

## **LAMPIRAN-LAMPIRAN**

## Lampiran 1



KEMENTERIAN RISET, TEKNOLOGI, DAN PENDIDIKAN TINGGI  
UNIVERSITAS NEGERI YOGYAKARTA  
FAKULTAS TEKNIK

Alamat : Kampus Karangmalang, Yogyakarta, 55281  
Telp. (0274) 586168 psw. 276,289,292 (0274) 586734 Fax. (0274) 586734  
Laman: ft.uny.ac.id E-mail: ft@uny.ac.id, teknik@uny.ac.id

Nomor : 283/UN34.15/LT/2019  
Lampiran : -  
Hal : Permohonan Izin Observasi

28 Februari 2019

Yth . Pimpinan PT PLN ( Persero ) TJBT UPT Salatiga  
Jl. Diponegoro No.149, Sidorejo Lor, Sidorejo, Kota Salatiga, Jawa Tengah 50714

Kami sampaikan dengan hormat, bahwa mahasiswa tersebut di bawah ini, akan melaksanakan observasi di lingkungan instansi yang Bapak/Ibu pimpin, dalam rangka untuk melengkapi tugas mata kuliah "Tugas Akhir" atas nama :

| No | Nama            | NIM         | Prodi               |
|----|-----------------|-------------|---------------------|
| 1  | Pupung Pamuji   | 16506134037 | Teknik Elektro - D3 |
| 2  | Fahri Ali Sidik | 16506134029 | Teknik Elektro - D3 |

Waktu Pelaksanaan : 4 - 16 Maret 2019  
Observasi

Judul / Keperluan : OBSERVASI DI PT. PLN GARDU INDUK 150 KV WIROBRAJAN TENTANG GANGGUAN DAN SISTEM KEAMANAN PADA SISTEM DISTRIBUSI TENAGA LISTRIK SEBAGAI BAHAN PENELITIAN TUGAS AKHIR

Untuk dapat terlaksananya maksud tersebut, kami mohon dengan hormat Bapak/Ibu berkenan memberi izin dan bantuan seperlunya.

Atas izin dan bantuannya diucapkan terima kasih.

Dekan,

Dr. Ir. Drs. Widarto, M.Pd.  
NIP. 19631230 198812 1 001

Tembusan :  
1. Sub. Bagian Pendidikan;  
2. Mahasiswa yang bersangkutan.

## Lampiran 2



PLN ( Persero )  
UNIT INDUK TRANSMISI JAWA BAGIAN TENGAH  
UNIT PELAKSANA TRANSMISI SALATIGA

PLN

Jl. Diponegoro 149, Salatiga 50714  
Telepon : (0298)323167

Facsimile : (0298)323169

Web : www.pln.co.id

Nomor : 0049 /SDM.04.09/UPT SLT/2019  
Surat Sdr No : -  
Lampiran : 1 (satu) lembar  
Sifat : Biasa  
Perihal : Perijinan Observasi

05 April 2019

KEPADA :  
UNIVERSITAS NEGERI  
YOGYAKARTA  
FAKULTAS TEKNIK  
Karangmalang  
YOGYAKARTA 55281

Menjawab surat Saudara No. 283/UN34.15/LT/219 tanggal 28 Februari 2019 perihal Permohonan Izin Observasi dengan ini kami beritahukan bahwa pada prinsipnya kami dapat menerima permohonan tersebut, adapun Mahasiswa Saudara yang akan melakukan observasi untuk keperluan Tugas Akhir adalah :

| No. | Nama            | NIM         | Jurusan             |
|-----|-----------------|-------------|---------------------|
| 1.  | Pupung Pamuji   | 16506134037 | D3 - Teknik Elektro |
| 2.  | Fahri Ali Sidik | 16506134029 | D3 - Teknik Elektro |

Untuk melaksanakan observasi di kantor PT PLN (Persero) Unit Induk Transmisi Jawa Bagian Tengah Unit Pelaksana Transmisi Salatiga ULTG Yogyakarta Gardu Induk Wirobrajan pada tanggal 08 s.d 12 April 2019 dengan judul "Observasi di PT. PLN Gardu Induk 150 kV Wirobrajan Tentang Gangguan dan Sistem Keamanan pada Sistem Distribusi Tenaga Listrik sebagai Bahan Penelitian Tugas Akhir".

Selama melaksanakan observasi dimohon untuk mengikuti aturan yang berlaku di PT PLN (Persero) Unit Induk Transmisi Jawa Bagian Tengah Unit Pelaksana Transmisi Salatiga sesuai Informasi untuk peserta (terlampir).



