooring	2.2	2.6	22	Corridor section	L8	25
	*	White stone	white	Yellow flooring	3.2	3	3.1	Nurse Room	R41	26
	*	White stone	white	Yellow flooring	3.2	3	3.7	"South" patient room	R42-R46	27

window		Surface color			Dimensions of the room "meters"			Room usage	Room code	row
Doesn't have	have	wall	ceiling	floor	height	width	length			
	*	White stone	white	Yellow flooring	3.2	3	3.4	Medicine room	R47	28
*		White stone	white	Yellow flooring	Yellow flooring	Yellow flooring	Yellow flooring	Yellow flooring	Yellow flooring	Yellow flooring
Internal Department of Nerves and Women										
*		White stone	Green camphor	White stone	3.2,2.2	7.5	8.5	lobby	B5	30
*		White stone	Green camphor	Green flooring	2.2	2.7	10.3	Entrance hallway	L9	31
*		White stone	Green camphor	Green flooring	-	-	-	Nurse station	S4	32
*		White stone	Green camphor	Green flooring	2.2	2.4	49	Corridor section	L10	33
	*	White stone and color	white	Green flooring	3.2	3.4	6.7	"North" patient room	R49-R58	34
	*	White stone and color	white	Green flooring	3.2	3	3.7	"South" patient room	R59	35
*		White stone and color	white	Green flooring	2.2	2.2	3.4	Rest room	R60	36
Department of Obstetrics and Gynecology										
*		White stone	Green camphor	Cream flooring	2.2	2.7	12.6	Public corridor	L11	37
*		White stone	Green camphor	Cream flooring	2.2	2.4	13.7	Corridor section	L12	38
*		White stone and color	white	Cream flooring	3.2	3.4	3.5	Acceptance of normal babies	R61	39

	*	White stone and color	white	Cream flooring	-	-	-	Breastfeeding Clinic	R62	40
	*	White stone and color	white	Cream flooring	-	-	-	Breastfeeding mothers rooms	R62-R64	41
	*	White stone and color	white	Cream flooring	3.2	3.4	6.7	"South" patient room	R65-R75	42
*		White stone	Green flooring	Cream flooring	2.2	2.4	40.5	Corridor section	L13	43
*		White stone	Green flooring	Cream flooring	2.2	2.7	10.3	Entrance hallway	L14	44
*		White stone and color	white	Cream flooring	-	-	-	Nurse station	S5	45
*		White color	white	Cream flooring	3.2	3.4	3.5	Medicine room	R76	46
	*	White color	white	Cream flooring	3.2	3	3.2	Nurse room	R77	47
	*	White color	white	Cream flooring	3.2	2.4	3.16	Rest room	R78	48
Neonatal Intensive Care Unit (NICU)										
*		White stone	Green camphor	Green flooring	2.2	2.4	19.4	Corridor section	L15	49
	*	White stone	Green camphor	Green flooring	-	-	-	Nurse station	S6	50

window		Surface color			Dimensions of the room "meters"			Room usage	Room code	row
Doesn't have	have	wall	ceiling	floor	height	width	length			
	*	White stone and color	white	Green flooring	2.2	4.5	17	Baby room	R79	51
	*	White stone and color	white	Green flooring	2.2	2.7	35	equipment Corridor	L16	52
	*	White stone and color	white	Green flooring	2.2	2.2	4.5	isolated room	R80	53
	*	White stone and color	white	Green flooring	2.2	3	6.2	Dressing room and dining area	R81	54
	*	White stone and color	white	Green flooring	2.2	3	3.7	Rest room	R82	55
*		White stone and color	white	Green flooring	N.A	N.A	N.A	Children's emergency admission	R83	56
*		White stone and color	Green flooring	Green flooring	2.2	2.4	16.8	Corridor section	L17	57
*		White stone and color	white	Green flooring	2.2	2.2	4.5	isolated room	R84	58
*		White stone and color	white	Green flooring	2.2	4.5	17	Baby room	R85	59
	*	White stone and color	white	Green flooring	2.2	5	9	NICU 1	R86	60
	*	White stone and color	white	Green flooring	3.2	3	3.5	Fellowship Room	R86.1	60.1

	*	White stone and color	white	Green flooring	3.2	3	3.5	Nurse Room	R87	61
	*	White stone and color	white	Green flooring	3.2	3	3.5	Resident Room	R88	62
*		White stone and color	Green flooring	Cream flooring	2.2	2.7	10.3	Entrance hallway	L18	63
*		White stone and color	Green flooring	Cream flooring	2.2	2	46.7	Corridor pavilion	L19	64
	*	White stone and color	white	Cream flooring	3.2	3.3	6.5	Room of the day	R89	65
	*	White stone and color	white	Cream flooring	3.2	3.4	6.7	Rest room	R90-R90.10	66
	*	White stone and color	white	Cream flooring	3.2	3	3.7	Rest room	R91-R91.1	67
Maternity ward										
	*	White stone and color	Green flooring	Cream flooring	2.2	2.6	28	Public corridor	L20	68

window		Surface color			Dimensions of the room "meters"			Room usage	Room code	row
Doesn't have	have	wall	ceiling	floor	height	width	length			
			white							
	*	White stone	white camphor	White flooring	2.2	2	42.2	Public corridor	L21	69
*		Letron brown	white	White flooring	2.2	3.4	5.7	Pain room	R92-R94	70
	*	White stone	white	White flooring	N.A	N.A	N.A	Pain room	R95	71
*		White stone	white camphor	White flooring	-	-	-	Nurse station	S7	72
*		White stone	white camphor	White flooring	2.2	2.4	12.5	Corridor of the delivery room	L22	73
*		Green tiles	white camphor	White flooring	N.A	N.A	N.A	Delivery room	R96	74
*		White stone	white camphor	White flooring	2.2	2.4	6.9	Corridor section	L23	75
*		White stone	white camphor	White flooring	2.2	2.4	24.1	Corridor section	L24	76
*		White stone	white camphor	White flooring	N.A	N.A	N.A	locker room	R97	77
*		white	white	White flooring	2.2	2.4	3.3	Nurse Room	R98	78
*		white	white	White flooring	3.2	3	3.5	dining room	R99	79
*		white	white	White flooring	2.2	1.5	3	buttery	R100	80
*		Letron brown	white camphor	White flooring	N.A	N.A	N.A	Maternity entrance	R101	81
*		white	white	carpet	2.2	3.8	4	Doctor's rest room	R102	82
*		white	white	carpet	2.2	3.7	4.5	Mama's rest room	R103	83
Surgery room										
*		white	white	White stone	2.2	2.4	7	Public corridor	L25	84

*		white	white	White stone	2.2	2.4	12.3	Corridor section	L26	85
*		white	white	White stone	2.2	2.4	17.5	Corridor section	L27	86
*		White stone	white	White stone	2.2	2.9	5.6	locker room	R104	87
*		white	white	White stone	N.A	N.A	N.A	recovery	R105	88
	*	white	white	White stone	N.A	N.A	N.A	dining room	R106	89
	*	White stone	white	White flooring	N.A	N.A	N.A	packing	R107	90
*		Green tiles	white	green flooring	2.8	5	5.8	surgery room	R108	91
*		Green tiles	white	green flooring	2.8	5	5.8	surgery room	R109	92

window		Surface color			Dimensions of the room "meters"			Room usage	Room code	row
Doesn't have	have	wall	ceiling	floor	height	width	length			
*		Green tiles	white	Green flooring	2.8	5	5.8	surgery room	R110	93
*		white	white	White stone	-	-	-	The space behind the surgery room	R111	94
*		white	white	Green flooring	2.2	3.8	3.8	Nurse room	R112	95

In the following, according to the measurements, the results of "LUX" light intensity, type of lights, type and number of lamps, type of upstairs and upstream class on the second floor of Al-Zahra Hospital are given in Table 2-3. Other measurements for other classes are also given in Appendix 2

Upstairs class	Upstream type of fluorescent lamps	Number of lamps				Type of lamps			Type of lights		Lux	Room code
		String	Low consumption	Fluorescent		String	Low consumption	Fluorescent	Built-on	Built-in		
		100 W	23 W	20 W	40 W							
ENT department and vascular surgery												
D	Magnetic				6			*		Twin	40	L1
D	Magnetic				8			*		Twin	135	S1
D	Magnetic				24			*		Twin	70	L2
D	Magnetic			18	40				Twin		1200	R1-R12
D	Magnetic				6			*	Twin		1000	R13
D	Magnetic				4			*	Twin		320	R14
D	Magnetic				8			*	Twin		380	R15
D	Magnetic				10			*	Twin		600	R16
D	Magnetic				14			*	Twin	Twin	48	B1
Intern and Resident Pavilion "Brothers"												
D	Magnetic				6			*		Twin	120	L3
D	Magnetic				30			*		Twin	45	L4
D	Magnetic				6			*	Twin		1000	R17
D	Magnetic				39			*	Triplet		1200	R18-R28
D	Magnetic				8			*	Twin		580	R29,R30
Plastic surgery												
D	Magnetic				6			*		Twin	40	L5

Upstairs class	Upstream type of fluorescent lamps	Lamps number				Type of lamps			Type of lights		Lux	room code
		String	low consumption	Fluorescent		String	low consumption	Fluorescent	buit-on	buit-in		
		100 W	23 W	20 W	40 W							
D	Magnetic	4			8	*		*		twin	100	S2
D	Magnetic				12			*		twin	75	L6
D	Magnetic			9	18			*	twin		1120	R31-R36
D	Magnetic				8			*	twin		490	R37,R38
D	Magnetic				4			*	twin		320	R39
D	Magnetic				4			*	twin		500	R40
D	Magnetic				14			*	twin	twin	5	B4
Organ plant section												
D	Magnetic				26			*		twin	65	L7
D	Magnetic		5		10		*	*		twin	330	S3
D	Magnetic				16			*		twin	97	L8
D	Magnetic				4			*	twin		640	R41
D	Magnetic			11	22			*	twin		1020	R42-R46
D	Magnetic				4			*	twin		500	R47
D	Magnetic				4			*	twin		200	R48
D	Magnetic				14			*	twin	twin	70	B5
D	Magnetic				8			*		twin	73	L9
D	Magnetic		5		8		*	*		twin	250	S4
D	Magnetic				26			*		twin	56	L10
D	Magnetic			31	62			*	twin		1110	R49-R58
D	Magnetic				6			*	twin		615	R59
D	Magnetic	1			2	*		*	twin		73	R60
Department of Obstetrics and Gynecology												
D	Magnetic				8			*		twin	35	L11

