

# LAMPIRAN

## Lampiran A. Surat Balasan Tempat Penelitian



Nomor : 001/SPTA-KAP/II/24-EWO

Lampiran : -

Perihal : Balasan Surat Izin Permohonan Penelitian Tugas Akhir

Kepada Yth,  
Dekan Fakultas Teknik  
Universitas 17 Agustus 1945 Surabaya  
Di tempat

Berdasarkan surat dari Universitas 17 Agustus 1945 Surabaya Nomor : 34/K/FT/Akd/2024 yang diberikan kepada Perusahaan kami PT.Kencana Alam Putra tentang permohonan Penelitian Tugas Akhir, maka dengan ini **Memberikan Izin** untuk melakukan **Penelitian Tugas Akhir** dikantor maupun diproyek PT.Kencana Alam Putra kepada :

Nama : Moch Zainal Arifin  
NIM : 1452000013  
Prodi : Teknik Elektro  
Fakultas : Teknik

Demikian surat ini atas perhatiannya kami ucapkan terimakasih.

Hormat Kami,  
PT.Kencana Alam Putra

PT. KENCANA ALAM PUTRA  
SURABAYA

Eko Widodo  
Manajer Electrical



## Lampiran C. Data perbandingan dari software ETAP 19.0.1

|           |                  |           |                                 |
|-----------|------------------|-----------|---------------------------------|
| Project:  | <b>ETAP</b>      | Page:     | 1                               |
| Location: | 19.0.1C          | Date:     | 05-12-2024                      |
| Contract: |                  | SN:       |                                 |
| Engineer: | Study Case: GRD1 | Filename: | Grounding grid semen<br>grbogan |

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### Electrical Transient Analyzer Program

#### Ground Grid Systems

IEEE Std 80-2000/2013

|                                    |              |
|------------------------------------|--------------|
| Number of Ground Conductors:       | 34           |
| Number of Ground Rods:             | 0            |
| Total Length of Ground Conductors: | 2160.00 m    |
| Total Length of Ground Rods:       | 0.00 m       |
| Total Computational Time:          | 0.00 minutes |

|                   |   |
|-------------------|---|
| Frequency:        | 50.0  |
| Unit System:      | Metric  |
| Project Filename: | Grounding grid semen grbogan                                  |
| Output Filename:  | C:\ETAP 1901\Grounding grid semen grbogan\Grid1_Untitled.GR1S |

|           |                  |           |                                 |
|-----------|------------------|-----------|---------------------------------|
| Project:  | ETAP             | Page:     | 2                               |
| Location: | 19.0.1C          | Date:     | 05-12-2024                      |
| Contract: |                  | SN:       |                                 |
| Engineer: | Study Case: GRD1 | Filename: | Grounding grid semen<br>grbogan |

**Ground Grid Input Data**

**System Data**

| Freq.<br>Hz | Weight<br>kg | Ambient<br>Temp.<br>°C | Short-Circuit Current           |                       |                       |                                      | Fault Duration (Seconds)                    |  |      |
|-------------|--------------|------------------------|---------------------------------|-----------------------|-----------------------|--------------------------------------|---|--|------|
|             |              |                        | Total<br>Fault<br>Current<br>kA | Sf<br>Division<br>X/R | Cp<br>Projection<br>% | If<br>for<br>Total Fault<br>Duration | Ic<br>for<br>Sizing<br>Ground<br>Conductors | Is<br>for<br>Available<br>Body Current |      |
| 50.0        | 50           | 40.00                  | 40.000                          | 10.00                 | 60.0                  | 100.0                                | 1.00  | 1.00                                   | 1.00 |

**Soil Data**

| Surface Material |                      |            | Upper Layer Soil |                      |            | Lower Layer Soil |                      |
|------------------|----------------------|------------|------------------|----------------------|------------|------------------|----------------------|
| Material Type    | Resistivity<br>ohm.m | Depth<br>m | Material Type    | Resistivity<br>ohm.m | Depth<br>m | Material Type    | Resistivity<br>ohm.m |
| Crushed rock     | 5000.0               | 0.200      | Moist soil       | 4.1                  | 1.00       | Moist soil       | 0.0                  |

**Material Constants**

| Conductor/Rod   | Type                        | Conductivity<br>% | $\alpha_r$ Factor<br>@ 20 °C<br>1/°C | K0 @<br>0 °C | Fusing<br>Temperature<br>°C | Resistivity of<br>Ground Conductor<br>@ 20°C<br>micro ohm.cm | Thermal<br>Capacity<br>Per Unit Volume<br>J/(cm³.°C) |
|-----------------|-----------------------------|-------------------|--------------------------------------|--------------|-----------------------------|--|--|
| Conductor & Rod | Copper, annealed soft-drawn | 100.0             | 0.00393                              | 234.0        | 1033.0                      | 1.72   | 342  |