PT PLN (PERSERO) UNIT INDUK TRANSMISI JAWA BAGIAN TENGAH  
UNIT PELAKSANA TRANSMISI SALATIGA

Informasi untuk peserta riset/penelitian/kunjungan/observasi data :

1. Peserta harus mematuhi peraturan yang berlaku di lingkungan kerja PT PLN (Persero) UITJBT Unit Pelaksana Transmisi Salatiga.
2. Mengenakan seragam Almamater untuk hari Senin s.d. Kamis, batik untuk hari Jumat.
3. Apabila berhalangan hadir peserta wajib memberitahu pembimbing lapangan.
4. Jam pelaksanaan riset/penelitian/kunjungan :
  - a. Senin s.d. Kamis pukul 07.30 s.d. 16.00 WIB, istirahat pukul 12.00 s.d. 12.30 WIB.
  - b. Jumat pukul 07.30 s.d. 16.30 WIB, istirahat pukul 12.00 s.d. 13.00 WIB.
5. PT PLN (Persero) UITJBT Unit Pelaksana Transmisi Salatiga tidak menyediakan konsumsi, transportasi, dan penginapan.
6. Keselamatan kerja menjadi tanggung jawab masing-masing peserta riset/penelitian/pengambilan data.
7. Semua resiko / kerusakan peralatan yang disebabkan oleh peserta menjadi tanggung jawab yang bersangkutan.
8. Menyerahkan Hasil PKL/Penelitian (Laporan/Skripsi/Tesis/TA dll.) yang telah disahkan ke PT PLN (Persero) UITJBT Unit Pelaksana Transmisi Salatiga.

MANAGER KEU & ADM

  
SRI DARYATI

## Lampiran 3

2.1.1 Tabel XIII A - Penghantar AAC

| Penampang nominal (mm <sup>2</sup> ) | Jari-jari (mm) | Urat | GMR (mm) | Impedansi urutan positif ( $\Omega$ /km) | Impedansi urutan nol ( $\Omega$ /km) |
|--------------------------------------|----------------|------|----------|------------------------------------------|--------------------------------------|
| 16                                   | 2,2563         | 7    | 1,6380   | 1,8382+j 0,4035                          | 1,9862+j 1,6910                      |
| 25                                   | 2,8203         | 7    | 2,0475   | 1,1765+j 0,3895                          | 1,3245+j 1,6770                      |
| 35                                   | 3,3371         | 7    | 2,4227   | 0,8403+j 0,3791                          | 0,9883+j 1,6666                      |
| 50                                   | 3,9886         | 7    | 2,8957   | 0,5882+j 0,3677                          | 0,7362+j 1,6552                      |
| 70                                   | 4,7193         | 7    | 3,4262   | 0,4202+j 0,3572                          | 0,5682+j 1,6447                      |
| 95                                   | 5,4979         | 19   | 4,1674   | 0,3096+j 0,3464                          | 0,4576+j 1,6339                      |
| 120                                  | 6,1791         | 19   | 4,6837   | 0,2451+j 0,3375                          | 0,3931+j 1,6250                      |
| 150                                  | 6,9084         | 19   | 5,2365   | 0,1961+j 0,3305                          | 0,3441+j 1,6180                      |
| 185                                  | 7,6722         | 19   | 5,8155   | 0,1590+j 0,3239                          | 0,3070+j 1,6114                      |
| 240                                  | 8,7386         | 19   | 6,6238   | 0,1225+j 0,3157                          | 0,2705+ j 1,6032                     |

2.1.2 Tabel XIII B - Penghantar AAAC

| Penampang nominal (mm <sup>2</sup> ) | Jari-jari (mm) | Urat | GMR (mm) | Impedansi urutan positif ( $\Omega$ /km) | Impedansi urutan nol ( $\Omega$ /km) |
|--------------------------------------|----------------|------|----------|------------------------------------------|--------------------------------------|
| 16                                   | 2,2563         | 7    | 1,6380   | 2,0161+j 0,4036                          | 2,1641+j 1,6911                      |
| 25                                   | 2,8203         | 7    | 2,0475   | 1,2903+j 0,3895                          | 1,4384+j 1,6770                      |
| 35                                   | 3,3371         | 7    | 2,4227   | 0,9217+j 0,3790                          | 1,0697+j 1,6665                      |
| 50                                   | 3,9886         | 7    | 2,8957   | 0,6452+j 0,3678                          | 0,7932+ j 1,6553                     |
| 70                                   | 4,7193         | 7    | 3,4262   | 0,4608+j 0,3572                          | 0,6088+j 1,6447                      |
| 95                                   | 5,4979         | 19   | 4,1674   | 0,3396+j 0,3449                          | 0,4876+ j 1,6324                     |
| 120                                  | 6,1791         | 19   | 4,6837   | 0,2688+j 0,3376                          | 0,4168+j 1,6251                      |
| 150                                  | 6,9084         | 19   | 5,2365   | 0,2162+j 0,3305                          | 0,3631+j 1,6180                      |
| 185                                  | 7,6722         | 19   | 5,8155   | 0,1744+j 0,3239                          | 0,3224+ j 1,6114                     |
| 240                                  | 8,7386         | 19   | 6,6238   | 0,1344+j 0,3158                          | 0,2824+j 1,6033                      |

