## ELECTRICAL SYSTEM

### 16.1 CALCULATE THE LOAD EQUIPMENT:

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|       | The room record                                    | 72    | 6700         | 0.4554 | 1.35 | 2.92      | 6   | 432             |
|       | Rest room                                          | 72    | 6700         | 0.4554 | 1.35 | 3.58      | 6   | 432             |
|       | Preparation room                                   | 72    | 6700         | 0.4554 | 1.35 | 4.51      | 4   | 288             |
|       | The reception room                                 | 72    | 6700         | 0.4554 | 1.35 | 4.38      | 5   | 360             |
|       | Central air handling room AHU                      | 36    | 3350         | 0.4554 | 1.35 | 8.10      | 6   | 216             |
|       | The repository                                     | 36    | 3350         | 0.4554 | 1.35 | 4.51      | 2   | 72              |
|       | Electrical engineering room                        | 36    | 3350         | 0.4554 | 1.35 | 1.95      | 2   | 72              |
|       | The lobby staff                                    | 72    | 6700         | 0.4554 | 1.35 | 4.65      | 7   | 504             |
|       | Toilet female staff room                           | 18    | 1200         | 0.4554 | 1.35 | 6.92      | 6   | 108             |
|       | Toilet male staff room                             | 18    | 1200         | 0.4554 | 1.35 | 6.92      | 7   | 126             |
|       | Wash room map and transfer map dirty               | 72    | 6700         | 0.4554 | 1.35 | 2.39      | 3   | 216             |
|       | Women's Technical Dressing Room                   | 18    | 1200         | 0.4554 | 1.35 | 8.89      | 5   | 90              |</p>
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4th FLOOR

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| 3     | Consultations room                     | 6  | 1200                | 0.3| 2160  |
| 4     | Staff rooms, nursing and care assistants | 7 | 1200                | 0.3| 2520  |
| 5     | Administrative rooms                   | 15 | 1200                | 0.3| 5400  |
| 6     | The room thought between ca and record | 6  | 1200                | 0.3| 2160  |
| 7     | Tool handling room and sterilizing     | 3  | 1200                | 0.3| 1080  |</p>
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\[ \sum P = 46440 \]

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87<sup>ST</sup> FLOOR

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</table>
### 16.4 SELECT TRANSFORMERS-BACKUP GENERATOR-Calculate Capacity of Capacitors

#### 16.4.1 SELECT TRANSFORMERS

The total capacity of the load devices, sockets, to have:

\[
P = P_{OC} + P_{CS} + P_{SH} = 456.12 + 140.202 + 1104.687 = 1701.01 \text{ (kW)}
\]

The total electricity consumption of the building:

\[
\sum P_t = P \cdot K_e = 1701.01 \times 0.9 = 1530.91 \text{ (kW)}
\]

Apparent power:

\[
S_t = \sum P_t / 0.8 = 1530.91 / 0.8 = 1913.64 \text{ (KVA)}
\]

Reactive power of the building:

\[
Q = \sqrt{S_t^2 - P_t^2} = \sqrt{1913.64^2 - 1530.91^2} = 1148.19 \text{ kVAR}
\]

Select transformers Dong Anh

Rated quantities : 2000 KVA

The losses: no load loss \(\Delta P_0 = 2.6\) (KW), short circuit \(\Delta P_N = 19\) (KW)

Short circuit voltage: \(U_N = 6\%\)

No load current: \(i_0 = 0.9\%\)

Calculate the loss of capacity and power capacity in transformers

The loss of capacity:

Power loss (loss of copper)

\[
\Delta P_B = \Delta P_0 + \Delta P_N \left(\frac{S_{fr}}{S_{dm}}\right)^2 = 2.6 + 19 \left(\frac{1913.64}{2000}\right)^2 = 19.99 \text{ (KW)}
\]

Power loss (loss of iron)

\[
\Delta Q_B = \frac{i_0 \% \cdot S_{dm}}{100} = \frac{0.9 \times 2000}{100} = 18 \text{ (kVAR)}
\]

\[
\Delta Q_N = \frac{U_N \% \cdot S_{dm}}{100} = \frac{6 \times 2000}{100} = 120 \text{ (kVAR)}
\]

\[
\Delta Q_B = \Delta Q_0 + \Delta Q_N \left(\frac{S_{fr}}{S_{dm}}\right)^2 = 18 + 120 \left(\frac{1913.64}{2000}\right)^2 = 127.86 \text{ (KW)}
\]

Power loss:
\[ \Delta A_2 = \Delta P_0 t + \Delta P_N t \left( \frac{S_{tt}}{S_{dm}} \right)^2 = 2.6 \times 8760 + 19.8760 \left( \frac{1913.64}{2000} \right)^2 = 175152.57 \text{ (KWh)} \]

