Study of Electrical Installation Planning at Pratama Jagoi Babang Hospital

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ABSTRACT
Planning for Jagoi Babang Pratama Hospital is a Regional General Hospital owned by the Government which is located in Jagoi Babang District, Bengkayang Regency, West Kalimantan Province. Jagoi Babang Primary Hospital has a total land area of 10,275 m². The Study of Electrical Installation Planning at Pratama Jagoi Babang Hospital will be carried out in Building C, which at the time this research was appointed, development planning was being carried out and the location of Building C was on the 1st floor. The construction of this hospital is very dependent on electrical installations, especially lighting and air conditioning installations to support the needs of hospital staff and patients. For the smooth running of hospital activities, calculations are needed to design correct and proper electrical installations, according to the Indonesian National Standard based on the 2011 General Electrical Installation Requirements (PUIL) in section 23. In planning the electrical installation of Pratama Jagoi Babang Hospital, researchers made several calculations, namely lighting illumination, air conditioning capacity, safety size, cross-sectional area, total load, and voltage drop. Based on the results of calculations and analysis of the number of lamps counted, 470 lamps were obtained with the type of DL LED 14 Watt, TL LED 18 Watt. Then the total load required is 8168 Watt = 8.168 kW while for planning Air Conditioners with a total load required is 140.633 kW with a total of 35 Air Conditioners.

1. INTRODUCTION
The hospital is one of the public service facilities in the health sector where the function of the hospital itself is to serve the community such as consultations regarding health, checking, caring for and healing patients who experience health problems. So, with this it was designed "Electrical Installation Planning Study at Jagoi Babang Pratama Hospital" which will assist the community in dealing with health problems where this hospital will provide comfortable and safe facilities in treatment and care services for the community, specifically in the border area and its surroundings.

Jagoi Babang Pratama Hospital is a government-owned regional general hospital and is a type D hospital located in Jagoi Babang District, Bengkayang Regency, West Kalimantan Province. Jagoi Babang Primary Hospital has a total land area of 10,275 m² with 2 floors. The Electrical Installation Planning Study at Pratama Jagoi Babang Hospital will be carried out in Building C which at the time this study was carried out development planning and the location of Building C is on the 1st floor.

The construction of this hospital is very dependent on electrical installations, especially lighting and air conditioning installations to support the needs of hospital staff and patients. For the smooth running of hospital activities, calculations are needed to design correct and proper electrical installations, according to the Indonesian National Standard based on the 2011 General Electrical Installation Requirements (PUIL) in section 2 regarding electrical installation design and Regulation of the Minister of Health of the Republic of Indonesia Number 24 of 2016 concerning technical requirements for hospital buildings and infrastructure as stated in article 23, so that good, comfortable, and quiet service can be achieved for the users of the hospital [1],[6],[8]. General Provisions for Electrical Installation Planning, in planning electrical installations there are provisions in the form of regulations which are mentioned as follows:
1. Regulation of the Minister of Health of the Republic of Indonesia number 24 of 2016 concerning technical requirements for hospital buildings and infrastructure in article 23.
2. General Requirements for Electrical Installation (PUIL) of 2011 in section 2 regarding electrical installation design.
2. LITERATURE REVIEW

2.1 Previous research

As for some previous studies or similar research that has existed before that became the material for the preparation of this thesis.

Research conducted by Budi Mustafa. Thesis for 2017 Electrical Engineering Students at the Muhammadiyah University of Surakarta entitled "Design of the Electrical Installation of the Alisha Rahman Sejahtera Hospital Karawang Building" in which it stated that this study made a line diagram for planning electrical installations, determining the light points, determining the capacity of the AC (Air Conditioner) and determine the capacity of the water pump and determine the main safety measure at the Alisha Rahman Sejahtera Hospital, Karawang. Which is where this design uses the AutoCAD application [3].