## Lampiran 4

### 1. Hasil Simulasi Arus Hubung Singkat 2 Phase Dengan ETAP Pada WBN 1

Jarak 0% (0 km)

Sequence-of-Operation Events - Output Report: L-G

Line-to-Line (Symmetrical) fault on bus: WBN1 Jarak 0%

Data Rev.: Base Config: Normal Date: 05-17-2019

| Time (ms) | ID         | If (kA) | T1 (ms) | T2 (ms) | Condition                                      |
|-----------|------------|---------|---------|---------|------------------------------------------------|
| 567       | Relay WBN1 | 11.175  | 567     |         | Phase - OC1 - 51                               |
| 650       | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Phase - OC1 - 51         |
| 945       | Relay WBN1 | 11.175  | < 945   |         | Overload Phase - Thermal                       |
| 1028      | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Overload Phase - Thermal |

Jarak 25% (2.2 km)

Sequence-of-Operation Events - Output Report: L-G

Line-to-Line (Symmetrical) fault on bus: WBN1 Jarak 25%

Data Rev.: Base Config: Normal Date: 05-17-2019

| Time (ms) | ID         | If (kA) | T1 (ms) | T2 (ms) | Condition                                      |
|-----------|------------|---------|---------|---------|------------------------------------------------|
| 668       | Relay WBN1 | 6.178   | 668     |         | Phase - OC1 - 51                               |
| 751       | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Phase - OC1 - 51         |
| 945       | Relay WBN1 | 6.178   | < 945   |         | Overload Phase - Thermal                       |
| 1028      | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Overload Phase - Thermal |

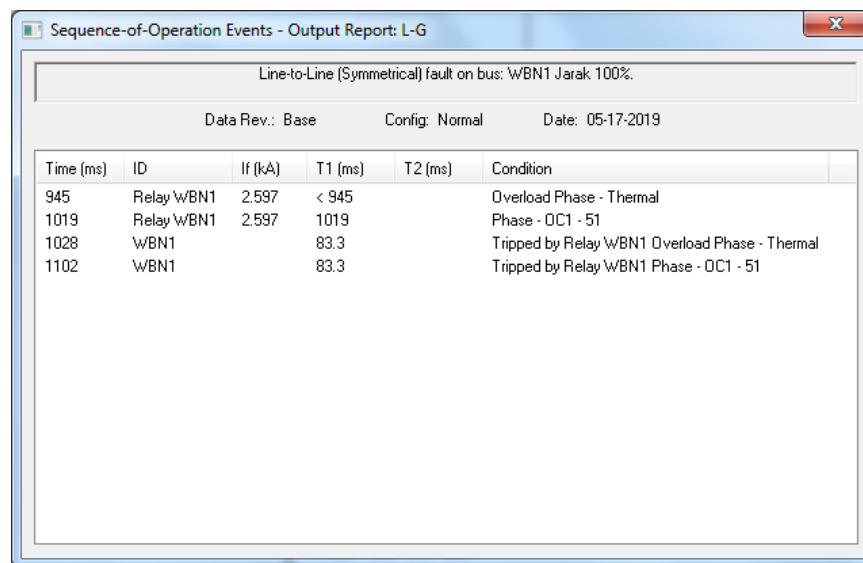
Jarak 50% (4.4 km)

| Sequence-of-Operation Events - Output Report: L-G       |            |                |         |                  |                                                |
|---------------------------------------------------------|------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Line (Symmetrical) fault on bus: WBN1 Jarak 50% |            |                |         |                  |                                                |
| Data Rev.: Base                                         |            | Config: Normal |         | Date: 05-17-2019 |                                                |
| Time (ms)                                               | ID         | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 786                                                     | Relay WBN1 | 4.24           | 786     |                  | Phase - OC1 - 51                               |
| 869                                                     | WBN1       |                | 83.3    |                  | Tripped by Relay WBN1 Phase - OC1 - 51         |
| 945                                                     | Relay WBN1 | 4.24           | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                    | WBN1       |                | 83.3    |                  | Tripped by Relay WBN1 Overload Phase - Thermal |

Jarak 75% (6.6 km)

| Sequence-of-Operation Events - Output Report: L-G       |            |                |         |                  |                                                |
|---------------------------------------------------------|------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Line (Symmetrical) fault on bus: WBN1 Jarak 75% |            |                |         |                  |                                                |
| Data Rev.: Base                                         |            | Config: Normal |         | Date: 05-17-2019 |                                                |
| Time (ms)                                               | ID         | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 902                                                     | Relay WBN1 | 3.222          | 902     |                  | Phase - OC1 - 51                               |
| 945                                                     | Relay WBN1 | 3.222          | < 945   |                  | Overload Phase - Thermal                       |
| 985                                                     | WBN1       |                | 83.3    |                  | Tripped by Relay WBN1 Phase - OC1 - 51         |
| 1028                                                    | WBN1       |                | 83.3    |                  | Tripped by Relay WBN1 Overload Phase - Thermal |

