

Hasanuddin University Training Center and Convention Hotel Electrical Installation Study

Andi Muh Iqbal Firalidi
Department of Electrical Engineering
Hasanuddin University
Makassar, South Sulawesi
iqbalfiralidi10@gmail.com

Ansar Suyuti
Department of Electrical Engineering
Hasanuddin University
Makassar, South Sulawesi
asuyuti@unhas.ac.id

Fitriyanti Mayasari
Department of Electrical Engineering
Hasanuddin University
Makassar, South Sulawesi
fitriyantimaya@unhas.ac.id

Abstract—The increasing demand for electric power, especially in the field of electrical installations, requires a technically reliable plan. A good electrical installation system in the building must comply with the Indonesian National Standard (SNI) and General Electrical Installation Regulations (PUIL), so that electrical installations in buildings can work effectively and efficiently and can overcome disturbances that occur in the process of distribution network or distributing electricity to the building. The overall study of the electrical installation at the Training Center and Convention Hotel, Hasanuddin University aims to determine the feasibility of the electrical installation system with the most recent PUIL standards. The method used in this study started with collecting the data, calculating the required illumination value according to the function of each room, and determining the type of conducting CRC installed in the building. The results of this study for data processing obtained the number of required illumination values installed using the lumen method equation, where the number of armatures varies according to the function of each room. The diameter of the current carrying capacity (KHA) used in a conductor is NYM 5 x 185 mm², with the value of the current flowing in the main KHA is 389.22 A, and the total power used in the building is 221.781 Watt with installed loads such as air conditioners, lighting, and electric sockets. The control system, protection system, and earthing system contained in the building can be said to be operating correctly and meets PUIL 2011 standards.

Keywords—Electrical installation, General Electrical Installation Regulations (PUIL), Current Carrying Capacity (KHA), Electrical Conductor.

I. INTRODUCTION

Training center and the Hasanuddin University convention hotel is one of the campus facilities built on the banks of the Unhas Tamalanrea lake in the science and technology building complex. This facility consists of 7 floors which cause the need for electric power to increase. This additional burden must be supported by the provision of adequate electric power and a good electrical installation system in the construction of the Hasanuddin University training center and convention hotel by SNI and PUIL. the

electrical installation of the Hasanuddin University hotel, the determination of the Conductivity Capability (KHA) of the conductors and the components of the electrical installation must comply with the latest 2011 PUIL.

Construction of a Hasanuddin University training center and convention hotel which is one of the campus facilities where the building must comply with PUIL 2011 by Law no. 30 of 2009 concerning electricity. Broadly speaking, the construction of the Hasanuddin University training center and convention hotel requires quite a lot of electrical energy sources, therefore we can calculate that the electrical energy used can be fulfilled by the amount of power or load needed on a component in the building and safe in the use of electrical installations.

In this study, planning of the electrical installation system will be carried out at the Hasanuddin University training center and convention hotel by PUIL and SNI. System planning will use the main source from PLN and will also use a generator as a backup source which is operated automatically and controlled by ATS (Automatic Transfer Switch). Then an electrical installation planning system will be carried out using the lumen method to calculate the illumination system with conducting KHA which will be used per PUIL 2011 provisions and using Microsoft Excel as software to input the data that has been obtained.

II. LITERATURE REVIEW

A. Electrical Power Distribution System

Power plants such as PLTA, PLTU, PLTG, PLTP, and PLTD are channeled through the transmission network where the voltage is increased by using a step-up transformer at the generator. The amount of voltage that is supplied to the high-voltage network in a generator through a transmission line with a voltage of 70 kV, 150 kV, and 500 kV for high-voltage overhead lines is then channeled through a distribution network where the voltage is lowered to a low voltage of 380/220 V, then it will be distributed to residential and large buildings. [1].

B. Electrical installation

Is a conductor of electricity or electrical equipment and components installed in a building that is connected to a power source. Design of an electrical installation with PUIL

2000 provisions and related regulations regarding the installation of an electrical installation. [2].

