LIGHTING, POWER DISTRIBUTION AND PROTECTION SCHEME OF A RESIDENTIAL ESTATE.

PROJECT INDEX: PRJ 059
BY:
MIRANG’A VALENTINE MOKEIRA
F17/40230/2011
OBJECTIVES

• Coming up with a Lighting scheme design.

• Power distribution.
  ~ Power points and communication points.
  ~ Load calculation.
  ~ Distribution system - consumer units and service turrets
  ~ Electrical distribution system reticulation

• Cable sizing.

• Protection and discrimination.

• Provision of a power backup system.

• Power factor correction.
ESTATE SITE PLAN

- Unit A2=11 houses
- Unit B2=40 houses
- Unit C2=24 houses
LIGHTING SCHEME DESIGN

The lumen method illustrated using lounge of housing unit A2.

• Dimensions: length = 5.54 m
  width = 5.39 m
  mounting height = 2.1 m

• Determination of room index: $K = \frac{5.54 \times 5.39}{2.1(5.54 + 5.39)} = 1.3$

  using ceiling, wall and floor reflectance of 0.7, 0.5 and 0.2 respectively and utilisation factor tables, utilisation factor was found to be 0.558.

• Product used: THORN CRUZ 160, 1x 26W, recessed with 2000 lumens per lamp; the dimensions being 0.16m by 0.146m by 0.138m (THORN catalogue used)
• Using illuminance of 100 lux and a maintenance factor of 0.7.

• The installed luminous flux was: \[ \frac{100 \times 29.86}{0.558 \times 0.7} = 7645 \text{ lumens} \]

• Number of fittings: \[ \frac{7645}{2000} = 4 \text{ fittings} \]

• 5 fittings were arrived at since they gave an average illuminance of 130, which is within the range of the illuminance value.
LIGHTING CIRCUITRY IN THE LOUNGE OF UNIT A2
POWER POINTS

• The *IEE on-site guide* used.
• 13A socket outlets, with ring configuration and protected by a 32A device is allowed for a floor area not exceeding 100m².
• Minimum number of twin socket outlets for lounges is 6 as given in *Modern Wiring Practice* chapter on *design and arrangement of final circuits*.
• Sockets catering for single phase loads were also incorporated. e.g cooker and water heater
• Communication points placed depending on the room.
POWER AND DATA POINTS IN LOUNGE
LOAD CALCULATION

• Load calculation was done in each house applying diversity factor as given in IEE on-site guide.

• Load currents were found to be 80.97A, 80.45A and 79.86A for unit A2, B2 and C2 respectively.

• Total load was 1446171W. Assuming power factor of 0.85 the apparent power was $\frac{1446171}{0.85} = 1701.38KVA$

• The load was split to 908.95 kVA and 795.43 kVA to reduce voltage drop between transformer and load. 2 1000kVA transformer were used.
DISTRIBUTION SYSTEM

• **underground** scheme of distribution was used.

• **Service turrets (STs):** 10 service turrets used to supply power to consumer units.

• **Consumer units (CUs)** with 100A integral isolator and 14 CB ways used to supply power to final circuits.

• **Spare ways included** in service turrets and CUs to cater for future load growth.
CABLE SIZING

• The load current used in cable sizing (20% load growth included).

• Current carrying capacity, cable cross sectional area and the voltage drop rate considered when sizing cables.

• The % voltage drop was found using:

\[
\frac{\text{length (m)} \times \text{current (A)} \times \text{voltage drop rate (mV/A/m)}}{1000 \times 240V} \times 100
\]