### 16.4.2 SELECT GENERATOR

- When there is trouble on the high-voltage grid 22 (kv), the computer is no longer a continuous power supply, if the sudden loss of power, the economic damage is huge.
- so the installation of a backup generator it is necessary to ensure the power supply is calculated constantly for the critical load, when the MBA is experiencing in the hospital.
- With total capacity used: 2000 KVA
  - Select the generator Mitsubishi
  - Model: MDS-2090T
  - Rotation speed: 1500 r/m
  - The frequency: 50 Hz
  - The voltage: 220-380V - 3 phase
  - Constant power: 1900 kVA
  - Redundant power: 2090 kVA

### 16.4.3 CALCULATE THE AMOUNT OF CAPACITOR

- Most of the load and in industry such as MBA, motor power, lights, ... are all power consumption so make the coefficient decreased, increased transmission line leads to the following status:
  - Power loss and voltage on the transmission line.
  - Size, the capacity of the electrical equipment such as cables, switches, transformers thing rise.
  - The power factor correction brings enhanced efficiency coefficient \( \cos \varphi \), reduce power loss and voltage power networks, General \( \cos \) of the enterprises is very low so the current enterprise ever compensation device In addition to raising the coefficient \( \cos \varphi \) up to a value of 0.85-0.95.
- Before supplemental \( \cos \varphi \)
  \[ \cos \varphi = \frac{P_{tt}}{S_{dm}} = \frac{1530.91}{2000} = 0,77 \Rightarrow \tan \varphi_1 = 0,83 \]
- After supplemental we have the coefficient \( \cos \varphi \)
  \[ \cos \varphi = 0,93 \Rightarrow \tan \varphi_2 = 0,395 \]
- Reactive power need to added:
  \[ Q_{\text{add}} = P_{tt} \times (\tan \varphi_1 - \tan \varphi_2) = 1530.91 \times (0.83 - 0.395) = 665.95 \text{ kVA} \]

We chose 14 capacitors of Mikro with parameters such as the following:
  - Model: MKC-445500KT 440V
  - The capacity of each capacitor: 50 KVAR

  **When the load of the plant working 100\% I closed both the convergence**

The audience reaction capacity after addition:

\[ Q' = Q - Q_{hub} = 1148.19 - 14 \times 50 = 448.19 \text{ (Kvar)} \]

Visible power after addition:
S' = \sqrt{P'^2 + Q'^2} = \sqrt{1530.91^2 + 448.19^2} = 1595.17 \text{ (KVA)}

Power factor after addition:
\[
\cos \phi_1 = \frac{P}{S'} = \frac{1530.91}{1595.17} = 0.96
\]

- **When the factory load work 80%**

Such a capacity audience response capacity needed to addition:

\[
Q_{\text{add}} = 80\% \times P_\text{tt} \times (\tan \varphi_1 - \tan \varphi_2) = 0.8 \times 1530.91 \times (0.83 - 0.395) = 532.76 \text{ (Kvar)}
\]

So there are 11 capacitors work

Reactive power after addition:

\[
Q' = 80\% Q - Q_{\text{bus}} = 0.8 \times 1148.19 - 50 \times 11 = 368.55 \text{ (Kvar)}
\]

Reactive power after addition:

\[
S' = \sqrt{80\% P_{\text{tt}}^2 + Q'^2} = \sqrt{0.8 \times 1530.91^2 + 368.55^2} = 1418.02 \text{ (KVA)}
\]

Power factor after addition:

\[
\cos \phi = \frac{80\% P_{\text{tt}}}{S'} = \frac{0.8 \times 1530.91}{1418.02} = 0.86
\]

- **When the factory load work 60%**

Reactive power need to addition:

\[
Q_{\text{need}} = 60\% \times P_\text{tt} \times (\tan \varphi_1 - \tan \varphi_2) = 0.6 \times 1530.91 \times (0.83 - 0.395) = 399.57 \text{ (Kvar)}
\]

So there are 8 capacitors work

\[
Q' = 60\% Q - Q_{\text{capacitors}} = 0.6 \times 1148.19 - 50 \times 8 = 288.91 \text{ (Kvar)}
\]

Reactive power after addition:

\[
S' = \sqrt{60\% P_{\text{tt}}^2 + Q'^2} = \sqrt{0.6 \times 1530.91^2 + 288.91^2} = 1220.52 \text{ (KVA)}
\]

Power factor after addition:

\[
\cos \phi = \frac{60\% P_{\text{tt}}}{S'} = \frac{0.6 \times 1530.91}{1220.52} = 0.75
\]

**16.5 SELECT WIRE-VOLTAGE CALCULATION**

**16.5.1 SELECT WIRE**

Select the wire from the transformer to the main distribution cabinets
Transformer with rated power: \( S_{rate} = 2000 \text{ KVA} \)