Research conducted by Arif Dermawan. Journal of 2017 Electrical Engineering Students at Tanjungpura University entitled "Evaluation of Lighting Installation Planning for Hotel Neo By Aston Pontianak" in which it states that this research evaluates lighting installation plans in which in this study it compares planning for the number of lights installed against calculating the number of lights needed [7].

Research conducted by Asrul Azmi. Thesis for 2018 Electrical Engineering Students at Tanjungpura University entitled "Study of Electrical Installation Requirements Planning at Jeumpa Maternity Hospital in Pontianak City" which states that this research plans electrical and air conditioning installations and calculates the total power [2].

Research conducted by Ardi Hartono. The 2019 thesis, Electrical Engineering Students, Yogyakarta State University entitled "Planning of Lights and Sockets Installation for the New EOP (Export Oriented Product) Production Plant Building at PT. Mega Andalan Kalasan” in which it states that this research is to find out the planning for lighting installations (lamps), sockets at production sites (factories) that are correct and according to standards so that they can meet the lighting needs of the building and find out the amount of power needed to meet load requirements. in the EOP building at PT. Mega Andalan Kalasan and to compare the results of the installation planning carried out by the company with the calculated installation planning [4].

The difference between this research and previous studies is that this research was conducted in a different place, namely in building C of the Jagoi Babang Pratama Hospital. This study determines the lighting points, AC capacity, safety large, cross-sectional area, total load and calculates the voltage drop and this research uses manual calculation simulations and uses Microsoft Office Excel software, while for AC capacity uses Heatload software based on the Regulation of the Minister of Health of the Republic of Indonesia Number 24 of 2016 concerning technical requirements for hospital buildings and infrastructure and General Electrical Installation Requirements (PUIL) 2011.

2.2 General Description of Electrical Installation Planning

In planning electrical installations there are provisions in the form of regulations which are mentioned as follows:

1. Regulation of the Minister of Health of the Republic of Indonesia number 24 of 2016 concerning technical requirements for hospital buildings and infrastructure in article 23.
2. General Requirements for Electrical Installation (PUIL) of 2011 in section 2 regarding electrical installation design.

From the regulations mentioned above, the Regulation of the Minister of Health of the Republic of Indonesia number 24 of 2016 concerning technical requirements for hospital buildings and infrastructure regulates the level of lighting intensity (lux) needed in each room, if there is no lighting level (lux) in the regulation then it can refer to the General Electrical Installation Requirements (PUIL) of 2011 [1],[5].

2.3 Electricity system

2.3.1. Share Link Panel

Connection Equipment (PHB) is an equipment to share electric power or control and protect circuits and electricity beneficiaries including circuit breaker switches, low voltage switchboards and so on. Types of Connecting Equipment According to their needs, PHB is divided into 2 types, namely:

1) Main PHB is a PHB that receives the flow of electric power and sources through the consumer's main switch and distributes the electricity to all user devices in the consumer's installation.
2). PHB Sub-Installation or PHB Branch is PHB from an installation to supply electricity to one consumer and the installation is part of an installation that supplies one or more consumers.

2.3.2. Sender/Cable

The conductor/electrical cable to be used must meet the requirements such as being able to withstand electrical, mechanical, thermal and chemical resistance. In addition, it can also deliver maximum current and must have the smallest possible losses. Here are some types of conductors/cables that are commonly used in electrical installations [9],[10]:

a. NYA
b. NYM
c. NYY
d. NYCY
e. NYAF

2.3.3. Light

The main component in lighting which is the last point in a lighting installation, serves as a source of light in rooms that need adequate lighting. There are many types of lamps that are often installed in homes, industrial buildings, and other buildings. The following types of lamps are often installed (popular) for lighting installations [9],[10].

a. Incandescent lamps
b. TL Lamp (Tubular Lamp)
c. Lampu LED (Light)
d. LED Downlight

2.4 Determine the Number of Lights

The technique of determining the number of lights is by paying attention to the appearance of the color which is described by the color temperature and the effect of the color on the object being illuminated which is explained by the color index number and also the efficiency of the room [9],[10],[11].