Jarak 100% (8.8 km)



Sequence-of-Operation Events - Output Report: L-G

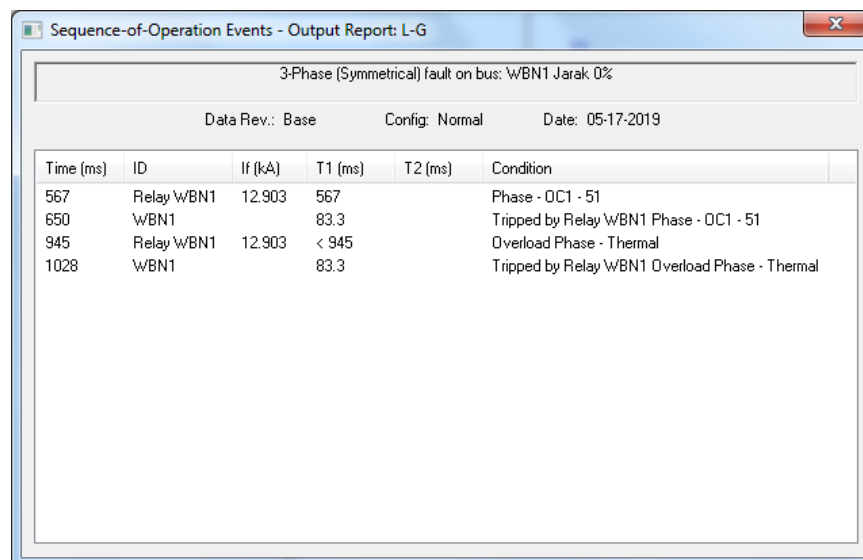
Line-to-Line (Symmetrical) fault on bus: WBN1 Jarak 100%.

Data Rev.: Base      Config: Normal      Date: 05-17-2019

| Time (ms) | ID         | If (kA) | T1 (ms) | T2 (ms) | Condition                                      |
|-----------|------------|---------|---------|---------|------------------------------------------------|
| 945       | Relay WBN1 | 2.597   | < 945   |         | Overload Phase - Thermal                       |
| 1019      | Relay WBN1 | 2.597   | 1019    |         | Phase - OC1 - 51                               |
| 1028      | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Overload Phase - Thermal |
| 1102      | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Phase - OC1 - 51         |

## 2. Hasil Simulasi Arus Hubung Singkat **3 Phase** Dengan ETAP Pada WBN 1

Jarak 0% (0 km)



Sequence-of-Operation Events - Output Report: L-G

3-Phase (Symmetrical) fault on bus: WBN1 Jarak 0%

Data Rev.: Base      Config: Normal      Date: 05-17-2019

| Time (ms) | ID         | If (kA) | T1 (ms) | T2 (ms) | Condition                                      |
|-----------|------------|---------|---------|---------|------------------------------------------------|
| 567       | Relay WBN1 | 12.903  | 567     |         | Phase - OC1 - 51                               |
| 650       | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Phase - OC1 - 51         |
| 945       | Relay WBN1 | 12.903  | < 945   |         | Overload Phase - Thermal                       |
| 1028      | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Overload Phase - Thermal |



Jarak 25% (2.2 km)

| Sequence-of-Operation Events - Output Report: L-G   |            |                |         |                  |                                                |
|-----------------------------------------------------|------------|----------------|---------|------------------|------------------------------------------------|
| 3-Phase (Symmetrical) fault on bus: WBN1 Jarak: 25% |            |                |         |                  |                                                |
| Data Rev.: Base                                     |            | Config: Normal |         | Date: 05-17-2019 |                                                |
| Time (ms)                                           | ID         | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 631                                                 | Relay WBN1 | 7.134          | 631     |                  | Phase - OC1 - 51                               |
| 714                                                 | WBN1       |                | 83.3    |                  | Tripped by Relay WBN1 Phase - OC1 - 51         |
| 945                                                 | Relay WBN1 | 7.134          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                | WBN1       |                | 83.3    |                  | Tripped by Relay WBN1 Overload Phase - Thermal |

Jarak 50% (4.4 km)

| Sequence-of-Operation Events - Output Report: L-G   |            |                |         |                  |                                                |
|-----------------------------------------------------|------------|----------------|---------|------------------|------------------------------------------------|
| 3-Phase (Symmetrical) fault on bus: WBN1 Jarak: 50% |            |                |         |                  |                                                |
| Data Rev.: Base                                     |            | Config: Normal |         | Date: 05-17-2019 |                                                |
| Time (ms)                                           | ID         | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 736                                                 | Relay WBN1 | 4.896          | 736     |                  | Phase - OC1 - 51                               |
| 820                                                 | WBN1       |                | 83.3    |                  | Tripped by Relay WBN1 Phase - OC1 - 51         |
| 945                                                 | Relay WBN1 | 4.896          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                | WBN1       |                | 83.3    |                  | Tripped by Relay WBN1 Overload Phase - Thermal |