Rated current of the transformer:

\[
I_{rate} = \frac{S_{dm}}{\sqrt{3} \times U_{dm}} = \frac{2000 \times 10^3}{\sqrt{3} \times 380} = 3038.69 \text{ A}
\]

\[I_{lvmax} = I_{dm} = 3038.69 \text{ A}\]

Allowed voltage of wire

\[I_{cp} \geq I_{lvmax}\]

Correction coefficient \( K \) (According to TL 5 tables G12, G13, G15, G17)

\[
k = k_1 \times k_2 \times k_3 \times k_4
\]

Correction factor when the ambient temperature is different from 30°C \( k_1 = 0.94 \)

Temperature correction factor in soil \( k_2 = 0.95 \)

Coefficients of soil buried cables \( k_3 = 1 \)

Reduction coefficient for a group containing more than one circuit \( k_4 = 0.87 \)

So the calibration coefficient

\[
k = 0.94 \times 0.95 \times 1 \times 0.87 = 0.78
\]

Permitted line of wire

\[
I_{cp} \geq \frac{I_{lvmax}}{k} = \frac{3038.69}{0.78} = 3895.76 \text{ A}
\]

We choose the cable manufactured by Cadivi

- With cross section \( F = 400 \text{ mm}^2 \)
- Allowable current \( I_{cp} = 708 \text{ A} \)
- Voltage drop 0.22 mV

Choose 7 cables like above

Allowable current intensity per phase

\[
I_{allow} = 7 \times I_{allow1ph} = 7 \times 708 = 4956 \text{ A}
\]

Can see \( I_{allow} \geq I_{cp} \)

Select the wire from the main distribution cabinets up to the main floor cabinets

<table>
<thead>
<tr>
<th>Location</th>
<th>( S_{dm} ) (kVA)</th>
<th>( I_{dm} ) (A)</th>
<th>k1</th>
<th>k2</th>
<th>k3</th>
<th>( I_{allow} ) (A)</th>
<th>Number of wires</th>
<th>Section ( F ) (mm(^2))</th>
<th>( I_{allow} ) of wires (A)</th>
<th>Voltage drop (mV/A/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The basement</td>
<td>139.30</td>
<td>211.64</td>
<td>0.94</td>
<td>0.77</td>
<td>1</td>
<td>173.36</td>
<td>4</td>
<td>4</td>
<td>45</td>
<td>10</td>
</tr>
<tr>
<td>1st floor</td>
<td>170.48</td>
<td>259.02</td>
<td>0.94</td>
<td>0.77</td>
<td>1</td>
<td>212.18</td>
<td>4</td>
<td>6</td>
<td>58</td>
<td>6</td>
</tr>
</tbody>
</table>
### 16.5.2 CALCULATION VOLTAGE DROP

Formula calculation for voltage drop (TL 5 page G21)

Voltage drop: \( \Delta U = k \times I_B \times L \)

Measured: K coefficient of check according to table G28 in the IEC Electrical Installation Design Guide.

- \( I_B \): the largest working current (A)
- \( L \): the length of the wire (km)

Check voltage drop on the wire from the transformer to the main distribution cabinets.

The line has a length of 10 m, cable diameter 400mm\(^2\), has \( k = 0.22 \)

\[ I_B = \frac{3895.76}{7} = 556.54 \text{ (A)} \]

So: \( \Delta U = 0.22 \times 556.54 \times 0.01 = 1.224 \)

\[ \% \Delta U = \frac{\Delta U}{U} = \frac{1.224}{380} \times 100\% = 0.32\% \]

Conditions of agreement

Summarize the results of the voltage drop on the wiring from the main distribution cabinet to the main distribution cabinet of the floor.
16.6 SHORT CIRCUIT CALCULATION AND THE PROTECTIVE DEVICE SELECTION

16.6.1 SELECT DEVICE PROTECTION

1. Select the CB for the main distribution cabinets.
   Maximum working voltage
   \[ I_{\text{vmax}} = 3038.69 \text{ A} \]
   Choose NF800-HEW
   The current level of: \( I_{\text{dmb}} = 2000 \text{A} \)
   The line circuit breaker: \( I_{\text{CB}} = 70 \text{ KA} \)

2. Select CB for on line from the main distribution cabinets to bedside stool turned the main floor.
   Select the CB for the main distribution cabinets (TCB) to the main distribution cabinets

<table>
<thead>
<tr>
<th>count</th>
<th>Wire line</th>
<th>Model</th>
<th>( I_{\text{dmb}} ) (A)</th>
<th>( I_{\text{vmax}} ) (A)</th>
<th>( I_{\text{CB}} ) (KA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The basement</td>
<td>NF250-CV</td>
<td>250</td>
<td>211.64</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>1\textsuperscript{st} floor</td>
<td>NF400-CW</td>
<td>300</td>
<td>259.02</td>
<td>36</td>
</tr>
</tbody>
</table>
16.6.2 CALCULATION OF SHORT CIRCUIT

a. Determine the total return of Transformers:

<table>
<thead>
<tr>
<th>Rate power</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_{\text{dim}}$ (kVA)</td>
<td>$\Delta P_o$</td>
</tr>
<tr>
<td>2000</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Because the transformers were air according to the diagram of the $\Delta/Y$ should a total of transformers are calculated according to the following formula.

$$Z_{tr} = \frac{U_{20}^2}{P_n} \times \frac{U_{sc}}{100}$$

Of which:

$U_{20}$ - the secondary line voltage when not loading (V)

$P_n$ – power of transformer (kVA)

$U_{sc}$ – voltage short circuit of transformer (%)

b. Determine the electrical resistance and impedance of CB:

In the low voltage grid, the total return of CB holding below the location of the problem need to be accounted for, the value regulators for each CB was 0, 15 m$\Omega$, while resistance can ignore.
c. Determine the electrical resistance and impedance of the bar:

Resistance of the contributions are ignored and the total return (regulators) reaches the value 0,15 mΩ for 1 m length (f = 50 Hz), (0, 18 m/mΩ length when f = 60 Hz). When the distance between the bars twice, then got promoted to lead regulators will increase by about 10%.

d. Determine the electrical resistance and impedance of this guide.

Resistance of a wire is calculated by the formula: \( R = \rho \frac{L}{S} \)

In that:   
\( L \) – wire length (m)  
\( \rho = 22,5 \text{mΩ mm}^2/\text{m} \) – electrical resistivity of the material the wire when the normal operating temperature (for copper)  
\( S \) – cross-section of conductor (mm^2).

Regulators of the cable can be retrieved by 0,08mΩ/m (when f=50Hz), 0,096mΩ/m (when f=60Hz)

e. Calculation of short circuit at low voltage bus bar of the MBA.

To determine the current calculation in three-phase short circuit I missed a total of medium voltage grid system

The current level of stupid bar low voltage distribution transformers:

\[ I_n = \frac{P_n \times 10^3}{\sqrt{3} \times U_{20}} = \frac{19 \times 10^3}{\sqrt{3} \times 400} = 27.42 \]

with : \( P_n \) - MBA power.  
\( U_{20} \) – the secondary side voltage no load.  
\( I_n \) – current in low-voltage distribution MBA bar.  
Line bar low voltage distribution MBA.  

\[ I_{sc} = \frac{I_n \times 100}{U_{sc}} = \frac{27.42 \times 100}{6} = 457 \text{ (kA)} \]

f. Calculation of short circuit in the main distribution cabinets (MBS).

✓ Related devices:
Transformers:  
Resistance of coil: can ignore the power is 1250kVA > 100kVA  
The total resistor \( Z_{MBA} \) of transformers seen from the bar (Second level):

\[ Z_{MBA} = \frac{U_{20}^2 \times U_{sc}}{P_n \times 100} = \frac{400^2 \times 6}{19 \times 100} = 505.26 \]

So regulators of coils : \( X = 505.26 \text{ (mΩ)} \)
✓ CB:  
Skip resistance.  
Regulators of CB : \( X = 0,15 \text{mΩ} \)
✓ Wire:

Impedance: \( R_d = \rho \frac{L}{S} = 22,5 \times \frac{10}{400} = 0.5625 \text{ (mΩ)} \)

Regulators: \( X_d = 0.08 \text{(mΩ)} \)
Inferred:
Total resistance: \( R = 0.6425 \text{ (mΩ)} \)
Regulators of wire: \( X = 505.26 + 0.15 + 0.6425 = 506.0525 \text{ (mΩ)} \)
Three phase short circuit currents:

\[ I_{sc} = \frac{U_{sc}}{\sqrt{3} \cdot R + X} = \frac{400}{\sqrt{3} \cdot 0.6425 + 0.025} = 0.456 \text{ (kA)} \]

Calculation of short circuit in the main distribution cabinets to each distribution cabinets.