D	Magnetic				12			*		twin	100	L12
D	Magnetic				8			*	twin		341	R61
D	Magnetic				4			*	twin		N.A	R62
D	Magnetic				13			*	single		490	R62-R64
D	Magnetic			20	60			*	twin		980	R65-R75
D	Magnetic				24			*		twin	50	L13
D	Magnetic				6			*		twin	36	L14

Upstairs class	Upstream type of fluorescent lamps	number of lamps				type of lamp			type of light		Lux	room code
		string	low consumption	Fluorescent		string	low consumption	Fluorescent	buit-on	buit-in		
		100 W	23 W	20 W	40 W							
D	Magnetic	3	2		8	*	*	*		twin	360	S5
D	Magnetic				4			*	twin		240	R76
D	Magnetic				4			*	twin		260	R77
D	Magnetic				4			*	twin		330	R78
(NICU)												
D	Magnetic				12			*		twin	44	L15
D	Magnetic				8			*		twin	485	S6
D	Magnetic				20			*	twin		350	R79
D	Magnetic				44			*	twin		800	L16
D	Magnetic				6			*		twin	323	R80
D	Magnetic				10			*	twin		415	R81
D	Magnetic				4			*	twin		320	R82
D	Magnetic				4			*		twin	170	R83
D	Magnetic				10			*		twin	23	L17

D	Magnetic				8			*		twin	180	R84
D	Magnetic		2		20		*	*	twin		240	R85
D	Magnetic				28			*	twin		500	R86
D	Magnetic				4			*	twin		100	R86.1
D	Magnetic				4			*	twin		200	R87
D	Magnetic				4			*	twin		70	R88
D	Magnetic				16			*		twin	-	L18
D	Magnetic				24			*		twin	-	L19
D	Magnetic				6			*	twin		-	R89
D	Magnetic							N.A			N.A	R90
D	Magnetic							N.A			N.A	R91
Maternity ward												
D	Magnetic				16			*		twin	65	L20
D	Magnetic				24			*		twin	72	L21
D	Magnetic				16			*		twin	130	R92-R94
D	Magnetic				8			*	twin		450	R95
D	Magnetic	1	2		8	*	*	*		twin	175	S7

Upstairs class	Upstream type of fluorescent lamps	number of lamps				type of lamp			type of light		Lux	room code
		string	low consumption	Fluorescent		string	low consumption	Fluorescent	buit-on	buit-in		
		100 W	23 W	20 W	40 W							
D	Magnetic				8			*		twin	120	L22
D	Magnetic				21			*	triplet		270	R96
D	Magnetic				4			*		twin	70	L23
D	Magnetic				12			*		twin	80	L24
D	Magnetic				10			*		twin	200	R97

D	Magnetic				4			*		twin	220	R98
D	Magnetic				4			*		twin	130	R99
D	Magnetic				4			*		twin	210	R100
D	Magnetic				14			*		twin	162	R101
D	Magnetic				4			*		twin	200	R102
D	Magnetic				8			*		twin	100	R103
surgery room												
D	Magnetic				4			*		twin	180	L25
D	Magnetic				10			*		twin	180	L26
D	Magnetic				10			*		twin	110	L27
D	Magnetic				12			*		twin	105	R104
D	Magnetic				18			*	twin		300	R105
D	Magnetic				16			*	twin		360	R106
D	Magnetic				6			*	twin		650	R107
D	Magnetic				16			*	twin		570	R108
D	Magnetic				16			*	twin		630	R109
D	Magnetic				16			*	twin		580	R110
D	Magnetic				26			*	twin		340	R111
D	Magnetic				4			*	twin		300	R112

At Al-Zahra Hospital, all fluorescent lamps with magnetic ballasts work with class D. The types of production ballasts are divided into different classes A1, A2, A3, B1, B2, C, D. Classes B1, B2, C, D are related to magnetic ballasts and electronic ballasts are in class A. "2" Due to the fact that the ballast class in Al-Zahra Hospital is D, the magnetic ballast losses for a 40-watt, 10-watt lamp are considered. The N.A. sign in the tables means that measurement is not possible due to the constraints in the desired location.

3-5: Bills and estimation of annual electricity consumption

According to the bills received in 2010 and 2011 related to Al-Zahra Hospital, the amount of active consumption between medium load, peak load, low load, and reactive is given in Table 3-3 by period

per.	from	to	days	Displayed Power (KW)	Active Energy Consumed (KWh)			Reactive Energy Consumed (KVARh)
					Normal Load	Peak Load	Low Load	
1	1389/09/17	1389/10/20	33	1520	328,000	104,000	178,667	344,000
2	1389/10/20	1389/11/17	27	1520	404,000	136,000	228,000	444,000
3	1389/11/17	1389/12/18	31	1440	452,000	144,000	252,000	480,000
4	1389/12/18	1390/1/24	31	1440	472,000	156,000	272,000	500,000
5	1390/01/24	1390/2/18	25	1440	320,000	100,000	176,000	124,000
6	1390/2/18	1390/3/28	41	1840	724,000	228,000	392,000	128,000
7	1390/3/28	1390/4/20	23	2040	488,000	148,000	256,000	88,000
8	1390/4/20	1390/5/17	28	2000	600,000	188,000	336,000	88,000
9	1390/5/17	1390/6/17	31	1920	596,000	200,000	352,000	80,000
10	1390/6/17	1390/7/19	33	1720	592,000	192,000	328,000	104,000
11	1390/7/19	1390/8/17	28	1360	368,000	120,000	196,000	100,000
12	1390/8/17	1390/9/19	32	1520	468,000	152,000	264,000	92,000
Sum			363	——	5,812,000	1,868,000	3,230,667	——

In the following, according to the received bills, the diagram of electrical energy consumption is shown in Figure 1-3, separated by peak load times, medium load and low load hours.

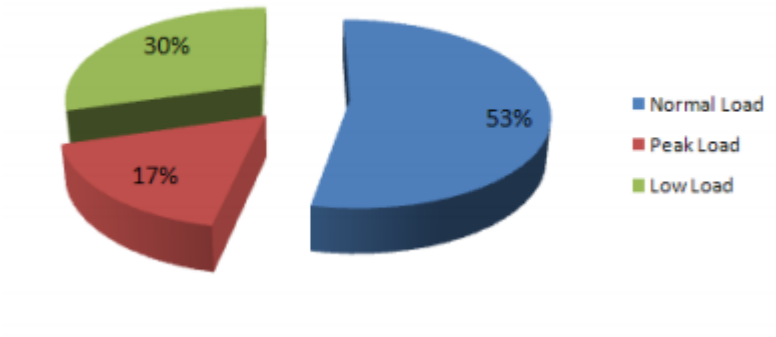


Figure 3-1

According to the above figure, it can be seen that the highest energy consumption is related to short hours and the lowest energy consumption is related to peak hours. In Table 3-4, according to the bill numbers of 2010 and 2011, the annual energy consumption is obtained and by dividing the mentioned amount by the area of the building infrastructure, the total building consumption index is calculated

Energy consumption index of the whole building (KWh/m^2/Year)	Hospital infrastructure area (m^2)	Annual energy consumption (KWh/Year)	year
136.4	80,000	10,910,667	89-90

Table 3-4

3-6: Light consumption

In the following, according to the measurements made on feeders 1 and 2, which provide the main part of the hospital building lighting, the amount of power consumption in different time intervals for each feeder is obtained in Table 3-5.

Feeder name	Average power consumption at the time of measurement (KW)		
	23:00 - 07:00	07:00 - 12:00	12:00 - 23:00
1	46.7	86	73.8
2	49	94	79

Table 3-5

Therefore, the annual energy consumption for lighting according to tables is 3-5 equal to:

Approximate annual energy consumption of the lighting sector= Total overnight energy consumption of feeders 1 and 2 * 365=

$$=\big((46.7*8+86*5+73.8*11)+(49*8+94*5+79*11)\big)\times 365$$

Then, by having the annual energy consumption limits of lighting and the area of the building infrastructure, the amount of energy consumption index of the lighting sector can be obtained by dividing the energy consumption limits of lighting on the building infrastructure. According to the table below

Rural energy consumption index (KWh/m^2/Year)	Building infrastructure area (m^2)	The share of energy consumption in the lighting sector (%)	Total annual energy consumption (KWh)	Annual energy consumption for lighting (KWh)
15.3	80,000	11	10,910,667	1,221,436

table 3-6

As the numbers in the table above show, the lighting sector accounts for about 11% of electrical energy consumption. Also, the energy consumption index in the lighting sector is 3.15 kWh per square meter per year.

In the following, according to the above, the energy balance diagram in Al-Zahra Hospital building is shown in Figure 2-3.

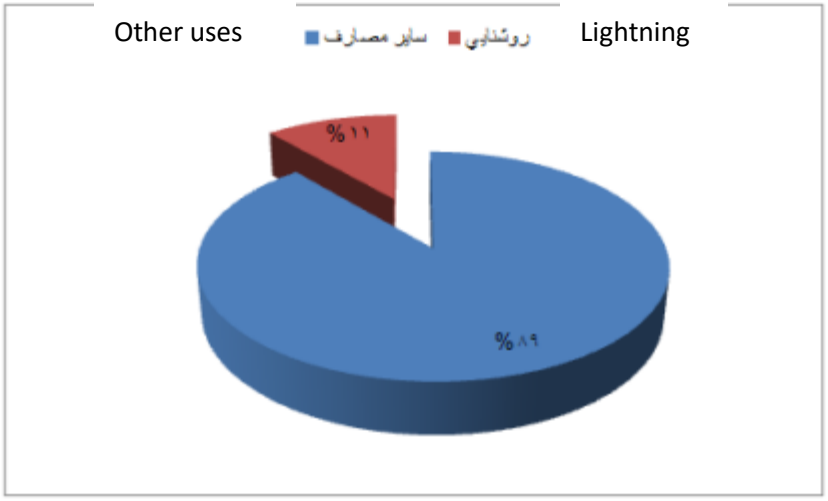


Figure 3-2

It should be noted that according to the hospital's electricity manager, part of the power consumption for lighting, including operating room lighting, is powered by feeders 4, 5, 8, which are also used for other purposes, but there isn't a plan or document to separate lighting uses. There are no other uses in these feeders. Therefore, the share of light consumption, which is about 11%, is obtained according to feeders 1 and 2.