Jarak 75% (6.6 km)

Sequence-of-Operation Events - Output Report: L-G

3-Phase (Symmetrical) fault on bus: WBN1 Jarak 75%

Data Rev.: Base      Config: Normal      Date: 05-17-2019

| Time (ms) | ID         | If (kA) | T1 (ms) | T2 (ms) | Condition                                      |
|-----------|------------|---------|---------|---------|------------------------------------------------|
| 837       | Relay WBN1 | 3.721   | 837     |         | Phase - OC1 - 51                               |
| 920       | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Phase - OC1 - 51         |
| 945       | Relay WBN1 | 3.721   | < 945   |         | Overload Phase - Thermal                       |
| 1028      | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Overload Phase - Thermal |

Jarak 100% (8.8 km)

Sequence-of-Operation Events - Output Report: L-G

3-Phase (Symmetrical) fault on bus: WBN1 Jarak 100%

Data Rev.: Base      Config: Normal      Date: 05-17-2019

| Time (ms) | ID         | If (kA) | T1 (ms) | T2 (ms) | Condition                                      |
|-----------|------------|---------|---------|---------|------------------------------------------------|
| 938       | Relay WBN1 | 2.999   | 938     |         | Phase - OC1 - 51                               |
| 945       | Relay WBN1 | 2.999   | < 945   |         | Overload Phase - Thermal                       |
| 1021      | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Phase - OC1 - 51         |
| 1028      | WBN1       |         | 83.3    |         | Tripped by Relay WBN1 Overload Phase - Thermal |

### 3. Hasil Simulasi Arus Hubung Singkat 1 Phase-Tanah Dengan ETAP Pada

WBN 4

Jarak 0% (0 km)

| Sequence-of-Operation Events - Output Report: Untitled |               |                |         |                  |                                                |
|--------------------------------------------------------|---------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Ground (Symmetrical) fault on bus: WBN 1 0%    |               |                |         |                  |                                                |
| Data Rev.: Base                                        |               | Config: Normal |         | Date: 05-22-2019 |                                                |
| Time (ms)                                              | ID            | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 521                                                    | OCR GFR WBN 1 | 13.206         | 521     |                  | Ground - OC1 - 51                              |
| 567                                                    | OCR GFR WBN 1 | 13.206         | 567     |                  | Phase - OC1 - 51                               |
| 605                                                    | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Ground - OC1 - 51     |
| 650                                                    | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Phase - OC1 - 51      |
| 945                                                    | OCR GFR WBN 1 | 13.206         | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                   | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Overload Phase - T... |

Jarak 25% (1.35 km)

| Sequence-of-Operation Events - Output Report: Untitled |               |                |         |                  |                                                |
|--------------------------------------------------------|---------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Ground (Symmetrical) fault on bus: WBN 1 25%   |               |                |         |                  |                                                |
| Data Rev.: Base                                        |               | Config: Normal |         | Date: 05-22-2019 |                                                |
| Time (ms)                                              | ID            | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 521                                                    | OCR GFR WBN 1 | 4.535          | 521     |                  | Ground - OC1 - 51                              |
| 605                                                    | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Ground - OC1 - 51     |
| 796                                                    | OCR GFR WBN 1 | 4.535          | 796     |                  | Phase - OC1 - 51                               |
| 880                                                    | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Phase - OC1 - 51      |
| 945                                                    | OCR GFR WBN 1 | 4.535          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                   | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Overload Phase - T... |

### Jarak 50% (4.4 km)

| Sequence-of-Operation Events - Output Report: Untitled |               |                |         |                  |                                                |
|--------------------------------------------------------|---------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Ground (Symmetrical) fault on bus: WBN 1 50%   |               |                |         |                  |                                                |
| Data Rev.: Base                                        |               | Config: Normal |         | Date: 05-22-2019 |                                                |
| Time (ms)                                              | ID            | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 526                                                    | OCR GFR WBN 1 | 2.732          | 526     |                  | Ground - OC1 - 51                              |
| 609                                                    | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Ground - OC1 - 51     |
| 945                                                    | OCR GFR WBN 1 | 2.732          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                   | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Overload Phase - T... |
| 1047                                                   | OCR GFR WBN 1 | 2.732          | 1047    |                  | Phase - OC1 - 51                               |
| 1131                                                   | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Phase - OC1 - 51      |