2.4.1. Space Index

The room index or form index expresses the comparison between the main dimensions of a square-shaped room, which is formulated by the following equation:

$$ R_k = \frac{p \times l}{h(p+l)} $$  \hspace{1cm} (1)

Where:
p = Length of room (m)
l = Width of the room (m)
h = Height of the light source to the work area (m)

2.4.2. Space Efficiency

Room efficiency can be determined with the lighting efficiency table by finding the right room index value (k). If the value (k) is not found correctly in the existing table of lighting systems, efficiency and depreciation, then the room efficiency is obtained by the interpolation method, namely [10]:

The formula for calculating room efficiency is:

$$ \eta = \eta_1 + \frac{k-k_1}{k_2-k_1}(\eta_2-\eta_1) $$  \hspace{1cm} (2)

Where:
\eta_1 = utility factor lower limit
\eta_2 = upper limit utility factor
k = Index of the room to be determined
k_1 = Lower limit room index
k_2 = Upper limit room index

2.4.3. Light

After determining some of the parameters above, the following equation is used to find the number of lights:

$$ n = \frac{E \times A}{\text{armatur} \times \text{AND}} $$  \hspace{1cm} (3)

Where:
AND = Illumination intensity (lux)
∅  = Luminous flux (lumens)
A  = Unit area (m²)
η  = Room efficiency
d  = Depreciation factor

2.4.4. Power Requirements

To calculate the power requirement from the number of lamps obtained is as follows:

\[ W_{\text{total}} = \text{Number of Lights} \times W_{\text{ Lights}} \] (4)

2.5 AC Capacity Calculation (Air Conditioner)

Air Conditioner (AC) or air conditioning device is a modification of the development of engine cooling technology. This tool is used to provide cool air and provide the moisture needed for the body. To be able to produce air with the desired conditions, the equipment installed must have a capacity that matches the cooling load that the room has. For this reason, a survey is needed and determines the amount of cooling load[9]. The formula used to calculate the power requirements of the Air Conditioner is:

\[ W = Jumlah \ AC \times AC \ power \] (5)

2.6 Determine the Cross-sectional Area

The nominal load current (In) passing through a conductor can be calculated using the following formula:

For single phase alternating current:

\[ I_n = \frac{P_0}{IN \times \cos \phi} \text{ Ampere} \] (6)

For three-phase alternating current:

\[ I_n = \frac{P_{3\phi}}{\sqrt{3} \times IN \times \cos \phi} \text{ Ampere} \] (7)

Where:

\( p_0 \) = Power of one phase (watts)
\( p_{3\phi} \) = Three-phase power (watts)
\( V_L \) = Tegangan phase-phase (volt)
\( V_r \) = phase-neutral voltage (volts)
\( \cos \phi \) = Power factor

Current-carrying strength (KHA) in the final circuit is determined by the formula:

\[ KHA = 125\% \times I_n \] (8)

Calculating the final circuit overcurrent protection rating is determined by the formula:

\[ I_{rat} = 115\% \times I_n \] (9)

Where:

KHA = Strong Current Delivery (ampere)
\( I_{rat} \) = Protection rating (amperes)
In = Nominal load current (amperes)

2.7 Calculation of Voltage Drop

Voltage drop is the amount of voltage lost in a conductor. The voltage drop on electric power lines is generally directly proportional to the length of the line and the load and inversely proportional to the cross-sectional area of the conductor [9],[10],[11]. In this discussion what is meant by voltage drop (\( \Delta V \)) is the difference between the sending voltage (Vs) and the receiving voltage (Vr), then the voltage drop can be defined as:

\[ \Delta V = (V_s) - (V_r) \] (10)

The relative voltage drop is called the voltage regulation VR (Voltage Regulation) and is expressed by the formula:

\[ VR = \frac{Vs - Vr}{Vr} \times 100\% \] (11)