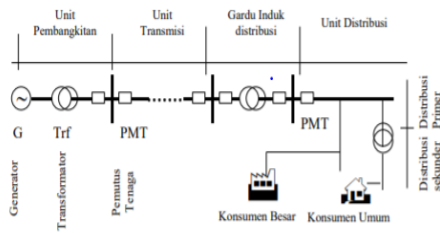


Figure 1. Power Distribution Grouping System

The installation of electric lighting in a building is a source of electrical energy that is channeled to equipment or component by providing electrical power such as lighting, for example, lamps, where the light produced by the lamp can illuminate the place according to its needs. In electrical installations that we can often encounter, there are 2 types, namely installations inside buildings and outside buildings. Where is the installation in buildings such as living rooms, rooms, and toilets. For outdoor installations such as street lighting. [3].

C. Basic Principles of Electrical Installation

The basic principles must exist in an electrical installation so that equipment or components can be connected to the installation of a building that is safe from damage. some basic principles in electrical installations, namely:

- Security
Installation of electrical installations for the safety of living things and equipment or components of other electrical installations that are used when there are disturbances that occur such as short circuits, leakage currents, or overloads.
- Reliability
To overcome damage to electrical installation equipment within normal limits, and easy to understand when operations are carried out under normal and emergency conditions. Thus, the installation of electrical installations must be planned and installed in a safe condition where there is no flowing electricity.
- Availability
That is, by providing sufficient backup resources in case of additional electrical installation power in the future.
- Beauty
That is, electrical installations with components and other equipment installed must be neat and look beautiful following applicable regulations.
- Environmental Influence
Therefore, if an installation or part of an installation is located in a place subject to abnormal external influences, adequate protection is required. Therefore, the installation of electrical installations must have an appropriate calculation and analysis plan [2].

D. Lighting

Lighting is needed by humans to illuminate a place to recognize an object directly. The quality of the lighting level influences an object, and both high and low lighting can affect the objects we can see. Luminance is the intensity And brightness of the light. Although nits are The same, the difference between both of them is illumination Which is generated by source light whereas luminance is illumination Which is influenced by factor other. [4]

E. delivery

A conductor or cable is needed to supply loads and components or equipment in electrical installations so they can function properly. Therefore, the conductor is the most important component in an electrical installation. Installation of electrical installations must require conductors that match the size and diameter of the KHA that are connected to the load that is supplied and y the applicable PUIL so that the electrical installation system remains safe and also the quality of equipment or other electrical component is guaranteed safety.

As for the equipment or components of the electrical installation, an electrical installation design is needed in an electrical circuit, namely the control circuit and the power circuit where the function of the circuit is to carry out system functions by the working principle of the equipment. As for types of conductors or cables that we can encounter or often see in electrical installations such as those found in large buildings or small buildings, for example in hotels or industries using NYM, NYA, and so on. [2].

F. Safety

In electrical installations, there is a component called safety or protection which is useful for protecting electrical equipment from things that we don't want due to disturbances such as overload or shortcircuits. The use of protection is very important to prevent damage to electrical installations caused by heat due to overload or short circuits. Some safety components that are commonly used in electrical installations for lighting are:

- MCB (Miniature Circuit Breaker)
In the thermal component (bimetal), there is an electrical circuit breaker or MCB type safety which functions to protect the electrical circuit when an overload occurs. Apart from that, there is also an electromagnetic relay that acts as a safeguard in the event of a short circuit in an electrical circuit.
- MCCB (Molded Case Circuit Breaker)
It is a component in power electrical installations that has the same working principle as the MCB, namely to protect equipment and electrical installation components in the event of a short circuit and limit the increase in current due to an increase in load. The main difference between MCCB and MCB is their shape. Where the MCB for three phases consists of three connected single-phase MCB units, while the MCCB also has three phase terminals in one casing.
- ELCB (Earth Leakage Circuit Breaker)
ELCB is a type of electrical safety that works by cutting off electricity when an electric leak is detected on the ground or ground. The ELCB can also function as an electric circuit

breaker if the human body is connected to grounding when touching equipment that has an electric current. The working principle of the ELCB is to detect leakage of electric current in-ground faults or ground faults.