### Jarak 75% (6.6 km)

| Sequence-of-Operation Events - Output Report: Untitled |               |                |         |                  |                                                |
|--------------------------------------------------------|---------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Ground (Symmetrical) fault on bus: WBN 1 75%   |               |                |         |                  |                                                |
| Data Rev.: Base                                        |               | Config: Normal |         | Date: 05-22-2019 |                                                |
| Time (ms)                                              | ID            | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 595                                                    | OCR GFR WBN 1 | 1.954          | 595     |                  | Ground - OC1 - 51                              |
| 678                                                    | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Ground - OC1 - 51     |
| 945                                                    | OCR GFR WBN 1 | 1.954          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                   | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Overload Phase - T... |
| 1320                                                   | OCR GFR WBN 1 | 1.954          | 1320    |                  | Phase - OC1 - 51                               |
| 1403                                                   | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Phase - OC1 - 51      |

Jarak 100% (8.8 km)

| Sequence-of-Operation Events - Output Report: Untitled |               |                |         |                  |                                                |
|--------------------------------------------------------|---------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Ground (Symmetrical) fault on bus: WBN 1       |               |                |         |                  |                                                |
| Data Rev.: Base                                        |               | Config: Normal |         | Date: 05-22-2019 |                                                |
| Time (ms)                                              | ID            | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 659                                                    | OCR GFR WBN 1 | 1.521          | 659     |                  | Ground - OC1 - 51                              |
| 742                                                    | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Ground - OC1 - 51     |
| 945                                                    | OCR GFR WBN 1 | 1.521          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                   | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Overload Phase - T... |
| 1637                                                   | OCR GFR WBN 1 | 1.521          | 1637    |                  | Phase - OC1 - 51                               |
| 1720                                                   | WBN 1         |                | 83.3    |                  | Tripped by OCR GFR WBN 1 Phase - OC1 - 51      |

## Lampiran 5

### 1. Hasil Simulasi Arus Hubung Singkat 2 Phase Dengan ETAP Pada WBN 4

Jarak 0% (0 km)

Sequence-of-Operation Events - Output Report: L-G

Line-to-Line (Symmetrical) fault on bus: WBN4 Jarak 0%

Data Rev.: Base Config: Normal Date: 05-17-2019

| Time (ms) | ID         | If (kA) | T1 (ms) | T2 (ms) | Condition                                      |
|-----------|------------|---------|---------|---------|------------------------------------------------|
| 567       | Relay WBN4 | 11.175  | 567     |         | Phase - OC1 - 51                               |
| 650       | WBN4       |         | 83.3    |         | Tripped by Relay WBN4 Phase - OC1 - 51         |
| 945       | Relay WBN4 | 11.175  | < 945   |         | Overload Phase - Thermal                       |
| 1028      | WBN4       |         | 83.3    |         | Tripped by Relay WBN4 Overload Phase - Thermal |

Jarak 25% (1.35 km)

Sequence-of-Operation Events - Output Report: L-G

Line-to-Line (Symmetrical) fault on bus: WBN4 Jarak 25%

Data Rev.: Base Config: Normal Date: 05-17-2019

| Time (ms) | ID         | If (kA) | T1 (ms) | T2 (ms) | Condition                                      |
|-----------|------------|---------|---------|---------|------------------------------------------------|
| 620       | Relay WBN4 | 7.487   | 620     |         | Phase - OC1 - 51                               |
| 703       | WBN4       |         | 83.3    |         | Tripped by Relay WBN4 Phase - OC1 - 51         |
| 945       | Relay WBN4 | 7.487   | < 945   |         | Overload Phase - Thermal                       |
| 1028      | WBN4       |         | 83.3    |         | Tripped by Relay WBN4 Overload Phase - Thermal |

Jarak 50% (2.7 km)

| Sequence-of-Operation Events - Output Report: L-G       |            |                |         |                  |                                                |
|---------------------------------------------------------|------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Line (Symmetrical) fault on bus: WBN4 Jarak 50% |            |                |         |                  |                                                |
| Data Rev.: Base                                         |            | Config: Normal |         | Date: 05-17-2019 |                                                |
| Time (ms)                                               | ID         | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 695                                                     | Relay WBN4 | 5.599          | 695     |                  | Phase - OC1 - 51                               |
| 778                                                     | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Phase - OC1 - 51         |
| 945                                                     | Relay WBN4 | 5.599          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                    | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Overload Phase - Thermal |

Jarak 75% (4.05 km)

| Sequence-of-Operation Events - Output Report: L-G       |            |                |         |                  |                                                |
|---------------------------------------------------------|------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Line (Symmetrical) fault on bus: WBN4 Jarak 75% |            |                |         |                  |                                                |
| Data Rev.: Base                                         |            | Config: Normal |         | Date: 05-17-2019 |                                                |
| Time (ms)                                               | ID         | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 767                                                     | Relay WBN4 | 4.463          | 767     |                  | Phase - OC1 - 51                               |
| 851                                                     | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Phase - OC1 - 51         |
| 945                                                     | Relay WBN4 | 4.463          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                    | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Overload Phase - Thermal |

Jarak 100% (5.4 km)

Sequence-of-Operation Events - Output Report: L-G

Line-to-Line (Symmetrical) fault on bus: WBN4 Jarak 100%.