3-7: Perform input power measurement:

An inspection of Al-Zahra building revealed that there are 8 main feeders to supply electricity to this building.

The summary of the measurement results on the feeders of this building is given in Table 3-7.

Power factor	Medium power (Kw)	Voltage level (Kv)	Feeding place	Feeder name
0.96	67.3	380	Lighting	1
0.96	72.2	380	Lighting	2
0.93	143.5	380	Other uses	3
0.57	72.7	380	Other uses	4
0.98	142.5	380	Other uses	5
0.95	181.6	380	Other uses	6
0.97	49.6	380	Other uses	7
0.99	77.2	380	Other uses	8

Table 3-7

Also, the power consumption graph of the measured feeders is shown in Figure 3-3 to Figure 3-10

Figure 3-3

Figure 3-4

The diagrams in Figure 3-3 and Figure 3-4 are related to the power consumption of the hospital lighting. As it is clear from the above diagrams, the power consumption of the mentioned feeders has decreased in the period of 23:30 to 6 in the morning. Input 1 is about 40 kW and for feeder input 2 is about 45 kW. This power outage is related to when a large number of lamps are off.

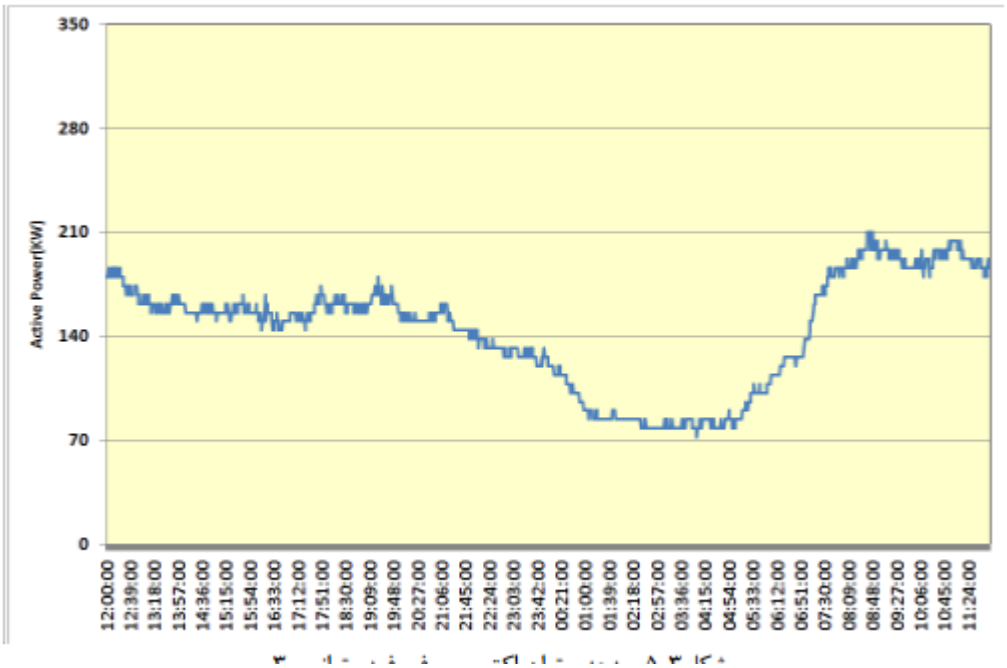


Figure 3-5

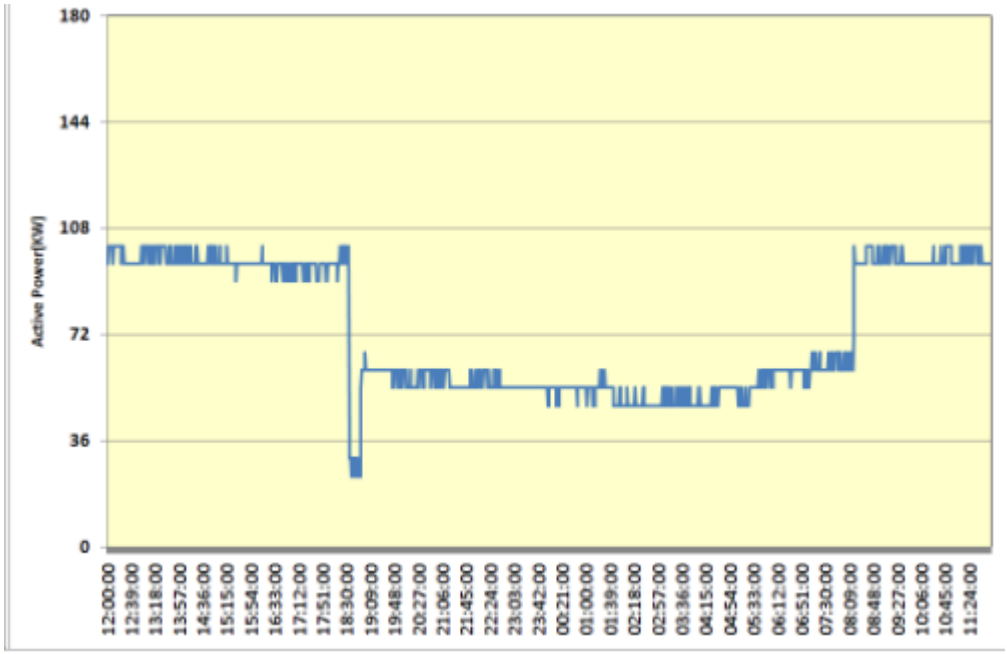


Figure 3-6

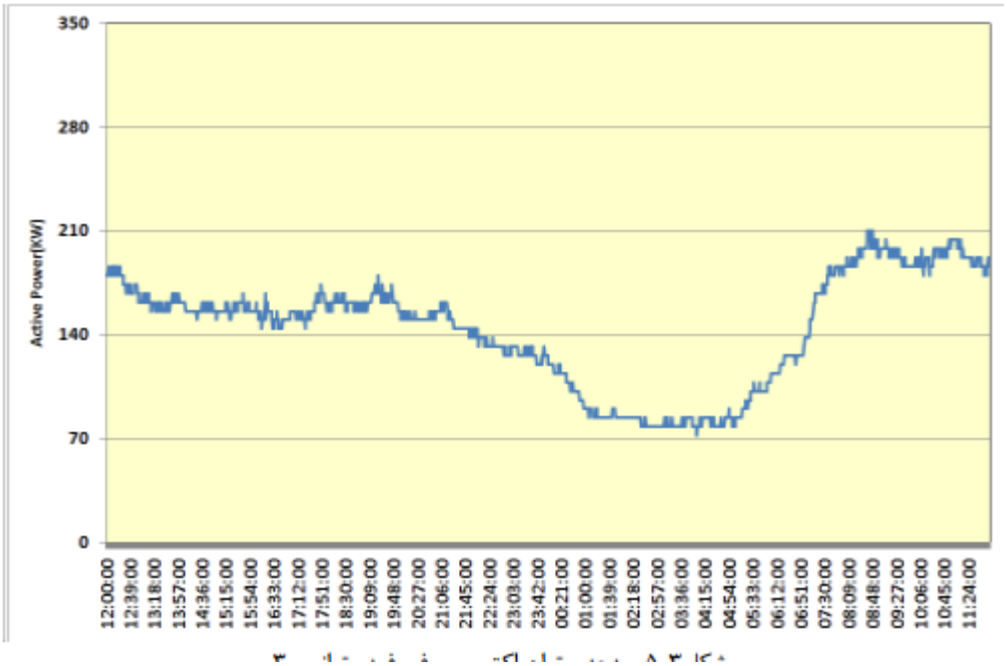


Figure 3-7

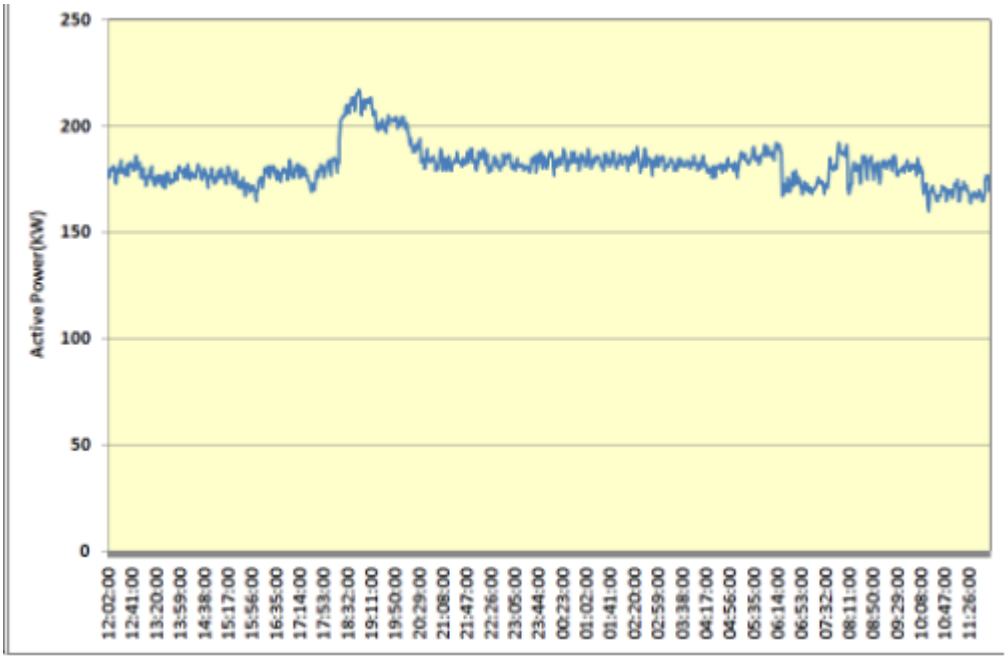


Figure 3-8

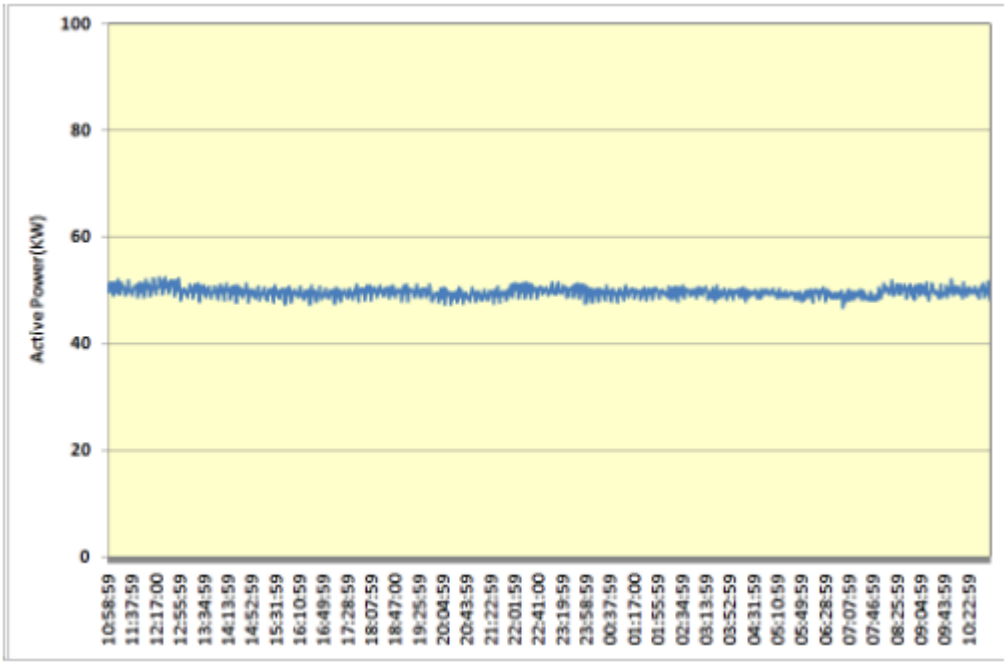


Figure 3-9

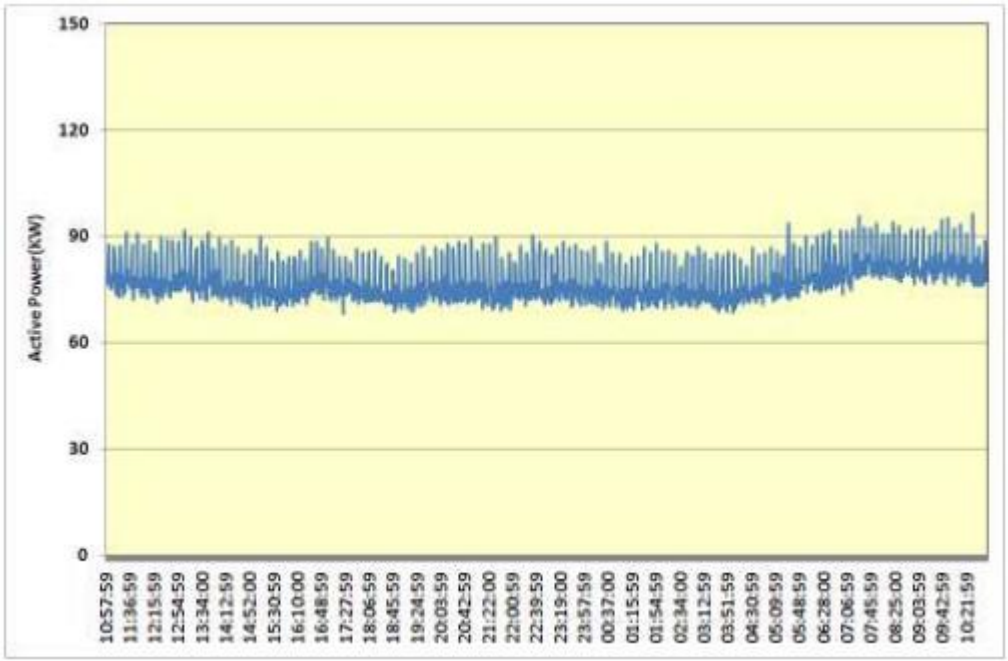


Figure 3-10

It should be noted that the power consumption curves of feeders 3 to 8 transformers, which are given in Figure 3-5 to Figure 3-10, are related to other electricity consumption of Al-Zahra Hospital.

In the following, by summing the active powers of the 8 input feeders, the active power consumption curve of the whole hospital is given in Figure 3-11.

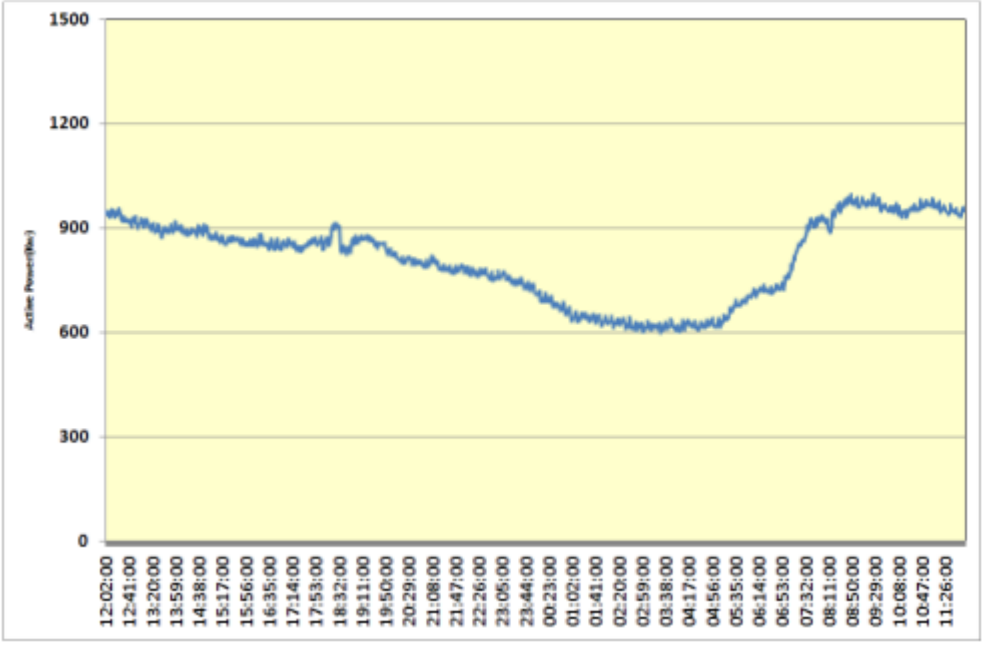