G. Switch

Is an electrical equipment that functions as a breaker and liaison device for the flow of electricity from a source to a load. The switch as a component of the electrical installation plays a very important role in disconnecting or connecting from the source to the light load. The switches have various types, for example in lighting installations, high voltage, power installations, etc. But in the world of electricity where electrical installation components can be found in everyday life, such as at home, on campus, in hotels, and other public places. There are various kinds of switches along with single diagrams and wiring diagrams, ranging from single, series, exchange and cross switches that we can see in buildings such as hotels, housing, and industry.

H. Earthing System

Earthing is a protection for a component or device in an electrical installation in the event of an overload current. This earthing system connects an equipment or electrical installation component with the earth. In terrestrial systems, we first know that a system is a set of components and elements combined to achieve a specific goal. The grounding system is a circuit or network that arises from a grounding rod or connecting electrode of a cable or conductor to a grounding terminal, whose function is to drain excess current to the ground to protect humans from electric shock (shock) and to secure the installation of parts in the ground. so that it is protected from external current and voltage hazards and the device can be operated following the relevant technical regulations. The standard value refers to PUIL 2000 with applicable regulations, namely less than 5 ohms. We can state that at a value of 5 ohms, this is the maximum value of grounding resistance or the highest limit that can still be tolerated. Values in the range of 0 – 5 ohms are still safe for electrical installation devices or components.

III. RESEARCH METHODOLOGY.

A. Place of Research Implementation

This research took place on the Hasanuddin University Campus, namely at the Unhas training center and convention hotel located on Jl. Independence pioneer No. km. 10, Tamalanrea Indah, Tamalanrea District, Makassar City, South Sulawesi, where the building is located on the Hasanuddin Tamalanrea University campus to be precise on the shores of the Hasanuddin University lake.

B. Data collection and processing methods

In the collection And processing of data For writing work, several methods are to be used To obtain information needed in the study This. As for the method used writer For make work, this is:

- Interview
Conducting interviews with related parties to obtain data related to the object to be examined regarding the

electrical installation of the Training Center and Convention Hotel, Hasanuddin University.

- Data collection techniques
Primary data collection was carried out by collecting data obtained at the research location and secondary data, namely data that already exists in references such as those found in PUIL.
- Data analysis
Perform analysis of the data that has been obtained and then input it into Microsoft Excel to calculate the illumination and CRC standards used related to the object to be studied.
- Study of literature
Namely by collecting information from various media such as books, the internet, and some other information related to the material discussed in this study.

C. Data analysis method

This data analysis method is used for the electrical installation of the Unhas training center and convention hotel with the data obtained first put together and inputted into Microsoft Excel then determines the illumination in each room for the calculation of the lighting system using the lumen method formula with a standard KHA conductor that attached to each load and calculate the voltage loss in the building.

- Using Microsoft Excel
In using this Microsoft Excel software, where the data that has been obtained is then collected first to analyze the lighting system at the Unhas hotel training center and convention in several rooms and input into Microsoft Excel and then calculate the illumination using the lumen method.
- Calculation of the illumination system using the lumen method
Calculation of the illumination system using the lumen method requires data for each room such as the length of the room, the width of the room, the height of the lamp from the floor, the wall reflectance, the type of lamp used, and the amount of illumination needed for each room.

The steps used to determine the level of lighting in a room are given in Equation (1):

$$k = \frac{pl}{h(p + l)} \tag{1}$$

And determine the number of light units with Equation (2):

$$n = \frac{EA}{\phi hd} \tag{2}$$

- Calculate and determine the type of conducting CRC used
To determine the type of conducting CRC to be used in electrical installations in the Unhas hotel training center and convention building with a three-phase voltage source using Equation (3):

$$I = \frac{P}{\sqrt{3} V \cos \phi} \tag{3}$$

Because the building requires a large enough power that is used in electrical installation components or equipment.