Data Rev.: Base      Config: Normal      Date: 05-17-2019

| Time (ms) | ID         | If (kA) | T1 (ms) | T2 (ms) | Condition                                      |
|-----------|------------|---------|---------|---------|------------------------------------------------|
| 839       | Relay WBN4 | 3.708   | 839     |         | Phase - OC1 - 51                               |
| 922       | WBN4       |         | 83.3    |         | Tripped by Relay WBN4 Phase - OC1 - 51         |
| 945       | Relay WBN4 | 3.708   | < 945   |         | Overload Phase - Thermal                       |
| 1028      | WBN4       |         | 83.3    |         | Tripped by Relay WBN4 Overload Phase - Thermal |

## 2. Hasil Simulasi Arus Hubung Singkat 3 Phase Dengan ETAP Pada WBN 4

Jarak 0% (0 km)

Sequence-of-Operation Events - Output Report: L-G

3-Phase (Symmetrical) fault on bus: WBN4 Jarak 0%

Data Rev.: Base      Config: Normal      Date: 05-17-2019

| Time (ms) | ID         | If (kA) | T1 (ms) | T2 (ms) | Condition                                      |
|-----------|------------|---------|---------|---------|------------------------------------------------|
| 567       | Relay WBN4 | 12.903  | 567     |         | Phase - OC1 - 51                               |
| 650       | WBN4       |         | 83.3    |         | Tripped by Relay WBN4 Phase - OC1 - 51         |
| 945       | Relay WBN4 | 12.903  | < 945   |         | Overload Phase - Thermal                       |
| 1028      | WBN4       |         | 83.3    |         | Tripped by Relay WBN4 Overload Phase - Thermal |



Jarak 25% (1.35 km)

| Sequence-of-Operation Events - Output Report: L-G   |            |                |         |                  |                                                |
|-----------------------------------------------------|------------|----------------|---------|------------------|------------------------------------------------|
| 3-Phase (Symmetrical) fault on bus: WBN4 Jarak: 25% |            |                |         |                  |                                                |
| Data Rev.: Base                                     |            | Config: Normal |         | Date: 05-17-2019 |                                                |
| Time (ms)                                           | ID         | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 588                                                 | Relay WBN4 | 8.646          | 588     |                  | Phase - OC1 - 51                               |
| 671                                                 | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Phase - OC1 - 51         |
| 945                                                 | Relay WBN4 | 8.646          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Overload Phase - Thermal |

Jarak 50% (2.7 km)

| Sequence-of-Operation Events - Output Report: L-G   |            |                |         |                  |                                                |
|-----------------------------------------------------|------------|----------------|---------|------------------|------------------------------------------------|
| 3-Phase (Symmetrical) fault on bus: WBN4 Jarak: 50% |            |                |         |                  |                                                |
| Data Rev.: Base                                     |            | Config: Normal |         | Date: 05-17-2019 |                                                |
| Time (ms)                                           | ID         | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 656                                                 | Relay WBN4 | 6.465          | 656     |                  | Phase - OC1 - 51                               |
| 739                                                 | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Phase - OC1 - 51         |
| 945                                                 | Relay WBN4 | 6.465          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Overload Phase - Thermal |

Jarak 75% (4.05 km)

| Sequence-of-Operation Events - Output Report: L-G   |            |                |         |                  |                                                |
|-----------------------------------------------------|------------|----------------|---------|------------------|------------------------------------------------|
| 3-Phase (Symmetrical) fault on bus: WBN4 Jarak: 75% |            |                |         |                  |                                                |
| Data Rev.: Base                                     |            | Config: Normal |         | Date: 05-17-2019 |                                                |
| Time (ms)                                           | ID         | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 720                                                 | Relay WBN4 | 5.154          | 720     |                  | Phase - OC1 - 51                               |
| 803                                                 | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Phase - OC1 - 51         |
| 945                                                 | Relay WBN4 | 5.154          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Overload Phase - Thermal |

Jarak 100% (5.4 km)

| Sequence-of-Operation Events - Output Report: L-G    |            |                |         |                  |                                                |
|------------------------------------------------------|------------|----------------|---------|------------------|------------------------------------------------|
| 3-Phase (Symmetrical) fault on bus: WBN4 Jarak: 100% |            |                |         |                  |                                                |
| Data Rev.: Base                                      |            | Config: Normal |         | Date: 05-17-2019 |                                                |
| Time (ms)                                            | ID         | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 782                                                  | Relay WBN4 | 4.282          | 782     |                  | Phase - OC1 - 51                               |
| 866                                                  | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Phase - OC1 - 51         |
| 945                                                  | Relay WBN4 | 4.282          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                 | WBN4       |                | 83.3    |                  | Tripped by Relay WBN4 Overload Phase - Thermal |