<table>
<thead>
<tr>
<th>count</th>
<th>Tầng</th>
<th>R</th>
<th>X</th>
<th>Ics (kA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The basement</td>
<td>281.33</td>
<td>786.74</td>
<td>0.276</td>
</tr>
<tr>
<td>2</td>
<td>1\textsuperscript{st} floor</td>
<td>202.58</td>
<td>707.99</td>
<td>0.3136</td>
</tr>
<tr>
<td>3</td>
<td>2\textsuperscript{nd} floor</td>
<td>326.33</td>
<td>831.74</td>
<td>0.2585</td>
</tr>
<tr>
<td>4</td>
<td>3\textsuperscript{rd} floor</td>
<td>348.83</td>
<td>854.24</td>
<td>0.2503</td>
</tr>
<tr>
<td>5</td>
<td>4\textsuperscript{th} floor</td>
<td>247.58</td>
<td>752.99</td>
<td>0.2914</td>
</tr>
<tr>
<td>6</td>
<td>5\textsuperscript{th} floor</td>
<td>393.83</td>
<td>899.24</td>
<td>0.2352</td>
</tr>
<tr>
<td>7</td>
<td>6\textsuperscript{th} floor</td>
<td>416.33</td>
<td>921.74</td>
<td>0.2283</td>
</tr>
<tr>
<td>8</td>
<td>7\textsuperscript{th} floor</td>
<td>175.58</td>
<td>680.99</td>
<td>0.3284</td>
</tr>
<tr>
<td>9</td>
<td>8\textsuperscript{th} floor</td>
<td>184.58</td>
<td>689.99</td>
<td>0.3233</td>
</tr>
<tr>
<td>10</td>
<td>The terrace</td>
<td>1290.08</td>
<td>1795.49</td>
<td>0.1045</td>
</tr>
<tr>
<td>11</td>
<td>Roof floor</td>
<td>40.58</td>
<td>545.99</td>
<td>0.4218</td>
</tr>
</tbody>
</table>

16.7 SECURE COMPUTING AND LIGHTNING PROTECTION FOR BUILDINGS

16.7.1 SECURE COMPUTING

a. Electric shock:

Electric shock occurs when electric current goes through and cause the biological effect up the body.
Flow of people will affect the muscles, circulatory and respiratory functions, sometimes that can cause severe burns, the level of danger for the victim and a function according to the magnitude of the electric current, the parts of the body that runs across the line and time existence of this power line.
IEC 60479-1 update in 2005 defined four regions correspond to line/amplitude relationship of time exist, in the case described the biological influence, any person exposed to the power of danger due to electric shock.

b. The electric contact form: there are two forms

Direct:

Direct contact with the situation is the vessel cell in normal operating status.
Protection against direct electric touch.

- Protected by insulated insulating parts
- Protected with a barrier or enclosure sealed

All the measures specified above may be sufficient to prevent the electric touch, however operating experience shows there are many causes that may lead to errors such as.

- Lack of appropriate maintenance
- Due to careless inattention
- The insulation is reduced to normal and chronic tearing place isolated by being folded and scratched in the connectors.
- Due to accidentally touch the electric
- Due to flooding

In these cases to protect power users need the protection device has high sensitivity and fast impact as the RCDs had ngūng the line so skewed enough appropriate sensitivity 30mA to protect against direct electric touch.

**Touching indirectly:**

Touching indirectly is the condition of the person in contact with the metal casing section appears the voltage, due to line problems do voltage metal casing to the tang of the dangerous levels, this voltage can cause electric current running through the human body when exposed to the metal sheath being touched.

Protection against indirect electric touch.

- Level 1: connect all metal casing of the device in the electrical network created an equipotential grid
- Level 2: automatic cut the supply to the electrical circuit mistakenly related to the requests between voltage/time exposure allowing safe voltage levels corresponding to exposure.

**16.7.2 THE FORM SITE MAP**

**TT-form diagrams**

![Diagram of TT-form](image)

Characteristics of the diagram: connection point stars (or connect the roll down of distribution transformers pá mỳ) of the source will connect directly with the Earth, grounding parts and conductor will naturally be the common connection to grounding pole of the Earth , This electrode can be independent or dependent on the electrode to electrode source, 2 the influence might cover taken together that do not affect the operation of the protection device.
**TN-form diagrams**

Diagram characteristics

- Sources of ground connection according to the diagrams TT
- Shell, metals and the natural grid conductor will be neutral wire connection

**Form diagrams TT**

**TN – C (4 wire) - diagrams**

Characteristics of the diagram:
- Neutral Wire and the wire guard is General be goi is the wire PEN
- This scheme does not permit the use for the cross-section
  - With copper wire not smaller than 10 mm²
  - With aluminium wire has not been less than 16mm²
- This diagram requires an equal pressure results in a grid with many repeated ground connection point
- In the first TN-C protection functions of the PEN is up top

**TN – S (5 wire) - diagrams**

- Neutral Point of the MBA is connected to Earth at the beginning of grid
- The metal Casing and a natural conductor is connected to the protective wire and connections with the central computer of the MBA
- Wire Guard and neutral wire is distinct, for lead sheath cable line protection is often the lead sheath
- Site map are not allowed to use for:
  - With copper wire not smaller than 10 mm²
  - With aluminium wire has not been less than 16mm²
- With site map TN-S wire neutral wire with a separate PE and is determined by the line of the greatest problems may occur

**TN – C – S diagrams**
• In your network diagram by wire cross-section can change often have a combination between the two diagrams TN-C and TN-S should be called site map TN-S-C, two diagrams are used Chung for a mesh.
• Site map TN-C-S, diagram of TN-C (4 wires) was never used after the diagram of the TN-S.
• Equinox line PE PE wire is usually separated from the beginning of grid.
• TN-C in the diagram, the protection of the PEN is put on top, the PEN should be ground connection directly with the device's ground connector then connect with the new head of central computer equipment.
• Wire PEN being League to the central computer.
• Make ground connection to repeat in the necessary position along the line PEN.
• Wire PEN not be cut in any case.