**Rod Data**

| Diameter<br>cm | Length<br>m | No. of<br>Rods | Arrangement               | Cost<br>\$/Rod |
|----------------|-------------|----------------|---------------------------|----------------|
| 2.000          | 10.00       | 0              | Rods Throughout Grid Area | 100.00         |

**Grid Configuration**

| Conductor<br>Size<br>mm² | Depth<br>m | Grid Length m |       | Number of Conductor |                   | Separation m      |                   | Cost<br>\$/m |
|--------------------------|------------|---------------|-------|---------------------|-------------------|-------------------|-------------------|--------------|
|                          |            | Lx            | Ly    | in X<br>Direction   | in Y<br>Direction | in X<br>Direction | in Y<br>Direction |              |
| 150                      | 0.80       | 108.00        | 45.00 | 10                  | 24                | 4.7               | 5.0               | 10.00        |



Shape: Rectangular

**Cost**

| Conductor |                   |            | Rod       |                   |            | Total Cost<br>\$ |
|-----------|-------------------|------------|-----------|-------------------|------------|------------------|
| Total No. | Total Length<br>m | Cost<br>\$ | Total No. | Total Length<br>m | Cost<br>\$ |                  |
| 34        | 2160              | 21600.00   | 0         | 0                 | 0.00       | 21600.00         |

|           |                  |           |                                 |
|-----------|------------------|-----------|---------------------------------|
| Project:  | <b>ETAP</b>      | Page:     | 3                               |
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**Ground Grid Summary Report**

| Rg<br>Ground<br>Resistance<br>ohm | GPR<br>Ground<br>Potential Rise<br>Volts | Touch Potential    |            |      | Step Potential     |            |     |
|-----------------------------------|--|--------------------|------------|------|--------------------|------------|-----|
|                                   |  | Tolerable<br>Volts | Calculated |      | Tolerable<br>Volts | Calculated |     |
|                                   |  |                    | Volts      | %    |                    | Volts      | %   |
| 0.028                             | 675.6                                    | 826.3              | 87.2       | 10.6 | 2957.3             | 56.7       | 1.9 |

|                       |           |                                     |        |
|-----------------------|-----------|-------------------------------------|--------|
| Total Fault Current:  | 40.000 kA | Reflection Factor (K):              | -0.998 |
| Maximum Grid Current: | 24.379 kA | Surface Layer Derating Factor (Cs): | 0.816  |
|                       |           | Decrement Factor (Df):              | 1.016  |

**Report of Intermediate Constants for IEEE 80 Methods**

- Correction factor for grid geometry regarding touch voltage (K<sub>im</sub>): 2.833
- Correction factor for grid geometry regarding step voltage (K<sub>is</sub>): 2.833
- Spacing factor for touch voltage (K<sub>m</sub>): 0.659
- Spacing factor for step voltage (K<sub>s</sub>): 0.321
- Corrective weighting factor that adjusts for the effects of inner conductors on the corner mesh (K<sub>ii</sub>): 0.633
- Constants 1 related to the geometry of system (K<sub>1</sub>): 1.307
- Constants 2 related to the geometry of system (K<sub>2</sub>): 5.696

## Lampiran D. Perhitungan MAPE dari data perhitungan manual dengan hasil software ETAP

MAPE adalah Mean Absolute Percentage Error pengertian MAPE sendiri yaitu Pengukuran statistik tentang akurasi perkiraan pada metode peralaman. Metode MAPE memberikan informasi seberapa besar kesalahan peramalan atau perhitungan manual dengan nilai sebenarnya atau nilai perbandingan dari software atau sumber yang lainnya. Semakin kecil nilai presentasi kesalahan (percentage error) pada MAPE maka semakin akurat hasil peramalan atau perhitungan tersebut dan nilai paling bagus yaitu dibawah 10%.