Where:

Vs = voltage at the sending end
Vr = voltage at the receiving end

In simplifying the calculation, it is assumed that the loads are balanced phase loads and the power factor is between 0.53 to 0.85. The voltage drop can be calculated based on the relationship approach formula as follows [12]:

\[ \Delta V = I (R \cdot \cos \phi + X \cdot \sin \phi)L \] (12)

Where:
3. RESEARCH METHODOLOGY

3.1 Place and time of research
This research was conducted at Jagoi Babang Pratama Hospital located in Jagoi Babang District, Bengkayang Regency, West Kalimantan Province and this research was carried out for 6 months.

3.2 Tools and materials
1. Laptops and support applications, namely AutoCAD, Microsoft Office Excel and Heatload Software.
2. A flash disk used to store data.
3. Calculator and stationery.

3.3 Research methods
1. Study Literature
   Literature study is the author's study of existing references in the form of books, scientific papers related to this writing, which can later be used in guidelines for making research reports.
2. Analytical Descriptive
   Analytical Descriptive, which describes in full the results of the calculations from the planning, where later the results obtained can be used as a comparison suggestion with the Indonesian National Standard which refers to the Regulation of the Minister of Health of the Republic of Indonesia Number 24 of 2016 and the General Regulations for Electrical Installation (PUIL) of 2011.

3.4 Variables or Research Data
In this study the data referred to are in the form of hospital drawings and plans, room sizes, electrical loads, and regulations that will be used in this study.

3.5 Research procedure
1. Preparation phase
   a. Doing a literature study, and descriptive analytic.
   b. Collecting drawing data or planning plans, the size of the room to be used in Building C, Pratama Jagoi Babang Hospital.
2. Level of Implementation and Calculation
   a. Performing illumination calculations according to Indonesian National Standards can use the formula equation 2.1 to calculate the spatial index, equation 2.2 to calculate room efficiency, equation 2.3 to calculate the number of lamps and equation 2.4 to calculate power requirements.
   b. As for the calculation of AC capacity (Air Conditioner) can use the Heatload Software application.
   c. Calculating the cross-sectional area and size of the safety as well as the voltage drop according to the Indonesian National Standard can use the formula equation 2.7 for the cross-sectional area of 1 phase and 2.8 for the cross-sectional area of 3 phases. For KHA (Current Conductivity) use equation 2.9 and to calculate the final circuit overcurrent protection rating use equation 2.10 while for voltage drop use equation 2.14.
3. Level of Analysis and Conclusion
   a. Perform calculation analysis based on the calculation results obtained.
   b. Making conclusions and suggestions on this research.

3.6 Results Analysis
Based on observations in the Islamic Middle School and High School Al-Azhar Pontianak buildings which still use energy-efficient lamps and AC, an analysis can be carried out regarding differences in electrical energy consumption, if the building uses energy-saving lamps and AC.

3.7 Flowchart
4. ANALYSIS AND CALCULATIONS

4.1 Calculation of the Number of Lights in Building C at Jagoi Babang Primary Hospital

1. Inpatient Building Corridor
   a. room data
      Room length\(p\) : 25.5 m
      Room width\(l\) : 2.5 m
      Room height\(t\) : 3 m
      High field of work\(h\) : 2 m \((t - 1m)\)

   b. Space Index
      Using equation (2.1) the room index is determined:
      \[ R_k = \frac{P \times L}{h \times (p + l)} \]
      \[ R_k = \frac{25.5 \times 2.5}{2 \times (25.5 + 2.5)} \]
      \[ R_k = 1.13 \]

   c. Room Efficiency

**Figure 1. Flowchart System.**
From the calculation of the room index with a direct lighting system, for room efficiency values refer to table (2.3) and to obtain lighting efficiency use equation (2.2) as follows:

\[ k_1 = 1 \quad \eta_1 = 0.39 \]
\[ k_2 = 1.2 \quad \eta_2 = 0.43 \]

\[ \eta = \eta_1 + \frac{k-1}{k_2-k_1} (\eta_2 - \eta_1) \]
\[ \eta = 0.39 + \frac{0.1341}{1.2-1} (0.43 - 0.39) \]
\[ \eta = 0.418 \]