16.7.3 SELECTION DIAGRAM

When choosing grounding diagram need separate cases analysis and the final selection was based on the special grid tied roast.

The method chosen must satisfy the following standards scramble:
• Against electric shock.
• Provide your lien continue.
• Fire resistant electric.
• Protect the pressure too quickly.
• Electromagnetic protection.

Here due to economic requirements, and should we content environment diagram of TN-C-S.

16.7.4 THE SAFETY GROUND CONNECTION

For power network voltage 1000V, grounding resistors at each time of the year is not exceeded $4 \Omega$ (Rdyc = $4 \Omega$), Private small devices, the total capacity of the transformer is not exceeded 100KVA allows 10 $\Omega$ .

So we choose the grounding resistor allows the required standard is: Rdyc = $4 \Omega$
• To calculate preliminary we choose:
Select the electrical resistivity of the soil: E23 table "electrical installation design guide according to international standard IEC" soil specific resistance is: $\rho_d = 200 \ \Omega \cdot m$.

Choose a pole ground connection: a rectangle, each of length $c$ at least 0, 5 m, to be chosen according to the vertical direction so that the heart of a how the soil surface of at least 1 m.

A 3 mm thick plated steel pole.

The approximate resistance is determined:

$$R = \frac{0.8 \times \rho}{L}$$

In that

- $L$ – the perimeter of a pole (m)
- $\rho$ – electrical resistivity of soils ($\Omega \cdot m$)

vày để nói đất an toàn thì $R \leq R_{ady}$

### 16.7.5 CALCULATION OF GROUNDING ELECTRODE 1 STAKES

- Electricity vertical 2.5 m long pile using steel angle L 60 * 60 * 6
- Electrical resistivity of the soil in place of ground connection (when humidity = 10-20% of the weight $\rho = 10^{4}(\Omega / cm)$)
- Correction factor of electrical resistivity of soils $K_{\text{max}}=1,4$
- With the buried deep $t_0 = 0,8$ (m); pile length $L = 2,5$ (m)

$$t = t_0 + \frac{L}{2} = 0,8 + \frac{2,5}{2} = 2,05$$

- Computation of ground resistivity for the electrodes is vertical piles:

$$\rho_{tt} = K_{\text{max}} \times \rho = 1,4 \times 10^4 = 14000(\Omega / cm) = 140(\Omega / m)$$

- Electrodes used in steel piles L 60 * 60 * 6 external diameter equal value is calculated as follows:

$$d = 0,95 \times b = 0,95 \times 0,06 = 0,057m$$

- So grounding resistance of a pile is determined as follows:

$$R_{1_{\text{cc}}} = \frac{\rho_{tt}}{2 \times \pi \times L} \times \left( \ln \frac{2 \times L}{d} + \frac{1}{2} \times \log \frac{4 \times t + L}{4 \times t - L} \right)$$

$$R_{1_{\text{cc}}} = \frac{140}{2 \times \pi \times 2,5} \times \left( \ln \frac{2 \times 2,5}{0,057} + \frac{1}{2} \times \log \frac{4 \times 2,05 + 2,5}{4 \times 2,05 - 2,5} \right) = 41,12\Omega$$

Preliminary determination of pile:

$$n = \frac{R_{1_{\text{cc}}}}{\eta_c \times R_d}$$

In that
\( R_d \): the inner ground resistance as defined

\( \eta_c \): deposit use coefficient \( \eta_c = 0,62 \) (tables using coefficients of piles and the horizontal bar)

\[
\eta_c = \frac{41,12}{0,62 \times 4} = 16,6 \, \text{coc}
\]

We choose 17 stakes

Determine the horizontal connection of resistors:

\[
R_t = \frac{\rho_w}{2 \times \pi \times L} \times \ln \left( \frac{2 \times L^2}{b \times \tau_0} \right)
\]

in that:

\[
\rho_w = \rho_d \times K_{max} = 10^4 \times 3 (\Omega/cm) = 300 (\Omega/m)
\]

\[L = 2 \times (a + b) = 2 \times (10 + 5) = 30 \, \text{m} \, \text{(the perimeter ring circuits)}\]

\[b = 0,04 \, \text{m thickness}\]

\[
R_t = \frac{300}{2 \times \pi \times 30} \times \ln \left( \frac{2 \times 30^2}{0,04 \times 0,7} \right) = 17,63 \, \Omega
\]

➢ Resistor required for the full number of piles:

\[
R_t' = \frac{R_t}{\eta_t} = \frac{17,63}{0,3} = 58,77 \, \Omega
\]