Figure 3-11

According to the above figure, the average daily power consumption of the entire hospital is estimated at about 900 kW and the average night power consumption at about 600 kW.

3-8: Information on how to maintain the building lighting

According to the investigations carried out and according to the negotiations carried out with the officials of the repair and facilities department in Al-Zahra Hospital, the following cases can be mentioned.

- Cleaning the walls: they are painted every three or four years.

- Cleaning the lights: when replacing the burned bulbs, they are cleaned.

- Cleaning and washing windows: When windows are dirty, they are cleaned.

- Replacing incandescent bulbs with high-efficiency bulbs: In this building, more incandescent bulbs are used

Appendix 1

Table 1: Physical characteristics of different parts of the first floor

window		surface color			dimentions of the room"meters"			room usage	room code	row
doesn't have	have	wall	ceiling	floor	height	width	length			
Heart section										
*		white	camphor white	flooring green	2.2	2.35	25	Corridor section	L1	1
	*	-	-	flooring green	3.2	3.3	6.7	North Rooms	R1-R10	2
	*	-	-	flooring green	3.2	3	3.7	South Rooms	R11-R14	3
	*	stone	-	flooring green	-	-	-	nurse station	S1	4
*		stone	camphor white	stone	3.2,2.2	7.5	8.5	lobby	B1	5
	*	white	white	flooring green	2.2	2.1	15.5	Entrance hallway	L2	6
	*	-	-	flooring green	3.2	3.4	6.7	room of the day	R15	7
		-	-	flooring green	3.2	3	3.4	examination room	R16	8
	*	-	-	flooring green	3.2	3	3.1	nurse room	R17	9
Cardiac Intensive Care										
	*	-	-	-	2.6	2.5	42	Public corridor	L3	10
	*	-	-	-	3.2	3.8	5	South Rooms	R18-R25	11
	*	-	-	-	3.2	3	3.8	North Rooms	R26-R27	12
	*	-	-	-	3.2	3	3.8	rest room	R28	13