- Calculate the voltage drop
In the distribution of electric power contained in the electrical installation system, there will be a difference between the voltage on the source side and the load side. Calculate the voltage drop using Equation (4).

$$\Delta U = \sqrt{3} I l (R L \cos \cos \varphi + X L \sin \sin \varphi) \quad (4)$$

Because the building is large, it uses 3-phase voltage.

D. Research flow

The research flow used in the electrical installation of the Unhas training center and convention hotel, is s shown in the following steps:

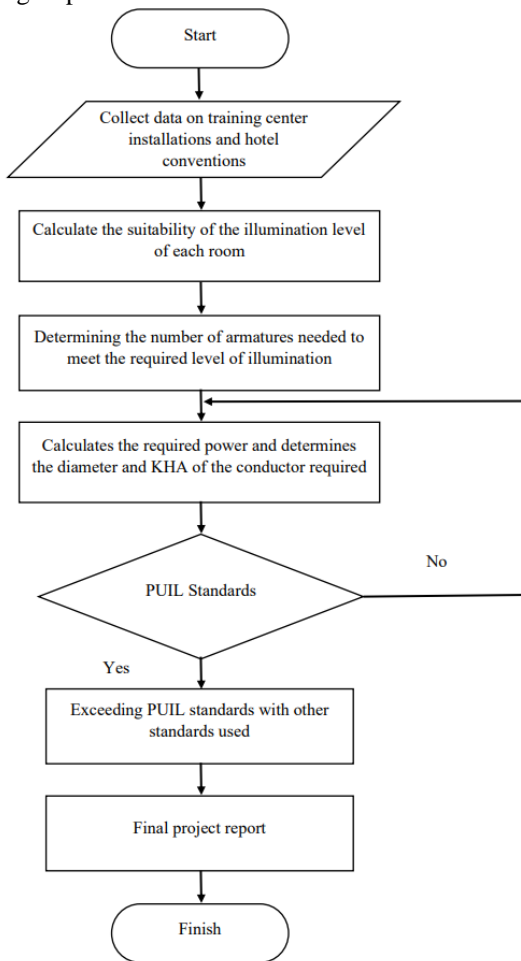


Figure 2. Research Flowchart

- Data collection
The data that has been obtained and inputted into Microsoft Excel is then calculated manually to calculate the illumination value and standard CRC by PUIL.
- Calculate the appropriate level of illumination for each room
Calculations using the lumen method require data such as the length of the room, the width of the room, the height of the lamp from the floor, ceiling reflectance, wall reflectance, and the type of lamp used in each room.
- Determine the number of armatures required

Then determine the number of armatures that will be needed for each room to meet the lighting level based on the function of the room.

- Calculate the power and determine the diameter of the conductor KHA
Then calculate the power and determine the diameter of the conducting KHA type according to PUIL standards which will be used in the construction of the Unhas training center and convention hotel.
- PUIL standard
If the installation of electrical installations in the construction of the Unhas training center and convention hotel is not by PUIL standards, then the calculation and determination of the diameter and type of conductor material that has been used already use another standard.
- Exceed PUIL standards
Installation of electrical installations at the training center and convention hotel Unhas if it exceeds the PUIL standards will use other standards used in the development.