➢ The number of columns is determined exactly:

\[
N = \frac{R_1 \text{coc}}{\eta_c \times R_c} = \frac{41,18}{0,62 \times 4,29} = 15,48 \, \text{coc}
\]

We select 15 stakes

➢ Check the grounding resistor of 15 columns

\[
R = \frac{R_1 \text{coc}}{\eta_c \times N} = \frac{41,18}{0,62 \times 15} = 4,43 \, \Omega
\]

➢ Resistance of grounding system includes stakes and rods
16.8 CALCULATION OF LIGHTNING PROTECTION For BUILDINGS

16.8.1 THE CONCEPT OF LIGHTNING AND LIGHTNING PROTECTION

a. Concept of lightning

In the atmosphere, between the clouds when the area of the left will produce electric charge. Before the electrical discharge of lightning had the division and accrued charges are very high in the clouds, thunderstorms, due to the impact of the hot air rises and the water vapor condenses in the cloud. The voltage between the cloud and the earth to newt worth tens, even hundreds of millions of volts. Between the clouds and the earth formed the giant capacitor. The intensity of the electric field of the capacitor between the cloud and the earth keeps growing and if the intensity of the electric field reaches the critical value (kv/cm 25-30) then start the discharge or called lightning.

b. The consequences of lightning and the protection against direct lightning:

When choosing the method of direct lightning strike countering guard report on the works, need to choose the appropriate protect method with structural characteristics, purpose of use, requirements of the technology in the process of.

Lightning directly into the power lines cause more serious harm, such as disrupting the power supply of the system, do short circuit, ground the phases in the electrical equipment due to overvoltage leads to damaged insulation of the equipment. When lightning struck the electrical works, buildings; the current lightning generated will cause the use of heat, electrical, mechanical strabismus from causing property damage: widgets, device and danger to human life, therefore, protection against lightning is the need for the works.

The landing location of the lightning selected feature, advisable in technical people that selective lqidung to protect lightning straight into the work. By using the stick or wire metal lightning is connected fine, placed higher than the real estate works are protected for Lightning on it and limit the possibility of lightning on the work.

The protection against direct lightning strike is usually accomplished by methods using wire or lightning-lightning-column, including: Division lightning, grounding parts and components led power dissipation of the lightning line ground (connects from lightning and grounding parts).

Contains the type of the type of lightning-like:

- Lightning-set independent Column.
- Lightning collectors (stretch wire shape antenna).
- Grids lightning (lightning-line).
- Lightning-parts mixture, including columns and lightning lightning associated with each other.

❖ Direct lightning strike protection

The principles of the protector
- Lightning protection according to key principles:
Apply to works under 15 m level and works are not important, according to the key protection method, only those parts are often lightning must protect. As for the roof by using the key, protect the four corners, roof and wall surrounding the structure rises from the ground, for the roof slopes, is the top in the corner, the roof of the Bank and leading the structure rises up from the roof.

- Protect the entire principle:

Apply for the high works on 20 m and the explosive important works. According to this principle, then the whole project must be in the scope of protection of the lightning-column. Here for this building has a height of 42.5 m we will implement measures to protect the whole and will have 2 options to perform, that's lightning protection using classic and lightning protection lightning protection using special lightning head.

### 16.8.2 CALCULATION OF LIGHTNING

#### A. Protection radius

Giant sale of lightning protection is determined by the formula

\[ R_p = \sqrt{h(2D - h) + \Delta L(2D + \Delta L)} \geq 5m \]

In that:

- \( R_p \): the radius of lightning protection (m)
- \( D = 20m, 45m, 60 \): for protection levels 1, 2, 3,
- \( H \): the height of the lightning is calculated from the tip of the needle to the protected surface (m).
- \( \Delta L \): the gain of the first rays directed distance is calculated by the formula: \( \Delta L = 10^{6} \Delta T \)

**Radius of the Stormaster Lightning Protection Needle**

<table>
<thead>
<tr>
<th>PROTECTION RADIUS (M) – (RP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H = height of Stormaster needle in protected area (m)</td>
</tr>
<tr>
<td>Level 1 (top level)</td>
</tr>
<tr>
<td>Stormaster 15</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Stormaster 30</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Stormaster</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Stormaster 60</td>
</tr>
<tr>
<td>Stormaster 15</td>
</tr>
<tr>
<td>Stormaster 30</td>
</tr>
<tr>
<td>Stormaster 50</td>
</tr>
<tr>
<td>Stormaster 60</td>
</tr>
<tr>
<td><strong>Level 2 (high protection)</strong></td>
</tr>
<tr>
<td>Stormaster 60</td>
</tr>
<tr>
<td>Stormaster 60</td>
</tr>
<tr>
<td><strong>Level 3 (level of protection standards)</strong></td>
</tr>
<tr>
<td>Stormaster 15</td>
</tr>
<tr>
<td>Stormaster 30</td>
</tr>
<tr>
<td>Stormaster 50</td>
</tr>
<tr>
<td>Stormaster 60</td>
</tr>
</tbody>
</table>