*		-	-	-	2.2	2	22	Corridor section	L4	14
*		-	-	-	-	-	-	nurse station	S2	15
*		-	-	-	3.2,2.2	7.5	8.5	lobby	B2	16
	*	-	-	-	2.2	2.2	13.5	Corridor	L5	17
Eco section										
		-	-	-	N.A	N.A	N.A	reception	S3	18
		-	-	-	N.A	N.A	N.A	Waiting room	R29	19
		-	-	-	N.A	N.A	N.A	examination room	R30	20

window		surface color			dimentions of the room"meters"			room usage	room code	row
doesn't have	have	wall	ceiling	floor	height	width	length			
Central Intensive Care 1										
*		-	-	-	2.8	2.5	13.5	Public corridor	L6	21
*		-	-	-	2.2	2.1	20	Entrance hallway	L7	22
*		-	-	-	-	-	-	nurse station	S4	23
*	*	-	-	-		3.8	4.8	patient rooms	R31-R51	24
		-	-	-				nurse room	R52	25
*		-	-	-	-	-	-	nurse station	S5	26
*		-	-	-				dining room	R53	27
*		-	-	-	2.2	2	50	Corridor	L8	28
surgery room										
*		tile white	camphor white	flooring green	2.8	3.4	75	Corridor١	L9	29
	*	tile	camphor	flooring	2.8	3.4	26.3	Corridor٢	L10	30

		white	white	green						
*		tile white	camphor white	flooring green	2.8	2.8	70	Corridor۳	L11	31
	*	tile white	camphor white	flooring green	2.8	2.8	26.5	Corridor۴	L12	32
*		tile green	white	flooring green	3.2	5	5.3	surgery rooms	R54-R74	33
*		-	-	-	2.2	3	6.4	packing room	R75	34
*		-	-	-	-	-	-	store	R76	35
*		-	-	-	-	-	-	entrance recovery	R77	36
*		-	-	-	-	-	-	Output recovery	R78	37
*		-	-	-	-	-	-	pharmacy	R79	38
*		-	-	-	-	-	-	nurse room	R80	39
*		-	-	-	-	-	-	men’s dining room	R81	40
*		-	-	-	-	-	-	women’s dining room	R82	41
*		-	-	-	-	-	-	Corridor middle	L13	42
*		-	-	-		4.1	4.8	locker room men	R83	43
*		-	-	-		4.1	4.8	locker room women	R84	44
*		-	-	-	-	-	-	entrance lobby	B3	45
Skincare unit										

window		surface color			dimentions of the room”meters”			room usage	room code	row
doesn’t have	have	wall	ceiling	floor	height	width	length			

	*	-	-	-	2.2	8	10	lobby	B4	46
*		-	-	-	3.2	3	3.2	doctor’s room	R85	47
*		-	-	-	3.2	3	3.2	injections	R86	48
	*	-	-	-	3.2	3	3.2	Light treatment	R87	49
*		-	-	-	-	-	-		R88	50
*		-	-	-	3.2	3	3.2	side room	R89	51
Clinic 2										
*		-	-	-	2.2	8	10	lobby *	B5	52
*		-	-	-	3.2	3	3.2	face and jaw	R90	53
*		-	-	-	3.2	3	3.2	Immunology*	R91	54
	*	-	-	-	3.2	3	3.2	urology	R92	55
*		-	-	-	2.2	8	10	Internal Nerve Lobby	B6	56
	*	-	-	-	3.2	3	3.2	Adult glands	R93	57
*		-	-	-	3.2	3	3.2	Internal pediatric nerves	R94	58
*		-	-	-	3.2	3	3.2	Child Psychiatry	R95	59
	*	-	-	-	3.2	3	3.2	Child gland	R96	60
*		white	-	flooring green	2.2	8	10	lobby endoscopy	B7	61
	*	-	-	-	3.2	3	3.2	doctor’s room	R97	62
	*	-	-	-	-	-	-	surgery room	R98	63
*		-	-	-	3.2	3	3.2	Audio meter	R99	64
*		-	-	-	-	-	-	Child heart	R100	65
ICU2										
*		white	-	flooring green	2.2	2.3	38.5	Corridor	L14	66
*	*	ceramic	white	flooring	3.2	3.3	6.7	patient room	R101	67

				green						
	*	ceramic	white	flooring green	3.2	3	3.4	Doctor’s room	R102	68
	*	white	-	flooring green	3.2,2.2	7.5	8.5	Corridor	L15	69
*		white	-	flooring green	2.8	2.6	38	Corridor	L16	70
*		white	-	flooring	2.2	2	13.2	Corridor	L17	71

window		surface color			dimentions of the room”meters”			room usage	room code	row
doesn’t have	have	wall	ceiling	floor	height	width	length			
				green						
Selected intensive care										
*		-	-	-	-	-	-	nurse station	S6	72
*		-	-	-	2.2	2.4	22	Corridor	L18	73
	*	-	-	-	2.2	3.8	4.8	patient room	R103	74
	*	-	-	-	3.2	3	3.8	nurse room	R104	75
	*	-	-	-	-	-	-	dining room	R105	76
*		-	-	-	2.2	3	10	Corridor	L19	77
Neurosurgery										
*		-	-	-	2.2	2.7	13	Entrance hallway	L20	78
*		-	-	-	-	-	-	nurse station	S7	79
	*	-	-	-	2.2	2.4	32	Corridor section	L21	80
	*	-	-	-	3.2	3.3	6.7	North Rooms	R106-R116	81
	*	-	-	-	3.2	3	3.1	South Rooms	R117	82
	*	-	-	-	3.2	3.3	6.7	room of the day	R118	83

*		-	-	-	3.2	3	3.1	Medicine room	R119	84
	*	-	-	-	3.2	3	3.4	nurse room	R120	85

Table 2: Physical characteristics of different parts of the third floor

window		surface color			dimentions of the room"meters"			room usage	room code	row
doesn't have	have	wall	ceiling	floor	height	width	length			
Tracks section										
*		stone white	campho r green	stone white	3.2,2.2	7.5	8.5	lobby	B1	1
*		stone white	campho r green	flooring yellow	2.2	2.7	10.2	Entrance hallway	L1	2
*		stone white	campho r green	flooring yellow	2.2	2.4	40.5	Corridor section	L2	3
*		stone white	campho r green	flooring yellow	-	-	-	nurse station	S1	4
	*	white	white	flooring yellow	3.2	3	3.1	Nurse room	R1	5

window		surface color			dimentions of the room"meters"			room usage	room code	row
doesn't have	have	wall	ceiling	floor	height	width	length			

	*	white	white	flooring yellow	3.2	3.5	3.8	rest room	R2	6
	*	white	white	flooring yellow	3.2	3.3	6.7	room of the day	R3	7
	*	tile and white	white	flooring yellow	3.2	3	3.7	North Rooms	R4,R5	8
	*	tile and white	white	flooring yellow	3.2	3.4	6.7	South Rooms	R6-R14	9
*		tile and white	white	flooring yellow	3.2	2.5	3.2	examination room	R15	10
Children's section										
*		stone white	campho r green	green flooring	3.2,2.2	7.5	8.5	lobby	B2	11
	*	white	white	green flooring	3.2	3	3.1	Endocrinology Room and Pediatric Endocrinology Commission	R16	12
*		stone white	campho r green	green flooring	2.2	2.7	10.2	Entrance hallway	L3	13
*		stone white	campho r green	green flooring	2.2	2.4	45	Corridor section	L4	14
*		green	campho r green	green flooring	3.2	3.4	3.5	medicine room	R17	15
	*	green	white	green flooring	3.2	3	3.1	Nurse room	R18	16
	*	white	white	green flooring	3.2	3	3.5	Brain tape room	R19	17
*		stone white	campho r green	green flooring	-	-	-	nurse station	S2	18

	*	green	white	green flooring	3.2	3.4	6.7	South Rooms	R20-R27	19
	*	green	white	green flooring	3.2	3	3.7	North Rooms	R28,R29	20
	*	green	white	green flooring	3.2	3	3.7	examination room	R30	21
	*	green	white	green flooring	3.2	3	3.7	doctor’s room	R31	22
	*	green	white	green flooring	3.2	3.4	6.7	Isolated room	R32	23
	*	green	white	green flooring	3.2	3.3	6.7	room of the day	R33	24
	*	stone and color white	white	green flooring	3.2	3.5	6.7	Intensive care unit	R34	25
Men's orthopedic department										
*		stone white	campho r green	flooring green	3.2,2.2	7.5	8.5	lobby	B3	26
*		stone white	campho r	flooring green	2.2	2.7	10.3	Entrance hallway	L5	27

window		surface color			dimentions of the room”meters”			room usage	room code	row
doesn’t have	have	wall	ceiling	floor	height	width	length			
			green							
	*	white	white	flooring green	3.2	3	3.6	rest room	R35	28
	*	white	white	flooring green	3.2	3	3.5	Nurse room	R36	29
	*	tile and white	white	flooring green	3.2	3.3	6.2	Breath room	R37	30

	*	tile white	white	flooring green	3.2	3.3	6.2	Intern room	R38	31
	*	white	campho r green	flooring green	2.2	2	3.2	Breath room	R39	32
*		white	white	flooring green	3.2	3	3.4	medicine room	R40	33
*		stone white	campho r green	flooring green	-	-	-	nurse station	S3	34
*		stone white	campho r green	flooring green	2.2	2.7	42	Corridor section	L6	35
	*	white	white	flooring green	3.2	3.3	6.7	South Rooms	R41-R50	36
	*	white	white	flooring green	3.2	3	3.1	North Rooms	R51-R53	37
	*	white	white	flooring green	3.2	3.5	6.5	room of the day	R54	38
Department of Child and Adolescent Psychiatry										
*		stone white	campho r green	flooring yellow	3.2,2.2	7.5	8.5	lobby	B4	39
*		white	white	flooring yellow	3.2	3	3.6	rest room	R55	40
*		stone white	campho r green	flooring yellow	2.2	2.7	10.5	Entrance hallway	L7	41
*		stone white	campho r green	flooring yellow	2.2	2.4	46.5	Corridor section	L8	42
	*	letron and color	white	flooring yellow	3.2	3	3.1	Nurse room	R56	43
	*	letron	white	flooring yellow	3.2	3.5	3.7	Group room	R57	44

*		letron and color	white	flooring yellow	3.2	3.3	3.4	Isolated room	R58	45
*		stone white	campho r green	flooring yellow	-	-	-	nurse station	S4	46
	*	letron and color	white	flooring yellow	3.2	3.3	4.1	Psychologist room	R59	47
	*	letron and color	white	flooring yellow	3.2	3.3	6.2	Workroom and treatment	R60	48
	*	letron and color	white	flooring yellow	3.2	3.3	6.2	South room	R61-R66	49
	*	letron and color	white	flooring yellow	3.2	3.3	6.2	Occupational therapy room	R67	50

window		surface color			dimentions of the room"meters"			room usage	room code	row
doesn't have	have	wall	ceiling	floor	height	width	length			
	*	letron	white	flooring yellow	3.2	3.3	6.7	room of the day	R68	51
	*	letron and color	white	flooring yellow	3.2	3	3.6	North room	R69	52
	*	letron and color	white	flooring yellow	3.2	3	3.6	doctor's room	R70	53
	*	letron and color	white	flooring yellow	3.2	3	3.6	doctor's room	R71	54
	*	letron and color	white	flooring yellow	3.2	3	3.6	Assistance class	R72	55