IV. RESULTS AND DISCUSSION

A. Single Line Diagram of the Unhas Training Center and Convention Hotel generating system

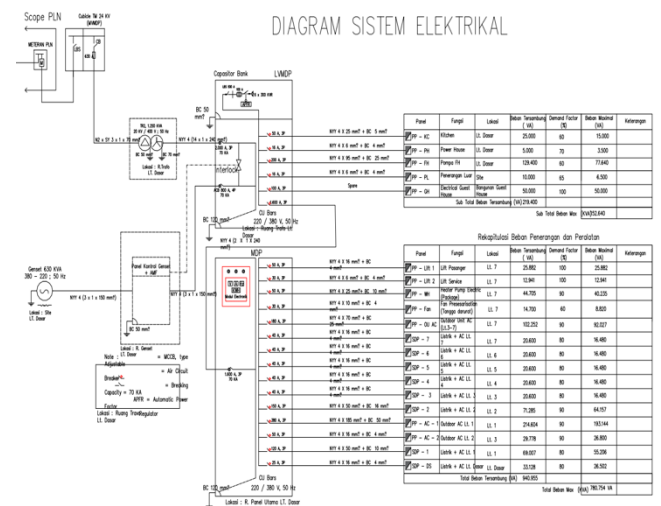


Figure 3. Electrical System Diagram

The generator system at the Unhas training center and convention hotel which is supplied by PLN as the main source of electricity is connected to the TM 24 KV cubicle (MVMDP) then the voltage is channeled from the MVMDP to the transformer with a voltage of 20 kV then the voltage from the transformer is reduced to 1 phase and 3 phases namely 220/380 V. The output from the transformer is then channeled to the capacitor bank and incoming LVMDDB. Then there is also a generator that functions as a backup source in the event of a power outage which is equipped with an ATS/AMF system where the generator is also connected to a capacitor bank. Then from the capacitor bank, it is channeled to each room using PHB with the amount of KHA used following PUIL standards and also the safety system used for each component or electrical equipment.

B. Calculation of Illumination System Using the Lumen Method

- Ballroom Illumination Calculation Example

For the calculation of illumination in the ballroom, where this room is the widest part because it requires maximum lighting, an example of calculating illumination is taken.

Table 1. Ballroom Data

Parameter	Data
Length (L)	16m
Width(L)	16m
Lamp Height from Floor	6m
Ceiling reflectance (pc)	White
Wall reflectance (pw)	White
The type of lamp used	Downlights50W LEDs
Luminous flux for the type of lamp used	3750 Lumens
Appropriateness of illumination required for the room	300 Lux

To determine the spatial index or form index (k) in this ballroom, the lights are mounted on the ceiling, and the distance from the floor to the working plane is usually 0.8 m, so $h = 6 - 0.8 = 5.2$. And by using Equation (1), obtained:

$$k = \frac{pl}{h(p + l)} = \frac{16 \times 16}{5,2 (16 + 16)} = 1,53 \text{ m}$$

Large Maintenance Factor (MF) in this building where the room (Ballroom) is considered good or in the sense that it is considered clean then choose MF = 0.8

Luminous flux value Then the required luminous flux by modifying Equation (2) is obtained at 259459.45 Lumens. While the number of lamp armatures in determining the number of armatures needed in the room obtained $69.1 \approx 69$ Armatures

C. Calculation Analysis for Suitability of Illumination Level for Lighting Usage and Number of Armatures required for Illumination Level

Table 2. Calculation of the Lumen Method and the Number of Armatures needed for the Lighting Level in the Room

Floor	Room Name	Necessity (Lux)	Armature (Fruit)
ground	Warehouse	150	8
	Laundry	150	9
	parking area	100	45
	Pump Room	150	5
	LT Ground Panel Room	100	3
	Transformer Room	150	5
	Cubicle Space	150	5
	PLN Room	150	5
	Genset Room	150	5
	Kitchen	500	24
	prayer room	150	5
	Toilet	100	6
1st floor	Ballrooms	300	69
	Hall Ballroom	300	69
	1st Floor Panel Room	100	3
	Toilet	100	6

D. Hasanuddin University Training Center and Convention Hotel Room Data

Training center and the Unhas convention hotel is one of the campus facilities built on the shores of the Unhas Tamalanrea lake, a science, and technology building complex consisting of 8 floors. Where each floor has different rooms with their respective functions. The purpose of the specifications for the Unhas training center and convention hotel is to determine the occupancy information offered in each room. Where by making a table of specifications for the Unhas Training Center and Convention Hotel, we can find out the load installed per room in this building, so we can also find out the total overall load used in the Hasanuddin University training center and convention hotel.