* The maximum voltage drop set to 6%
<table>
<thead>
<tr>
<th>CU</th>
<th>Load current (A)</th>
<th>Design current (A)</th>
<th>Cable length (m)</th>
<th>Cable size (mm²)</th>
<th>Current carrying capability (A)</th>
<th>Voltage drop rate (mV/A/m)</th>
<th>Voltage drop (V)</th>
<th>% voltage drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>CU-A2-1</td>
<td>80.97</td>
<td>97</td>
<td>41</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>2.42</td>
<td>1.00</td>
</tr>
<tr>
<td>CU-A2-2</td>
<td>80.97</td>
<td>97</td>
<td>48</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>2.84</td>
<td>1.18</td>
</tr>
<tr>
<td>CU-A2-3</td>
<td>80.97</td>
<td>97</td>
<td>40</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>2.36</td>
<td>0.98</td>
</tr>
<tr>
<td>CU-A2-4</td>
<td>80.97</td>
<td>97</td>
<td>41</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>2.42</td>
<td>1.00</td>
</tr>
<tr>
<td>CU-A2-5</td>
<td>80.97</td>
<td>97</td>
<td>43</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>2.54</td>
<td>1.06</td>
</tr>
<tr>
<td>CU-A2-6</td>
<td>80.97</td>
<td>97</td>
<td>33</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>1.95</td>
<td>0.81</td>
</tr>
<tr>
<td>CU-A2-7</td>
<td>80.97</td>
<td>97</td>
<td>29</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>1.71</td>
<td>0.71</td>
</tr>
<tr>
<td>CU-A2-8</td>
<td>80.97</td>
<td>97</td>
<td>38</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>2.24</td>
<td>0.93</td>
</tr>
<tr>
<td>CU-A2-9</td>
<td>80.97</td>
<td>97</td>
<td>46</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>2.72</td>
<td>1.13</td>
</tr>
<tr>
<td>CU-A2-10</td>
<td>80.97</td>
<td>97</td>
<td>63</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>3.72</td>
<td>1.50</td>
</tr>
<tr>
<td>CU-A2-26</td>
<td>80.97</td>
<td>97</td>
<td>30</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>1.78</td>
<td>0.74</td>
</tr>
<tr>
<td>CU-B2-11</td>
<td>80.45</td>
<td>97</td>
<td>34</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>1.95</td>
<td>0.81</td>
</tr>
<tr>
<td>CU-B2-12</td>
<td>80.45</td>
<td>97</td>
<td>26</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>1.53</td>
<td>0.64</td>
</tr>
<tr>
<td>CU-B2-13</td>
<td>80.45</td>
<td>97</td>
<td>42</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>2.48</td>
<td>1.03</td>
</tr>
<tr>
<td>CU-B2-14</td>
<td>80.45</td>
<td>97</td>
<td>30</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>1.83</td>
<td>0.76</td>
</tr>
<tr>
<td>CU-B2-15</td>
<td>80.45</td>
<td>97</td>
<td>36</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>2.13</td>
<td>0.88</td>
</tr>
<tr>
<td>CU-B2-16</td>
<td>80.45</td>
<td>97</td>
<td>58</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>3.43</td>
<td>1.43</td>
</tr>
<tr>
<td>CU-B2-17</td>
<td>80.45</td>
<td>97</td>
<td>58</td>
<td>70</td>
<td>154</td>
<td>0.61</td>
<td>3.43</td>
<td>1.43</td>
</tr>
</tbody>
</table>
POWER BACKUP SYSTEM

• Generator used for backup.

• Load 1 = 908.95 KVA

• Optimal load of the generator is 80% of full load, thus;

\[
80\% = 908.95 \text{KVA}
\]

\[
100\% = 1136.19 \text{KVA}
\]

• A 1250KVA Cummins generator set, model C1250 D5 P at 50 Hz was selected for load 1 and a 1000KVA Cummins generator set, model RC-1000GF at 50 Hz for load 2. Muffler present and diesel used as the fuel.
POWER FACTOR CORRECTION

• Effects of low power factor: large equipment needed use of large cables and higher costs.

• Capacitors installed at the switchboard level to increase power factor.

150kVAR ABB 300series capacitor bank electronically switched in 3 steps of 50kVAR each was selected.

KVAR before power factor correction

= 772.61KW tan31.78°
= 478.66kVAR

KVAR after power factor correction

= 772.61KW tan 25.84°
= 374.19kVAR

Capacitor bank

= 478.66 – 374.19
= 104.47kVAR
PROTECTION

• Faults: overcurrent (overload and short circuits), earth faults and lightning surges.

• Use of MCBs and MCCBs for overcurrent protection.

• RCDs used for earth faults.

• Fault currents were calculated at various levels.

• Lightning protection was by use of lightning protection system and surge protectors.
LIGHTNING PROTECTION

DETAILS OF LIGHTNING ARRESTER

\[\begin{align*}
&\text{AIR TERMINAL} \\
&\text{DOWN CONDUCTOR} \\
&\text{EARTH ELECTRODE}
\end{align*}\]
DISCRIMINATION

- Circuit breaker nearest the fault operates rather than any of the circuit breakers or fuses upstream of it.
- Current discrimination was done by considering short circuit ratings/pick up value
- Time discrimination also achieved using the delay upstream.
- The MEM catalogue used in the selection of the breakers.
CONCLUSION

The set objectives were achieved:

- Lighting scheme was designed for the housing units
- Power distribution design done in accordance with IEE regulations.
- The sizes of cable were calculated and the voltage drop allowed was not below 6%.
- A backup system was installed using generators (1250kva and 1000kva)
- Power factor correction achieved by use of a 150 KVAR capacitors bank.
- Protection achieved.
RECOMMENDATIONS FOR FUTURE WORK

• Design of a program that would perform the calculations. for example, in cable sizing and fault current calculations.

• Preparing a bill of quantities.

• Using an alternative source of energy for backup power supply; solar energy would be a good option since it is economical.
THANK YOU