Table 3: Physical characteristics of different parts of the fourth floor

window		surface color			dimentions of the room"meters"			room usage	room code	row
doesn't have	have	wall	ceiling	floor	height	width	length			
Department of Urology and Maxillofacial Surgery										
*		stone white	-	stone white	3.2,2.2	7.5	8.5	lobby	B1	1
*		stone white	-	green flooring	2.2	3.7	10	Entrance hallway	L1	2
	*	letron and white	white	green flooring	3.2	3	3.1	Nurse room	R1	3
*		letron and white	white	green flooring	-	-	-	nurse station	S1	4
	*	letron and white	white	green flooring	3.2	3.5	3.8	Men's rest room	R2	5
*		stone white	-	green flooring	2.2	2.4	40.5	Corridor section	L2	6
	*	letron and white	white	green flooring	3.2	3	6.7	South Rooms	R3-R11	7
	*	letron and white	white	green flooring	3.2	3	3.7	North room	R12	8
	*	letron and white	white	green flooring	3.2	3.3	6.7	room of the day	R13	9
	*	letron and white	white	green flooring	3.2	3	3.6	Sonography room	R14	10
	*	letron and white	white	green flooring	3.2	3	3.1	doctor's room	R15	11
	*	letron and white	white	green flooring	3.2	2.2	3.4	Locker room	R16	12
*		letron and white	white	green flooring	3.2	3	3.4	medicine room	R17	13

Pediatric and neonatal surgery department										
*		stone white	camphor	stone white	3.2,2.2	7.5	8.5	lobby	B2	14
	*	white	white	green flooring	3.2	3.3	6.7	Lesson room	R18	15
*		stone white	camphor	green flooring	2.2	2.7	10.2	Entrance hallway	L3	16
*		stone white	camphor	green flooring	2.2	2.4	45	Corridor section	L4	17
	*	white	white	green flooring	3.2	3	3.1	Nurse room	R19	18
	*	-	-	-	-	-	-	Locker room	R20	19
*		stone white	camphor	green flooring	-	-	-	nurse station	S2	20

window		surface color			dimentions of the room"meters"			room usage	room code	row
*		white	white	green flooring	3.2	3.4	3.5	medicine room	R21	21
	*	white	white	green flooring	-	-	-	doctor's room	R22	22
	*	white	white	green flooring	-	-	-	Pavilion	R23	23
	*	white	white	green flooring	-	-	-	Take a vein	R24	24
*		stone	camphor	green flooring	2.2	2.7	13	Corridor section	L5	25
	*	white	white	green flooring	-	-	-	North Rooms	R25-R29	26

*		stone white	camphor	green flooring	-	-	-	Corridor section	L6	27
	*	white	white	green flooring	-	-	-	Infant Surgery Room	R30	28
*		white	white	green flooring	-	-	-	nurse stationج ن	S3	29
Adult Infectious Diseases										
*		stone white	camphor	green flooring	2.2	3.7	10	Entrance hallway	L7	31
	*	white	white	green flooring	3.2	3	3.1	Nurse room	R31	32
*		white	camphor	green flooring	-	-	-	nurse station	S4	33
*		stone white	camphor	green flooring	2.2	2.4	40.5	Corridor section	L8	35
	*	white	white	green flooring	3.2	3	3.7	South Rooms	R32-R33	36
	*	white	white	green flooring	3.2	3	6.7	north room	R34-R45	37
	*	white	white	green flooring	3.2	3.3	6.7	room of the day	R46	38
*		white	white	green flooring	3.2	3	3.4	examination room	R47	39
*		white	white	green flooring	3.2	3	3.4	doctor’s room	R48	40
*		white	white	green flooring	3.2	3	3.4	medicine room	R49	42
Lung section										
*		stone white	camphor green	stone white	3.2,2.2	7.5	8.5	lobby	B3	43
*		stone white	camphor green	green flooring	2.2	3.7	10	Entrance hallway	L9	44
	*	letron and white	white	green flooring	3.2	3	3.1	Nurse room	R50	45

*		letron and white	white	green flooring	-	-	-	nurse station	S5	46
*		stone white	camphor green	green flooring	2.2	2.4	40.5	Corridor section	L10	48
	*	letron and white	white	green flooring	3.2	3	6.7	South Rooms	R51-R60	49
	*	letron and white	white	green flooring	3.2	3	3.7	North Rooms	R61-R62	50
	*	letron and white	white	green flooring	3.2	3.3	6.7	room of the day	R63	51
	*	letron and white	white	green flooring	3.2	3	3.1	doctor's room	R64	53

window		surface color			dimentions of the room"meters"			room usage	room code	row
	*	letron and white	white	green flooring	3.2	2.2	3.4	Locker room	R65	54
*		letron and white	white	green flooring	3.2	3	3.4	medicine room	R66	55
Department of Nephrology										
*		stone	camphor green	stone	3.2,2.2	7.5	8.5	lobby	B4	56
*		stone	camphor green	green flooring	2.2	3.7	10	Entrance hallway	L11	57
	*	letron and white	white	green flooring	3.2	3	3.1	Nurse room	R67	58
*		letron and white	white	green flooring	-	-	-	nurse station	S6	59
*		stone	camphor green	green flooring	2.2	2.4	40.5	Corridor section	L12	60
	*	letron and white	white	green flooring	3.2	3	6.7	South Rooms	R68-R77	61

	*	letron and white	white	green flooring	3.2	3	3.7	North room	R78-R79	62
	*	letron and white	white	green flooring	3.2	3	3.7	Biopsy room	R80	63
	*	letron and white	white	green flooring	3.2	3.3	6.7	room of the day	R81	64
	*	letron and white	white	green flooring	3.2	3	3.1	doctor’s room	R82	65
	*	letron and white	white	green flooring	3.2	2.2	3.4	Locker room	R83	66
*		letron and white	white	green flooring	3.2	3	3.4	medicine room	R84	67
Digestive section										
*		stone	camphor green	green flooring	2.2	3.7	10	Entrance hallway	L13	68
	*	letron and white	white	green flooring	3.2	3	3.1	Nurse room	R85	69
*		letron and white	white	green flooring	-	-	-	nurse station	S7	70
*		stone white	camphor green	green flooring	2.2	2.4	40.5	Corridor section	L14	71
	*	letron and white	white	green flooring	3.2	3	6.7	South Rooms	R86-R97	72
	*	letron and white	white	green flooring	3.2	3	3.7	North room	R98-R99	73
	*	letron and white	white	green flooring	3.2	3.3	6.7	room of the day	R100	75
	*	letron and white	white	green flooring	3.2	3	3.1	doctor’s room	R101	76
	*	letron and white	white	green flooring	3.2	2.2	3.4	Locker room	R102	77
*		letron and white	white	green flooring	3.2	3	3.4	medicine room	R103	78
Selected surgery section										

*		stone white	camphor white	flooring yellow	2.2	3.7	10	Entrance hallway	L15	79

window		surface color			dimentions of the room"meters"			room usage	room code	row
	*	white	white	flooring yellow	3.2	3	3.1	Nurse room	R104	80
*		stone white	camphor white	flooring yellow	-	-	-	nurse station	S8	81
*		stone white	camphor white	flooring yellow	2.2	2.4	40.5	Corridor section	L16	82
	*	white	white	flooring yellow	3.2	3	3.7	South Rooms	R105-R106	83
	*	white	white	flooring yellow	3.2	3	6.7	North Rooms	R107-R116	84
	*	white	white	flooring yellow	3.2	3.3	6.7	room of the day	R117	85
*		white	white	flooring yellow	3.2	3	3.4	examination room	R118	86
*		white	white	flooring yellow	3.2	3	3.4	doctor's room	R119	87
*		white	white	flooring yellow	3.2	3	3.4	medicine room	R120	88

Appendix 2.

Table 1: Lighting specifications of different wards of Al-Zahra Hospital basement

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
Corridors												
D	magnetic				6			*		twin	20	L1
D	magnetic				10			*		twin	500	L2
D	magnetic				12			*		twin	422	L3

D	magnetic				12			*		twin	462	L4
D	magnetic				12			*		twin	391	L5
D	magnetic				8			*		twin	386	L6
D	magnetic				10			*		twin	457	L7
D	magnetic				36			*		twin	130	L8
Education group office												
D	magnetic				8			*		twin	395	L9
D	magnetic				88			*	twin		430	R1-R11
Engineering unit												
D	magnetic		5		20		*	*	twin		521	R12
D	magnetic				32			*	twin		165	R13
D	magnetic				8			*	twin		210	R14
D clinic												
D	magnetic			7	36		*	*	twin and single		145	R15
M.R.I												
D	magnetic				N.A			*	-		157	B1
D	magnetic			46				*	single		200	R16
D	magnetic				N.A			*	-		98	L10
دار and												
D	magnetic				50			*	twin		110	B2
D	magnetic				6			*	twin		210	R17
Physiotherapy												

ballast class	type of ballast	number of lights			type of lamp			type of light		Lux	
	fluorescent	string	low consumption	fluorescent	string						

		100 watt	23 watt	20 watt	40 watt		low consumption	fluorescent	build-on	build-in		room code
D	magnetic				18			*		twin	250	S1
D	magnetic				238			*	twin		238	R17
D	magnetic				12			*		twin	72	L11
D	magnetic				30			*	twin		265	R18
D	magnetic				8			*	twin		251	R19
D	magnetic				8			*	twin		425	R20
D	magnetic				12			*	twin		175	R21
D	magnetic				18			*	twin		240	R22
Central Australization												
D	magnetic				136			*	twin		200	B3
D	magnetic				4			*	twin		130	R23
necessities												
D	magnetic		2	3	133	*	*	*	single		100	B4
D	magnetic				4			*	single		230	R24
Staff lobby												
D	magnetic				57			*		twin	195	B5
Health unit												
D	magnetic				12			*		twin	207	L12
D	magnetic				4			*	twin		230	R29
D	magnetic				3			*	twin		386	R30
D	magnetic				4			*	twin		430	R31
D	magnetic				4			*	twin		320	R32
D	magnetic			2	4		*	*	twin		283	R33
kitchen												
D	magnetic		2	15	468		*	*	twin		72	B6
D	magnetic				8			*	twin		105	L13
D	magnetic				16			*	twin		256	R34