PERHITUNGAN MAPE ANTARA DATA HASIL PERHITUNGAN MANUAL DENGAN SOFTWARE  
ETAP 19.0.1

| No | Jenis nilai yang akan dibandingkan       | Hasil dari ETAP 19 | Hasil Perhitungan Manual | Error    | Nilai Absolut Error | Nilai absolut error dibagi dengan nilai Aktual | MAPE |
|----|--|--------------------|--------------------------|----------|---------------------|--|------|
|    |  | At                 | Ft                       | At - Ft  | At - Ft             | (At - Ft)/At                                   | %    |
| 1  | Factor Derating (Cs)                     | 0.816              | 0.8164                   | -0.0004  | 0.0004              | 0.000490196                                    | 0.05 |
| 2  | Tegangan Sentuh yang Diizinkan           | 826.3              | 852.9                    | -26.6    | 26.6                | 0.032191698                                    | 3.22 |
| 3  | Tegangan Langkah yang diizinkan          | 2957.3             | 2955.6                   | 1.7      | 1.7                 | 0.000574849                                    | 0.06 |
| 4  | Decrement Factor (Df)                    | 1.016              | 1.031                    | -0.015   | 0.015               | 0.01476378                                     | 1.48 |
| 5  | Anus Maksimal Grid                       | 24379              | 24740                    | -361     | 361                 | 0.014807826                                    | 1.48 |
| 6  | Tahanan Pentaratan                       | 0.028              | 0.0276                   | 0.0004   | 0.0004              | 0.014285714                                    | 1.43 |
| 7  | Ground Potential Ratio (GPR)             | 675.6              | 682.8                    | -7.2     | 7.2                 | 0.010657194                                    | 1.07 |
| 8  | Faktor berat koreksi (Kii)               | 0.633              | 0.623                    | 0.01     | 0.01                | 0.015797788                                    | 1.58 |
| 9  | Faktor jarak untuk tegangan sentuh (Km)  | 0.659              | 0.699                    | -0.04    | 0.04                | 0.060698027                                    | 6.07 |
| 10 | Tegangan sentuh aktual (Em)              | 87.2               | 90.5                     | -3.3     | 3.3                 | 0.037844037                                    | 3.78 |
| 11 | Faktor jarak untuk tegangan langkah (Ks) | 0.321              | 0.317                    | 0.004    | 0.004               | 0.012461059                                    | 1.25 |
| 10 | Tegangan langkah aktual (Es)             | 56.7               | 54.7                     | 2        | 2                   | 0.035273369                                    | 3.53 |
|    |  |                    |                          | <b>n</b> |                     | 1  |      |

## Lampiran E. Kartu Asistensi Bimbingan

PROGRAM STUDI - TEKNIK ELEKTRO  
 FAKULTAS TEKNIK - UNIVERSITAS 17 AGUSTUS 1945 SURABAYA

### KARTU ASISTENSI

PRAKT./TUGAS : Tugas Akhir NAMA : Moch. ZAINAL A  
 N.B.I : 1452000013  
 SEMESTER/THN : 8 / 2024 SEMESTER/THN : 8 / 2024

| NO. | TANGGAL | MATERI / KOMENTAR / SARAN                | TTD,<br>PEMBIMBING |
|-----|---------|--|--------------------|
| 1.  |         | Bab I                                    | <i>[Signature]</i> |
| 2.  | 27/2 24 | Bab II                                   | <i>[Signature]</i> |
| 3.  | 7/5 24  | Bab II perlu dicek kembali               | <i>[Signature]</i> |
| 4.  | 14/5 24 | Perhatikan kesimpulan & Perhitungan MAPE | <i>[Signature]</i> |
| 5.  | 16/5 24 | Bab IV                                   | <i>[Signature]</i> |
| 6.  | 20/5 24 | Pemilihan desain konfigurasi grounding   | <i>[Signature]</i> |
| 7.  | 24/5 24 | Perhitungan tegangan langkah dan sentuh  | <i>[Signature]</i> |
| 8.  | 28/5 24 | Final desain grounding dan kesimpulan    | <i>[Signature]</i> |
| 9.  | 01/6 24 | PPT, Buku masih Revisi                   | <i>[Signature]</i> |

POTONG DISINI

BUKTI PENYELESAIAN TUGAS ( untuk mahasiswa )  
 • Di foto copy, masukan ke kotak nilai

BUKTI PENYELESAIAN TUGAS ( untuk mahasiswa )

|                              |         |
|------------------------------|---------|
| PRAKT./TUGAS .....           | NILAI : |
| SEMESTER/THN .....           |         |
| NAMA .....                   |         |
| N B I .....                  |         |
| PRAKT./JUDUL TUGAS : .....   |         |
| Tanggal,<br>DOSEN PEMBIMBING |         |
| ( )                          |         |

|                              |         |
|------------------------------|---------|
| PRAKT./TUGAS .....           | NILAI : |
| SEMESTER/THN .....           |         |
| NAMA .....                   |         |
| N B I .....                  |         |
| PRAKT./JUDUL TUGAS : .....   |         |
| Tanggal,<br>DOSEN PEMBIMBING |         |
| ( )                          |         |

PERHATIAN : PENGISIAN DATA DIKETIK !!!