**d. Number of Lights**

To calculate the number of lights, standard lighting intensity \( E \) (lux) refers to table (3.3) and to obtain the number of lights use equation (2.3) as follows:

\[ \Sigma_{\text{armature}} = \sum_{\text{armature}} \frac{\phi_{\text{armature}} \times \eta \times d}{A \times 63.75} \]
\[ \Sigma_{\text{armature}} = \frac{100 \times 63.75}{1.200 \times 0.418 \times 1} \]
\[ \Sigma_{\text{armature}} = 12.70 \approx 13 \text{ buah} \]

**e. Power Requirements**

The power required for all armatures can be calculated by equation (2.4), namely:

\[ In_{\text{total}} = 13 \times 14 \text{ Watt} \]
\[ In_{\text{total}} = 182 \text{ Watt} \]

<table>
<thead>
<tr>
<th>No</th>
<th>Room Name</th>
<th>Space Indexes</th>
<th>Room Efficiency</th>
<th>Number of Lights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Inpatient Building Corridor</td>
<td>25.5 2.5 3 63.75</td>
<td>1.13</td>
<td>0.418</td>
</tr>
<tr>
<td>2.</td>
<td>Locker Room</td>
<td>2.6 2.3 3 5.98</td>
<td>0.61</td>
<td>0.274</td>
</tr>
<tr>
<td>3.</td>
<td>Linen/Tool Warehouse</td>
<td>3 3 3 9</td>
<td>0.75</td>
<td>0.323</td>
</tr>
<tr>
<td>4.</td>
<td>Action Space</td>
<td>4.2 3.2 3 13.44</td>
<td>0.90</td>
<td>0.367</td>
</tr>
<tr>
<td>5.</td>
<td>Medicine Room</td>
<td>2.6 2.3 3 5.98</td>
<td>0.61</td>
<td>0.274</td>
</tr>
<tr>
<td>6.</td>
<td>Staff Room</td>
<td>3.2 2.7 3 8.64</td>
<td>0.73</td>
<td>0.316</td>
</tr>
<tr>
<td>7.</td>
<td>Staff Room Toilet</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>8.</td>
<td>Janitor/Janitor’s Room</td>
<td>2 1.2 3 2.4</td>
<td>0.375</td>
<td>0.180</td>
</tr>
<tr>
<td>9.</td>
<td>Toilet/Janitor</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>10.</td>
<td>Inpatient Room 1</td>
<td>7.4 7.4 3 54.76</td>
<td>1.85</td>
<td>0.505</td>
</tr>
<tr>
<td>11.</td>
<td>Inpatient Toilet 1</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>12.</td>
<td>Inpatient Room 2</td>
<td>7.4 7.4 3 54.76</td>
<td>1.85</td>
<td>0.505</td>
</tr>
<tr>
<td>13.</td>
<td>Inpatient Toilet 2</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>14.</td>
<td>Inpatient Room 3</td>
<td>7.4 7.4 3 54.76</td>
<td>1.85</td>
<td>0.505</td>
</tr>
<tr>
<td>15.</td>
<td>Inpatient Toilet 3</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>16.</td>
<td>Inpatient Room 4</td>
<td>7.4 7.4 3 54.76</td>
<td>1.85</td>
<td>0.505</td>
</tr>
<tr>
<td>17.</td>
<td>Inpatient Toilet 4</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>18.</td>
<td>Inpatient Room 5</td>
<td>7.4 7.4 3 54.76</td>
<td>1.85</td>
<td>0.505</td>
</tr>
<tr>
<td>19.</td>
<td>Inpatient Toilet 5</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>20.</td>
<td>Inpatient Room 6</td>
<td>7.4 7.4 3 54.76</td>
<td>1.85</td>
<td>0.505</td>
</tr>
<tr>
<td>21.</td>
<td>Inpatient Toilet 6</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>22.</td>
<td>Inpatient Room 7</td>
<td>7.4 7.4 3 54.76</td>
<td>1.85</td>
<td>0.505</td>
</tr>
<tr>
<td>23.</td>
<td>Inpatient Toilet 7</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>24.</td>
<td>Inpatient Room 8</td>
<td>7.4 7.4 3 54.76</td>
<td>1.85</td>
<td>0.505</td>
</tr>
<tr>
<td>25.</td>
<td>Inpatient Toilet 8</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>26.</td>
<td>Inpatient Room 9</td>
<td>7.4 7.4 3 54.76</td>
<td>1.85</td>
<td>0.505</td>
</tr>
<tr>
<td>27.</td>
<td>Inpatient Toilet 9</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
<tr>
<td>28.</td>
<td>Inpatient Room 10</td>
<td>7.4 7.4 3 54.76</td>
<td>1.85</td>
<td>0.505</td>
</tr>
<tr>
<td>29.</td>
<td>Inpatient Toilet 10</td>
<td>1.9 1.5 3 2.85</td>
<td>0.41</td>
<td>0.198</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A</th>
<th>IRNA 1st Floor</th>
<th>p  i  t  h</th>
<th>Space Indexes</th>
<th>Efficiency</th>
<th>Number of Lights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Radiology Room</td>
<td>13 2.2 3 28.6</td>
<td>0.94</td>
<td>0.375</td>
<td>6</td>
</tr>
<tr>
<td>2.</td>
<td>Operator’s Room</td>
<td>2 2.8 3 5.6</td>
<td>0.58</td>
<td>0.263</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>Dark Room</td>
<td>2 3.2 3 6.4</td>
<td>0.61</td>
<td>0.275</td>
<td>3</td>
</tr>
</tbody>
</table>