### 3. Hasil Simulasi Arus Hubung Singkat 1 Phase-Tanah Dengan ETAP Pada

WBN 4

Jarak 0% (0 km)

| Sequence-of-Operation Events - Output Report: Untitled |               |                |         |                  |                                                |
|--------------------------------------------------------|---------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Ground (Symmetrical) fault on bus: WBN 4 0%    |               |                |         |                  |                                                |
| Data Rev.: Base                                        |               | Config: Normal |         | Date: 05-22-2019 |                                                |
| Time (ms)                                              | ID            | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 521                                                    | OCR GFR WBN 4 | 13.206         | 521     |                  | Ground - OC1 - 51                              |
| 567                                                    | OCR GFR WBN 4 | 13.206         | 567     |                  | Phase - OC1 - 51                               |
| 605                                                    | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Ground - OC1 - 51     |
| 650                                                    | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Phase - OC1 - 51      |
| 945                                                    | OCR GFR WBN 4 | 13.206         | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                   | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Overload Phase - T... |

Jarak 25% (1.35 km)

| Sequence-of-Operation Events - Output Report: Untitled |               |                |         |                  |                                                |
|--------------------------------------------------------|---------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Ground (Symmetrical) fault on bus: WBN 4 25%   |               |                |         |                  |                                                |
| Data Rev.: Base                                        |               | Config: Normal |         | Date: 05-22-2019 |                                                |
| Time (ms)                                              | ID            | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 521                                                    | OCR GFR WBN 4 | 6.085          | 521     |                  | Ground - OC1 - 51                              |
| 605                                                    | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Ground - OC1 - 51     |
| 699                                                    | OCR GFR WBN 4 | 6.085          | 699     |                  | Phase - OC1 - 51                               |
| 782                                                    | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Phase - OC1 - 51      |
| 945                                                    | OCR GFR WBN 4 | 6.085          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                   | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Overload Phase - T... |

Jarak 50% (2.7 km)

| Sequence-of-Operation Events - Output Report: Untitled |               |                |         |                  |                                                |
|--------------------------------------------------------|---------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Ground (Symmetrical) fault on bus: WBN 4 50%   |               |                |         |                  |                                                |
| Data Rev.: Base                                        |               | Config: Normal |         | Date: 05-22-2019 |                                                |
| Time (ms)                                              | ID            | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 521                                                    | OCR GFR WBN 4 | 3.944          | 521     |                  | Ground - OC1 - 51                              |
| 605                                                    | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Ground - OC1 - 51     |
| 853                                                    | OCR GFR WBN 4 | 3.944          | 853     |                  | Phase - OC1 - 51                               |
| 936                                                    | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Phase - OC1 - 51      |
| 945                                                    | OCR GFR WBN 4 | 3.944          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                   | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Overload Phase - T... |

Jarak 75% (4.05 km)

| Sequence-of-Operation Events - Output Report: Untitled |               |                |         |                  |                                                |
|--------------------------------------------------------|---------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Ground (Symmetrical) fault on bus: WBN 75%     |               |                |         |                  |                                                |
| Data Rev.: Base                                        |               | Config: Normal |         | Date: 05-22-2019 |                                                |
| Time (ms)                                              | ID            | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 521                                                    | OCR GFR WBN 4 | 2.916          | 521     |                  | Ground - OC1 - 51                              |
| 605                                                    | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Ground - OC1 - 51     |
| 945                                                    | OCR GFR WBN 4 | 2.916          | < 945   |                  | Overload Phase - Thermal                       |
| 1007                                                   | OCR GFR WBN 4 | 2.916          | 1007    |                  | Phase - OC1 - 51                               |
| 1028                                                   | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Overload Phase - T... |
| 1090                                                   | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Phase - OC1 - 51      |

Jarak 100% (5.4 km)

| Sequence-of-Operation Events - Output Report: Untitled |               |                |         |                  |                                                |
|--------------------------------------------------------|---------------|----------------|---------|------------------|------------------------------------------------|
| Line-to-Ground (Symmetrical) fault on bus: WBN 4       |               |                |         |                  |                                                |
| Data Rev.: Base                                        |               | Config: Normal |         | Date: 05-22-2019 |                                                |
| Time (ms)                                              | ID            | If (kA)        | T1 (ms) | T2 (ms)          | Condition                                      |
| 558                                                    | OCR GFR WBN 4 | 2.313          | 558     |                  | Ground - OC1 - 51                              |
| 641                                                    | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Ground - OC1 - 51     |
| 945                                                    | OCR GFR WBN 4 | 2.313          | < 945   |                  | Overload Phase - Thermal                       |
| 1028                                                   | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Overload Phase - T... |
| 1167                                                   | OCR GFR WBN 4 | 2.313          | 1167    |                  | Phase - OC1 - 51                               |
| 1251                                                   | WBN 4         |                | 83.3    |                  | Tripped by OCR GFR WBN 4 Phase - OC1 - 51      |

## Lampiran 6