Table 3. Ground Floor Load Specifications

No	Room	Burden							Stop Contact 200 VA	Total Power (Watts)
		AC (pk)			Lamp (Watts)					
		1	1.5	2	7	9	13	18		
1	Warehouse	2	-	-	-	-	-	8	2	2184
2	laundry	2	-	-	-	-	-	9	3	2362
3	Panel Lt. ground	-	-	-	3	-	-	-	1	181
4	Pump Room	-	-	-	-	-	-	5	-	250
5	parking area	-	-	-	-	-	45	-	-	585
6	prayer room	2	-	-	-	-	5	-	2	2105
7	Kitchen	-	3	-	-	-	-	24	5	4502
8	Transformer Room	-	-	-	-	-	-	5	2	410
9	cubicle	-	-	-	-	-	-	5	2	410
10	PLN Room	-	-	-	-	-	-	5	2	410
11	Genset Room	-	-	-	-	-	-	5	2	410
12	Toilet	-	-	-	6	-	-	-	-	42
Total Power (Watts)										13851

Table 4. Floor Load Specifications 1

No	Room	Burden							Stop Contact 200 VA	Total Power (Watts)
		AC (pk)			Lamp (Watts)					
		1	1.5	2	7	9	13	18		
1	Ballrooms	-	-	8	-	-	-	60	8	18650
2	Hall Ballroom	-	-	6	-	-	-	60	6	14400
3	Panel Room L1	-	-	-	3	-	-	-	1	181
4	Toilet	-	-	-	6	-	-	-	-	42
Total Power (Watts)										33273

Table 5. Floor Load Specifications 2

No	Room	Burden							Stop Contact 200 VA	Total Power (Watts)
		AC (pk)			Lamp (Watts)					
		1	1.5	2	7	9	13	18		

1	Restoran	-	-	5	-	-	66	-	4	10120
2	Salon	2	-	-	-	-	-	10	2	2220
3	Panel Room L2	-	-	-	3	-	-	-	1	181
4	Bartenders	-	-	3	-	-	91	-	5	7203
5	Gym	2	-	-	-	-	-	27	2	2526
6	meeting 1	-	2	-	-	-	-	4	2	2572
7	meeting 2	-	2	-	-	-	-	4	2	2572
8	Meeting 3	-	2	-	-	-	-	4	2	2572
9	meeting 4	-	2	-	-	-	-	4	2	2572
10	meeting 5	-	2	-	-	-	-	4	2	2572
11	Toilet	-	-	-	6	-	-	-	-	42
Total Power (Watts)										35152

Table 6. Floor Load Specifications 3-7

No	Room	Burden							Stop Contact 200 VA	Total Power (Watts)
		AC (pk)			Lamp (Watts)					
		1	1.5	2	7	9	13	18		
1	Panel Room L3	-	-	-	3	-	-	-	1	181
2	Room A	-	1	-	-	-	10	-	2	1540
3	Room B	-	1	-	-	-	10	-	2	1540
4	Room C	-	1	-	-	-	10	-	2	1540
5	Room D	-	1	-	-	-	10	-	2	1540
6	Room E	-	1	-	-	-	10	-	2	1540
7	Room F	-	1	-	-	-	10	-	2	1540
8	Room G	-	1	-	-	-	10	-	2	1540
9	Room H	-	1	-	-	-	10	-	2	1540
10	Room I	-	1	-	-	-	10	-	2	1540
11	Room J	-	1	-	-	-	10	-	2	1540
12	Room K	-	1	-	-	-	10	-	2	1540
13	Room L	-	1	-	-	-	10	-	2	1540
14	Room M	-	1	-	-	-	10	-	2	1540
15	Room N	-	1	-	-	-	10	-	2	1540
16	Room O	-	1	-	-	-	10	-	2	1540
17	Room P	-	1	-	-	-	10	-	2	1540
18	Room Q	-	1	-	-	-	10	-	2	1540
19	Room R	-	1	-	-	-	10	-	2	1540
Total Power (Watts)										27901

E. Delivery Selection

In the conductor selection section, we can see in Table 7 by determining the diameter of the ACC to be used in the rooms in the building and also the diameter of the main ACC to be used from the PLN source to other loads.