D	magnetic				100			*	twin		120	R35
Audio-visual unit												
D	magnetic				12			*	twin		270	R39

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
Class rooms												
D	magnetic			50			*			single	160	R40
D	magnetic			50			*			single	158	R41
D	magnetic			50			*			single	152	R42
D	magnetic			50			*			single	125	R43
D	magnetic			50			*			single	205	R44
Praying room												
D	magnetic				100			*	twin		289	B8
D	magnetic				8			*	twin		250	R45
D	magnetic				10			*	twin		120	L14

Table 2: Lighting specifications of different wards of the ground floor of Al-Zahra Hospital

		number of lights	type of lamp	type of light		

ballast class	type of ballast fluorescent	string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in	Lux	room code
		100 watt	23 watt	20 watt	40 watt							
lobby reception												
D	magnetic				84			*		twin	100	B1
D	magnetic		4		8		*	*		twin	330	R1
D	magnetic		3		8		*	*		twin	220	R2
Office and Computer Affairs Unit												
D	magnetic				22			*		twin	240	R3
D	magnetic				8			*		twin	420	L1
D	magnetic				14			*		twin	150	L2
D	magnetic				12			*		twin	300	R4
D	magnetic				8			*		twin	350	R5
D	magnetic				24			*		twin	345	R6
D	magnetic				8			*		twin	330	R7
D	magnetic				8			*		twin	400	l3
D	magnetic		1		2		*	*		twin	250	R8

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
library												
D	magnetic	15			122			*		twin	500	R9
D	magnetic				4			*		twin	250	R10
D	magnetic				12			*		twin	420	R11
Headquarters												

D	magnetic				18			*		twin	80	L4
D	magnetic				14			*		twin	280	B2
D	magnetic				8			*		twin	325	R12
D	magnetic				12			*		twin	275	R13
D	magnetic				10			*		twin	300	R14
pathology												
D	magnetic				10			*	twin		160	R15
D	magnetic				4			*		twin	170	L5
D	magnetic		1				*				60	R16
D	magnetic				8			*		twin	60	L6
D	magnetic				14			*		twin	200	S1
D	magnetic				72			*		twin	300	R17
D	magnetic				6			*		twin	113	R18
D	magnetic				16			*	twin		400	R19
D	magnetic				6			*		twin	240	R20
D	magnetic				26			*		twin	130	R21
D	magnetic				16			*		twin	95	L7
Clinical laboratory												
D	magnetic				10			*		twin	290	R22
D	magnetic				8			*		twin	230	R23
D	magnetic				14			*		twin	100	R24
D	magnetic				6			*		twin	153	R25
D	magnetic				16			*		twin	314	R26
D	magnetic				20			*		twin	68	L8
D	magnetic				20			*		twin	175	R27

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
Blood Bank Laboratory												
D	magnetic				30			*		twin	30	L9
D	magnetic				16			*		twin	115	S2
D	magnetic				26			*		twin	180	R28
D	magnetic				24			*		twin	160	S3
D	magnetic				8			*		twin	320	R29
D	magnetic				4			*		twin	280	R30
D	magnetic				22			*		twin	180	R31-R33
D	magnetic			180				*		single quadruplet	400	R34
D	magnetic				6			*		twin	160	R35
D clinic												
D	magnetic				10		*	*		twin	110	L10
D	magnetic		2		2		*	*	twin		255	R36
D	magnetic				4			*	twin		265	R37
D	magnetic				4			*	twin		265	R38
D	magnetic		2		4		*	*	twin		358	R39
D	magnetic				4			*	twin		110	R40
D	magnetic		2		2		*	*	twin		200	R41
D	magnetic		1		8		*	*	twin		200	R42
D	magnetic				10			*	twin		360	R43
Brain tape												

D	magnetic				8			*		twin	165	B3
D	magnetic	1	3				*				90	R44
D	magnetic		16		4		*	*	twin		185	R45
D	magnetic				24			*	twin		150	R46
D	magnetic		5		70			*		twin	75	B4
sonography												
D	magnetic				28			*	twin		230	S4

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
D	magnetic		26		120		*	*	twin		100	B5
Educational pharmacy of alzahra												
D	magnetic				30			*		twin	370	R47
clinic												
D	magnetic				44			*		twin	70	L11
D	magnetic				10			*	twin		250	R48
D	magnetic				10			*		twin	155	L12
D	magnetic				10			*	twin		270	R49
D	magnetic				10			*	twin		300	R50
D	magnetic				14			*	twin		330	R51
D	magnetic				18			*	twin		205	S5
D	magnetic				8			*		twin	75	L13
D	magnetic				4			*		twin	430	R52- R53
D	magnetic				4			*		twin	300	R54

D	magnetic				10			*		twin	110	L14
D	magnetic				8			*	twin		270	R55
D	magnetic				4			*	twin		110	R56
D	magnetic				8			*		twin	90	L15
D	magnetic				4			*	twin		310	R57
D	magnetic				10			*		twin	130	L16
D	magnetic				12			*		twin	360	R58
D	magnetic				8			*		twin	180	S6
D	magnetic				4			*	twin		280	R59
D	magnetic				18			*		twin	200	L17

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
D	magnetic				60			*	twin		450	R60
D	magnetic				8			*		twin	190	L18
D	magnetic				6			*	twin		225	R61
D	magnetic				8			*	twin		370	R62
D	magnetic				14			*		twin	250	S7
clinic[۳]												
D	magnetic				24			*		twin	90	L18
D	magnetic				16			*	twin		200	R63

D	magnetic				10			*	twin		500	R64
D	magnetic				12			*	twin		270	R65
D	magnetic				10			*	twin		230	R66
Telecommunication unit												
D	magnetic				10			*	twin		350	R67
D	magnetic				10			*		twin	280	L19
Men's internal surgery												
D	magnetic				86			*	twin		180	R68
Pediatric Cardiac Emergency												
D	magnetic				16			*	twin		280	R69
D	magnetic				16			*	twin		200	R70
D	magnetic				4			*	twin		250	R71
D	magnetic				18			*	twin		365	R72
D	magnetic				18			*	twin		272	R73
Women’s section												
D	magnetic				12	*		*	twin		120	R74-R76
D	magnetic				22	*		*	twin		500	R77
D	magnetic				4	*		*	twin		450	R78
D	magnetic				22	*		*	twin		430	R79

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
D	magnetic				22	*		*	twin		410	R80
D	magnetic				14	*		*	twin		510	R81
D	magnetic				20	*		*		twin	150	L20

D	magnetic				26	*		*		twin	100	L21
emergency												
D	magnetic				70			*	twin		500	R82
D	magnetic				20			*	twin		450	R83-R87
Stone breaker												
D	magnetic		30				*	*	-		86	L22
D	magnetic				30			*	twin		150	R88
radiology٢												
D	magnetic				16			*		twin	100	L23
D	magnetic				11			*	twin		35	R89
D	magnetic				12			*	twin		185	R90
Spiral city scan												
D	magnetic				16			*		twin	105	L24
D	magnetic				24			*	twin		160	R92
D	magnetic				18			*	twin		300	R93-R94
D	magnetic				18			*		twin	500	L25
Medical archive												
D	magnetic				10			*		twin	100	L26
D	magnetic				30			*	twin		160	R95
D	magnetic				4			*	twin		258	R96
D	magnetic			50				*	single		38	L27
D	magnetic				112			*	twin		222	R97
Administration unit												
D	magnetic				64			*	twin		300	R98
D	magnetic				12			*	twin		500	R99
D	magnetic		3		10			*	twin		260	R100

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
D	magnetic				10			*	twin		450	R101
D	magnetic				18			*		twin	250	L28
D	magnetic				10			*	twin		170	R102
D	magnetic				26			*	twin		280	R103

Table 3: Lighting specifications of different wards of the first floor of Al-Zahra Hospital

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
Heart section												
D	magnetic				22			*		twin	140	L1
D	magnetic		7	25	50		*	*	twin		850	R1-R10
D	magnetic		11	12	24		*	*	twin		360	R11-R14
D	magnetic		3		16		*	*		twin	520	S1
D	magnetic				14			*	twin	twin	80	B1
D	magnetic				10			*		twin	30	L2
D	magnetic				4			*	twin		800	R15
D	magnetic				4			*	twin		120	R16
D	magnetic				4			*	twin		310	R17
Intensive care unit												
D	magnetic				8			*		twin	200	L3
D	magnetic			12	24		*	*	twin		250	R18- R25
D	magnetic			4	8		*	*	twin		410	R26-

												R27
D	magnetic				4			*	twin		300	R28
D	magnetic				12			*		twin	130	L4
D	magnetic				8			*		twin	200	S2
D	magnetic				14			*		twin	95	B2
D	magnetic				8			*		twin	60	L5

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
Eco unit												
D	magnetic				8			*		twin	500	S3
D	magnetic				8			*	twin		165	R29
D	magnetic				8			*	twin		670	R30
Intensive care unit												
D	magnetic				62			*		twin	200	L6
D	magnetic				18			*		twin	150	L7
D	magnetic	1	3		16	*	*	*		twin	230	S4
D	magnetic		10	30	70		*	*	twin and single		265	R31- R51

D	magnetic		1		2		*	*	twin and single		175	R52
D	magnetic				16			*		twin	200	S5
D	magnetic			1	2			*	single		175	R53
D	magnetic			24	10			*		single	270	L8
surgery room												
D	magnetic				40			*		twin	80	L9
D	magnetic				14			*		twin	150	L10
D	magnetic				40			*		twin	95	L11
D	magnetic				14			*		twin	100	L12
D	magnetic		6		312		*	*	twin		400	R54-R74
D	magnetic		3		8		*	*	twin		580	R75
D	magnetic		1		4		*	*	twin		185	R76
D	magnetic				80			*	twin		180	R77
D	magnetic				86			*	twin		230	R78
D	magnetic		4		20		*	*	twin		322	R79
D	magnetic				12			*	twin		300	R80
D	magnetic				12			*	twin		480	R81
D	magnetic				14			*	twin		700	R82