- With the size of the entire home:
  + Length: 62 m
  + Width: 27 m
  + I select standard level level 1 (high protection): \( d = 79 \) m
  + Stormaster 60 metal type the height of the needle with the need to protect \( h = 5 \) m.
  + Radius of buildings:

\[
D' = \sqrt{62^2 + 27^2} = 67.6 \text{ m} < D = 79 \text{ m}
\]
We choose the Stormaster 60 with a protection radius of 79 m.

b. Earthing of lightning:

❖ Concept
Installation of the approach based on a wide range of soil types, each type has different electrical properties, the choice of a single real estate marketing techniques depending on both the land and the economy. A problem associated with the transmission of a pulse on the Earth, it causes the voltage at the point of lightning, voltage decreases with the distance from the point of lightning and create the dangerous step for humans.
The common ground connection method:
- Single wire, connect the air clay-poor results in the head only one way, the high ground at the place where the lightning.
- Grounding the single-propeller, tidbits: ideal for areas with higher ground impedance, formed a path for Lightning and power combined with high ability.
- Land lot: put the column the column depending on the depth of the close distance between the columns columns near by 2 times the depth.
- Approach the deep cavity: where are needed where the underground water level is low, mostly making occasional exposure into the hole and columns.

❖ Calculate grounding lightning protection for buildings:
➢ Grounding resistors are in the range specified from 4 to 10 Ω
➢ Electrical resistivity of the soil in place of ground connection (when humidity = 10-20% of the weight ρ = 10^4 (Ω/cm))
➢ Select the coefficient of the season \( K_m = 1,15 \) for piles, \( K_m = 1,2 \) for the rob
➢ Resistivity for piles

\[
\rho_{tt} = K_m \times \rho = 1,15 \times 10^4 = 11500(\Omega/cm) = 115(\Omega/m)
\]

➢ Electrical resistivity for the rob

\[
\rho_{tt} = K_m \times \rho = 1,2 \times 10^4 = 12000(\Omega/cm) = 120(\Omega/m)
\]

➢ Select the steel pile 6 cm in diameter, length \( l = 3 \) m, buried deep \( t_c = 0,7 \) m. The chinense buried within \( a = 3 \) m.
➢ Select the horizontal bar made of steel plates, cross-section 40 x 4 mm\(^2\) buried after \( t_i = 0,7 \) m,
➢ Grounding resistance of pile:

\[
R_{Pile} = \frac{\rho_{tt}}{2 \times \pi \times L} \times \left( \ln \frac{2 \times L}{d} + \frac{1}{4} \times \log \frac{4 \times t + L}{4 \times t - L} \right)
\]

➢ With the buried deep \( t_0 = 0,7 \) (m); pile length \( L = 2,5 \) (m)

\[
T = T_c + \frac{L}{2} = 0,7 + \frac{3}{2} = 2,2 \text{ m}
\]

\[
R_{Pile} = \frac{115}{2 \times \pi \times 3} \times \left( \ln \frac{2 \times 2,5}{0,06} + \frac{1}{4} \times \log \frac{4 \times 2,2 + 2,5}{4 \times 2,2 - 2,5} \right) = 27,77\Omega
\]

➢ Identify preliminarily of piles:
We selected 12 stakes

➢ Check the grounding resistor of 12 stakes

\[ R = \frac{r_{1, c_n}}{H_c \times n} = \frac{27,77}{0,62 \times 12} = 3,73 \ \Omega \]

➢ The length of the rods that connect the stakes together:

\[ L = (N - 1) \times a = (12 - 1) \times 3 = 33 \text{m} \]

➢ Identify the resistors of the horizontal connection

\[ R_T = \frac{P_T}{2 \times \pi \times L} \times \left( \frac{2 \times L^2}{B \times T_0} \right) \]

In that:

\[ L = 2 \times (A + b) = 2 \times (72,4 + 28,8) = 202,4 \text{ m (the perimeter ring circuits)} \]

\[ B = 0,04 \text{ m thickness} \]

\[ R_T = \frac{120}{2 \times \pi \times 100} \times \left( \frac{2 \times 202^2}{0,04 \times 0,7} \right) = 2,84 \ \Omega \]

➢ Resistors of the rod connected to the digital system using the rod \( H_T = 0,3 \)

\[ R_T' = \frac{R_T}{H_T} = \frac{2,84}{0,3} = 9,46 \ \Omega \]

➢ Resistance of grounding system includes stakes and rods

\[ R_T' = \frac{R_T}{R + R_T} = \frac{3,73 \times 2,84}{3,73 + 2,84} = 1,61 \ \Omega \]