Table 7. Determination of CRC and Floor Panel Security

No	Room	S (W)	V	Cos	in (A)	CRC	Peng send (mm ²)	Peng safe (A)	Ket
1	Warehouse	464	220	0.9	2,3	2,9	2,5	4	MCB
2	Laundry	642	220	0.9	3,2	4	2,5	6	MCB
3	G Floor Panels	181	220	0.9	1,0	1,3	2,5	2	MCB
4	Pump Room	250	220	0.9	1,3	1,7	2,5	2	MCB
5	parking area	585	220	0.9	3,0	3,8	2,5	4	MCB
6	prayer room	385	220	0.9	2,0	2,6	2,5	4	MCB
7	Kitchen	1232	220	0.9	6,2	7,8	2,5	10	MCB
8	Transformer Room	410	220	0.9	2,1	2,7	2,5	4	MCB
9	cubicle	410	220	0.9	2,1	2,7	2,5	4	MCB
10	PLN Room	410	220	0.9	2,1	2,7	2,5	4	MCB

11	Genset Room	410	220	0.9	2,1	2,7	2,5	4	MCB
12	Warehouse AC	1720	380	0.9	5,0	6,3	2,5	6	MCB
13	AC Laundry	1720	380	0.9	5,0	6,3	2,5	6	MCB
14	AC Mushollah	1720	380	0.9	5,0	6,3	2,5	6	MCB
15	Kitchen Ac	1720	280	0.9	9,6	12	2,5	16	MCB

Main KHA = Biggest KHA + Other Nominal Currents
 = 7,8+(2,9+4+1,3+1,7+3,8+2,6+2,7+2,7+2,7+2,7+6,3+6, 3+6,3+1
 = 65.8 A

By PUIL, the diameter for the conductor used in the main/main panel is NYM5 x 185 mm².

F. Calculation of Voltage Drop

For counting on drops voltage on something building, Where decline voltage between connection burden with point anywhere on installation electricity No can exceed 5% by PUIL standard. And calculated the voltage drop when the load is farthest from the main panel. which is connected to the load through the panel on the 7th floor. Then look for the voltage drop from the main panel to the 7th-floor panel according to Equation (4).

Assumption $\cos\phi = 0.9$ using the diameter of the NYY conductor KHA 4 x 2.5 mm²

And assuming the distance between the main panel to the 7th-floor panel is 50 m, then it obtained drop voltage (Δu) = 32.1 V or 8.44%.

From the results obtained, decline voltage does No fulfill standard PUIL. So mitigation is needed to minimize fall voltage on delivery electricity, that is, with enlarged diameter size CRC is used.

V. CONCLUSION

After performing calculations using the lumen method, the required illumination value in the Ballroom room is 300 lux with a light flux of 3750 lumens. When compared to the illumination installed in the ballroom, it is by PUIL 2011 standards by requiring 69 armatures because the room is quite large.

Based on the calculation of the conductor KHA in the main panel, the KHA value is 389.22 A. From this calculation, we can determine the type of conductor used, namely NYM with a conductor diameter of 185 mm². Meanwhile, for the conductors used in each room, for example in the laundry room which is on the ground floor with a 4 Ampere ACC, an NYM-type conductor with a diameter of 1.5 mm² is required. Meanwhile, the diameter of the conductor chosen, namely NYM 3 x 2.5 mm², is by the PUIL standard so that if there is a small voltage drop on the conductor and also as preparation, if there is additional power in the future.

Overall, based on the results of research or analysis, the electrical installation system for the Unhas training center and convention hotel can be said to be by PUIL 2011 standards.

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