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
D	magnetic				20			*		twin	100	L13
D	magnetic				30			*	twin		107	R83

D	magnetic				18			*	twin		103	R84
D	magnetic				66			*		twin	350	B3
Skincare unit												
D	magnetic				40			*		twin	250	B4
D	magnetic				10			*	twin		270	R85
D	magnetic				4			*	twin		300	R86
D	magnetic				6			*	twin		1000	R87
D	magnetic				4			*	twin		-	R88
D	magnetic				6			*	twin		-	R89
clinic٢												
D	magnetic				32			*		twin	260	B5
D	magnetic				14			*	twin		300	R90
D	magnetic				14			*	twin		300	R91
D	magnetic				12			*	twin		300	R92
D	magnetic				20			*	twin		150	B6
D	magnetic				14			*	twin		820	R93
D	magnetic				14			*	twin		260	R94
D	magnetic				6			*	twin		240	R95
D	magnetic				14			*	twin		320	R96
D	magnetic				10			*	twin		250	B7
D	magnetic				6			*	twin		290	R97
D	magnetic				34			*	twin		390	R98
D	magnetic				12			*	twin		319	R99
D	magnetic				8			*	twin		170	R100
ICU2												
D	magnetic				57					twin	75	L14
D	magnetic		11		35			*	twin		45	R101
D	magnetic				4				twin		285	R102
D	magnetic				4					twin	200	L15

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
D	magnetic				4					twin	60	L16
D	magnetic				24					twin	30	L17
Selected intensive care												
D	magnetic				8			*		twin	60	S6
D	magnetic				12			*		twin	110	L18
D	magnetic				32			*	twin		300	R103
D	magnetic				4			*	twin		300	R104
D	magnetic				8			*	twin		290	R105
D	magnetic				24			*		twin	220	L19
neurosurgery												
D	magnetic				6			*		twin	70	L20
D	magnetic				8			*		twin	330	S7
D	magnetic				26			*		twin	105	L21
D	magnetic			29	58			*	twin		600	R106-R116
D	magnetic			2	4			*	twin		215	R117
D	magnetic				6			*	twin		730	R118
D	magnetic				4			*	twin		105	R119
D	magnetic				4			*	twin		167	R120

Table 4: Lighting specifications of different wards of the third floor of Al-Zahra Hospital

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	Low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
Tracks unit												
D	magnetic				14			*	twin	twin	45	B1
D	magnetic				8			*		twin	100	L1
D	magnetic				22			*		twin	110	L2
D	magnetic	2	2		10	*	*	*		twin	600	S1
D	magnetic				4			*	twin		500	R1

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	Low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
D	magnetic				4			*	twin		480	R2
D	magnetic				6			*	twin		715	R3
D	magnetic				8			*	twin		450	R4,R5
D	magnetic			29	58			*	twin		1100	R6-R14
D	magnetic				4			*	twin		420	R15
Children section												
D	magnetic				14			*	twin	twin	50	B2
D	magnetic				12			*	twin		100	R16
D	magnetic				8			*		twin	80	L3
D	magnetic				26			*		twin	55	L4
D	magnetic				4			*	twin		250	R17

D	magnetic				4			*	twin		1000	R18
D	magnetic				4			*	twin		380	R19
D	magnetic	3	2		10	*	*	*		twin	225	S2
D	magnetic			18	36			*	twin		900	R20-R27
D	magnetic				8			*	twin		530	R28,R29
D	magnetic				4			*	twin		195	R30
D	magnetic				4			*	twin		300	R31
D	magnetic		3					*	-		880	R32
D	magnetic		5		6			*	twin		965	R33
D	magnetic			6	14			*	twin		2000	R34
Men's orthopedic unit												
D	magnetic				14			*	twin	twin	55	B3
D	magnetic				8			*		twin	130	L5
D	magnetic				4			*	twin		750	R35
D	magnetic				4			*	twin		1900	R36
D	magnetic				10			*	twin		150	R37
D	magnetic				12			*	twin		50	R38
D	magnetic				12			*	twin		820	R39
D	magnetic				4			*	twin		290	R40

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	Low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							

D	magnetic	4			10	*		*		twin	145	S3
D	magnetic				22			*		twin	60	L6
D	magnetic			27	54			*	twin		400	R41-R50
D	magnetic				12			*	twin		1100	R51-R53
D	magnetic				6			*	twin		450	R54
Children and adolescent Dentistry unit												
D	magnetic				14			*	twin	twin	10	B4
D	magnetic				8			*	twin		135	R55
D	magnetic				8			*		twin	360	L7
D	magnetic				22			*		twin	145	L8
D	magnetic				4			*	twin		950	R56
D	magnetic				4			*	twin		750	R57
D	magnetic				4			*	twin		250	R58
D	magnetic		5		10		*	*		twin	385	S4
D	magnetic				4			*	twin		2000	R59
D	magnetic				8			*	twin		700	R60
D	magnetic			28	56			*	twin		710	R61-R66
D	magnetic				4			*	twin		1200	R67
D	magnetic				6			*	twin		620	R68
D	magnetic				4			*	twin		360	R69
D	magnetic				4			*	twin		800	R70
D	magnetic				4			*	twin		1000	R71
D	magnetic				4			*	twin		1100	R72

Table 1: Lighting specifications of different wards of the fourth floor of Al-Zahra Hospital

		number of lights	type of lamp	type of light		

ballast class	type of ballast fluorescent	string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in	Lux	room code
		100 watt	23 watt	20 watt	40 watt							
Maxillofacial surgery department												
D	magnetic				14			*	twin	twin	55	B1
D	magnetic				8			*		twin	90	L1
D	magnetic				4			*	twin		500	R1
D	magnetic	2	3		10	*	*	*		twin	180	S1
D	magnetic				4			*	twin		400	R2
D	magnetic				26			*		twin	50	L2
D	magnetic			29	58			*	twin		1200	R3-R11
D	magnetic				4			*	twin		500	R12
D	magnetic				6			*	twin		430	R13
D	magnetic				4			*	twin		200	R14
D	magnetic				4			*	twin		160	R15
D	magnetic				4			*	twin		255	R16
D	magnetic				4			*	twin		250	R17
Neonatal and pediatric surgery department												
D	magnetic				14			*	twin	twin	20	B2
D	magnetic				12			*	twin		225	R18
D	magnetic				8			*		twin	52	L3
D	magnetic				24			*		twin	100	L4
D	magnetic				4			*	twin		150	R19
D	magnetic				4			*	twin		240	R20
D	magnetic		5		10		*	*		twin	123	S2
D	magnetic				4			*	twin		350	R21
D	magnetic				4			*	twin		120	R22
D	magnetic				4			*	twin		400	R23
D	magnetic				4			*	twin		600	R24

D	magnetic				16			*	twin		50	L5
D	magnetic		21				*		-		250	R25-R29

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
D	magnetic				8			*	twin		80	L6
D	magnetic		15				*		-		-	R30
D	magnetic				12			*	twin		370	S3
Infectious diseases of adults												
D	magnetic				8			*		twin	52	L7
D	magnetic				4			*	twin		387	R31
D	magnetic	2	3		10	*	*	*		twin	230	S4
D	magnetic				26			*		twin	60	L8
D	magnetic			29	58			*	twin and single		975	R32- R33
D	magnetic				8			*	twin		430	R34-R45
D	magnetic				6			*	twin		765	R46
D	magnetic				4			*	twin		105	R47
D	magnetic				4			*	twin		344	R48
D	magnetic				4			*	twin		108	R49
Lung unit												
D	magnetic				14			*	twin	twin	55	B3

D	magnetic				8			*		twin	90	L9
D	magnetic				4			*	twin		500	R50
D	magnetic	2	3		10	*	*	*		twin	180	S5
D	magnetic				26			*		twin	65	L10
D	magnetic			29	58			*	twin and single		1200	R51- R60
D	magnetic				8			*	twin		500	R61- R62
D	magnetic				6			*	twin		430	R63
D	magnetic				4			*	twin		160	R64
D	magnetic				4			*	twin		255	R65
D	magnetic				4			*	twin		250	R66

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
Department of Nephrology												
D	magnetic				14			*	twin	twin	45	B4
D	magnetic				8			*		twin	85	L11
D	magnetic				4			*	twin		365	R67
D	magnetic	2	3		10	*	*	*		twin	186	S6
D	magnetic				26			*		twin	72	L12
D	magnetic			29	58			*	twin and single		1050	R68- R77
D	magnetic				8			*	twin		430	R78- R79

D	magnetic				6			*	twin		395	R80
D	magnetic				4			*	twin		179	R81
D	magnetic				4			*	twin		260	R82
D	magnetic				4			*	twin		220	R83
D	magnetic				4			*	twin		275	R84
Digestion section												
D	magnetic				8			*		twin	70	L13
D	magnetic				4			*	twin		285	R85
D	magnetic	2	3		10	*	*	*		twin	300	S7
D	magnetic				26			*		twin	76	L14
D	magnetic			29	58			*	twin		850	R86-R97
D	magnetic				8			*	twin		410	R98-R99
D	magnetic				6			*	twin		940	R100
D	magnetic				4			*	twin		220	R101
D	magnetic				4			*	twin		145	R102
D	magnetic				4			*	twin		123	R103
Selected surgery unit												
D	magnetic				8			*		twin	90	L15
D	magnetic				4			*	twin		400	R104
D	magnetic	2	3		10	*	*	*		twin	330	S8

ballast class	type of ballast fluorescent	number of lights				type of lamp			type of light		Lux	room code
		string	low consumption	fluorescent		string	low consumption	fluorescent	build-on	build-in		
		100 watt	23 watt	20 watt	40 watt							
D	magnetic				26			*		twin	110	L16

D	magnetic			29	58			*	twin and single		910	R105-R106
D	magnetic				8			*	twin		620	R107-R116
D	magnetic				6			*	twin		920	R117
D	magnetic				4			*	twin		135	R118
D	magnetic				4			*	twin		290	R119
D	magnetic				4			*	twin		146	R120