Study of Electrical Installation Planning at Pratama Jogai Babang Hospital (Mardiana Dian)
Table 2. Recapitulation of Light Load Calculation Results in the IRNA Building

<table>
<thead>
<tr>
<th>Group</th>
<th>Function</th>
<th>Burden (Watt)</th>
<th>In (A)</th>
<th>KHA (A)</th>
<th>Cable</th>
<th>I rat (A)</th>
<th>MCB (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building A</td>
<td>1st Floor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Lighting</td>
<td>246</td>
<td>1.31</td>
<td>1.63</td>
<td>NYM 2 × 1.5 mm²</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>Lighting</td>
<td>288</td>
<td>1.54</td>
<td>1.92</td>
<td>NYM 2 × 1.5 mm²</td>
<td>1.77</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>Lighting</td>
<td>798</td>
<td>4.26</td>
<td>5.32</td>
<td>NYM 2 × 1.5 mm²</td>
<td>4.89</td>
<td>6</td>
</tr>
<tr>
<td>4.</td>
<td>Lighting</td>
<td>1064</td>
<td>5.68</td>
<td>7.1</td>
<td>NYM 2 × 1.5 mm²</td>
<td>6.53</td>
<td>10</td>
</tr>
</tbody>
</table>

Total: 470
4.2 Calculation of cross-sectional area and size

**Group A Power Security in building C Pratama Jagoi Babang Hospital**
For the calculation of the cross-sectional area and the safety of group A power, therefore the power to be taken is the overall load power in group A of 3194 Watts.

a. Calculate nominal current($I_n$)

By using equation (2.8) nominal current($I_n$) determined as follows:

Child: Power (P) \(= 3194\) Watt
Tegangan (V) \(= 380\) Volts
Power Factor\(\cos \phi\) \(= 0.85\)

\[
I_n = \frac{P_{380}}{\sqrt{3} \times 1N_1 \times \cos \cos \phi}
\]

\[
I_n = \frac{3194}{\sqrt{3} \times 380 \times 0.85}
\]

\[I_n = 5.70\ A\]

b. Calculating the value of Current Conductivity (KHA) of the final circuit

<table>
<thead>
<tr>
<th>Group</th>
<th>Function</th>
<th>Burden (Watt)</th>
<th>$I_n$ (A)</th>
<th>KHA (A)</th>
<th>Cable</th>
<th>$I$ rat (A)</th>
<th>MCB (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 1st Floor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1. AC</td>
<td>2304</td>
<td>12.32</td>
<td>15.40</td>
<td>NYM 3 × 2.5 mm²</td>
<td>14.17</td>
<td>16</td>
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<tr>
<td>2. AC</td>
<td>1246</td>
<td>6.66</td>
<td>8.33</td>
<td>NYM 3 × 2.5 mm²</td>
<td>7.66</td>
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<td>3. AC</td>
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<td>6.73</td>
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<td>7.74</td>
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<td>4. AC</td>
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<td>37.06</td>
<td>46.32</td>
<td>NYM 3 × 10 mm²</td>
<td>42.62</td>
<td>50</td>
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<tr>
<td>5. AC</td>
<td>6930</td>
<td>37.06</td>
<td>46.32</td>
<td>NYM 3 × 10 mm²</td>
<td>42.62</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>6. AC</td>
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<td>8. AC</td>
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<td>46.32</td>
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<td>9. AC</td>
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<td>46.32</td>
<td>NYM 3 × 10 mm²</td>
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<td>50</td>
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<td>10. AC</td>
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<td>NYM 3 × 10 mm²</td>
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<td>46.32</td>
<td>NYM 3 × 10 mm²</td>
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<td>12. AC</td>
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<td>42.62</td>
<td>50</td>
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<td>13. AC</td>
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<td>37.06</td>
<td>46.32</td>
<td>NYM 3 × 10 mm²</td>
<td>42.62</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>
By using equation (2.9) CRC is determined as follows:
\[ KHA = 125\% \times In \]
\[ KHA = 125\% \times 5.70 \]
\[ KHA = 7.12 \text{ A} \]
Based on table 2.1, the type of cable used is NYY 4× 2,5 mm²

c. Calculates the final circuit overcurrent protection rating
By using equation (2.10) \( I_{rat} \) determined as follows:
\[ I_{rat} = 115\% \times In \]
\[ I_{rat} = 115\% \times 5.70 \]
\[ I_{rat} = 6.55 \text{ A} \]
The amount of safety used is MCB 10A / 3P

Table 4. Recapitulation of the Calculation Results of the Cross-sectional Area and the Size of the Safety Guard in Building C of the Jagoi Babang Pratama Hospital

<table>
<thead>
<tr>
<th>Name</th>
<th>Burden (Watt)</th>
<th>In (A)</th>
<th>KHA (A)</th>
<th>Cable</th>
<th>I_{rat} (A)</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>3194</td>
<td>5.70</td>
<td>7.12</td>
<td>NYY 4× 2,5 mm²</td>
<td>6.55</td>
<td>MCB 10A / 3P</td>
</tr>
<tr>
<td>Group B</td>
<td>906</td>
<td>1.61</td>
<td>2.02</td>
<td>NYY 4× 1,5 mm²</td>
<td>1.86</td>
<td>MCB 2A / 3P</td>
</tr>
<tr>
<td>Group C</td>
<td>4068</td>
<td>7.27</td>
<td>9.08</td>
<td>NYY 4× 2,5 mm²</td>
<td>8.36</td>
<td>MCB 10A / 3P</td>
</tr>
<tr>
<td>AC. Group A</td>
<td>74109</td>
<td>132.46</td>
<td>165.57</td>
<td>NYY 4× 35 mm²</td>
<td>152.32</td>
<td>MCCB 160A/3P</td>
</tr>
<tr>
<td>AC. Group B</td>
<td>16655</td>
<td>29.77</td>
<td>37.21</td>
<td>NYY 4× 6.0 mm²</td>
<td>34.23</td>
<td>MCCB 40A/3P</td>
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<tr>
<td>AC. Group C</td>
<td>49869</td>
<td>89.13</td>
<td>111.41</td>
<td>NYY 4× 35 mm²</td>
<td>102.49</td>
<td>MCCB 125A/3P</td>
</tr>
</tbody>
</table>

4.3 Calculation of Voltage Drop

The voltage drop or more commonly called the voltage drop is the difference between the sending end voltages and depends on the impedance and admittance of the line as well as on the load power factor. The calculation of the voltage drop in building C at Jagoi Babang Primary Hospital is as follows:

1. Voltage Drop On Group A Lighting Panels
Is known:
Cross section = NYY 4× 2,5 mm²
I (nominal current) = 5.70 A
Channel Length(L) = 0.001 km (Distance from the main SDP panel)
Resistance (R) = 3.03 Ohm/Km
Reactance (X) = 0.094 Ohm/Km
\[ \cos (\Phi) = 0.85 \]
\[ \sin (\Phi) = 0.53 \]

\[ \Delta V = I \left( R \times \cos \phi + X \times \sin \phi \right) L \]
\[ = 5.70 \times \left( 3.03 \times 0.85 + 0.094 \times 0.53 \right) \times 0.001 \]
\[ = 0.014 V \]

Table 5. Recapitulation of Voltage Drop Calculation Results in Building C at Jagoi Babang Primary Hospital

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Voltage Drop (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Group A Lighting Panel</td>
<td>0.014 V</td>
</tr>
<tr>
<td>2.</td>
<td>Group B Lighting Panel</td>
<td>0.004 V</td>
</tr>
</tbody>
</table>
3. Group C Lighting Panel 0.019 V
4. Group A AC Panel 0.347 V
5. Group B AC Panel 0.078 V
6. Group C AC Panel 0.233 V

5. CONCLUSION

After carrying out the calculations, the calculation results obtained from the analysis of the results on the lighting are 470 lamps to be used, with the types of lamps being DL LED 14 Watt, DL LED 18 Watt, TL LED 18 Watt. So the total load required is 8168 Watts = 8.168 kW and the lamps used are Philips lamps. Then the lighting calculations carried out have met the standards of the 2011 General Electrical Installation Regulations (PUIL) and the Regulation of the Minister of Health of the Republic of Indonesia number 24 of 2016 concerning technical requirements for hospital buildings and infrastructure and have met the SNI 03-6197-2011 standards concerning Energy Conversion in Lighting System.

From the results of calculating the Air Conditioner Capacity, it was found that the number of ACs that will be used is 35 Air Conditioners with Wall Mounted and Ceiling Mounted Cassette types with capacities of ½ PK, ¾ PK, 1 PK, 1½ PK, 2 PK, 3 PK. The total load required is 140633 Watt = 140.633 kW and the AC used is DAIKIN AC.

Then, in calculating the voltage drop, 6 voltage drop points are taken namely Group A Lighting Panels, Group B Lighting Panels, Group C Lighting Panels, Group A AC Panels, Group B AC Panels and Group C AC Panels. The cross-section types used in these panels are NYY × 1.5 mm², NYY × 2.5 mm², NYY × 6 mm², and NYY × 35 mm². The results of the calculations show that the voltage drop on the Group A Lighting Panel is 0.014 V, the Group B Lighting Panel is 0.004 V, the Group C Lighting Panel is 0.019 V, the Group A AC Panel is 0.347 V, the Group B AC Panel is 0.078 V and the AC Panel Group C is 0.233 V.

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REFERENCE