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Redesign Protection System on Chemical Engineering Diponegoro University Building

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Abstract: The Chemical Engineering Department building was built in 1965, is one of the main places for learning activities at Diponegoro University. Along with the issuance of PUIL (General Electrical Installation Requirements) 2011, it is necessary to evaluate the electrical system of the Chemical Engineering Department building. This aims to ensure that building safety and security comply with established standards. Therefore, in this Final Project a redesign of the protection system was carried out in the Chemical Engineering Department building using ETAP 12.6.0. Determination of the nominal current protection device system design will be made by referring to the 2011 General Electrical Installation (PUIL) General Requirements while the protection device coordination uses the IEEE 242-2001 standard. In this final project result, there is a replacement of the protective device unit in accordance with the standard. The coordination of the protection devices is set according to the characteristics of the curve, the values, and the settings of each protection device.

Keywords: Protection, LVCB, ETAP 12.6, PUIL 2011, IEEE 242-2001, Redesain

1. Introduction

Department of Chemical Engineering Faculty of Engineering Diponegoro University (DTKU) was established in 1965 and was officially endorsed by the Government of the Republic of Indonesia with the Decree of the Directorate of Higher Education, Ministry of Education and Culture No. 106 / DIKTI / Kep / 1984 [1]. Diponegoro University Chemical Engineering Department building has 3 main buildings, namely building A, building B and building C which are used for lecture rooms, laboratories and offices. In order to support the activities of lecturers and students in research and learning, an adequate and reliable electrical system is needed. The Chemical Engineering Department Building and currently more than 50 years old needs to be evaluated for electrical installations. This aims to determine the current electrical condition of a building that still meets technical and safety requirements. Both in the form of changes in quality and quantity. These changes affect the feasibility of the installation and the safety of the wearer.The choice of capacity of the protective device does not only calculate the nominal current flowing, but also must consider the short-circuit current that can flow in the network. Determination of inappropriate short-circuit current can cause the protection device to not run optimally. In addition, coordination between protective devices must also be considered so that the selective nature of the protection requirements can be met.Based on this, in this study a redesign of the protection system of the Diponegoro University Chemical Engineering Department Building was in accordance with the 2011 General Electricity Requirements (PUIL) standard using ETAP 12.6 software. Simulation and calculation methods are used as approaches to determine the specifications of the protection device and its coordination with reference to IEEE 242-2001.

2. Research Methods

Data collection was carried out directly through physical checking based on real equipment data in the Diponegoro University Chemical Engineering Department Building. In addition, data was also obtained from books on floor plans and equipment provided by the Dean of the Faculty of Engineering and the Chemical Engineering Department of Diponegoro University, as well as data taken from several equipment datasheets, equipment nameplates, and also based on statements from the Faculty of Engineering and the Department Chemical Engineering, Diponegoro University as a complement.

a. Single Line Diagram

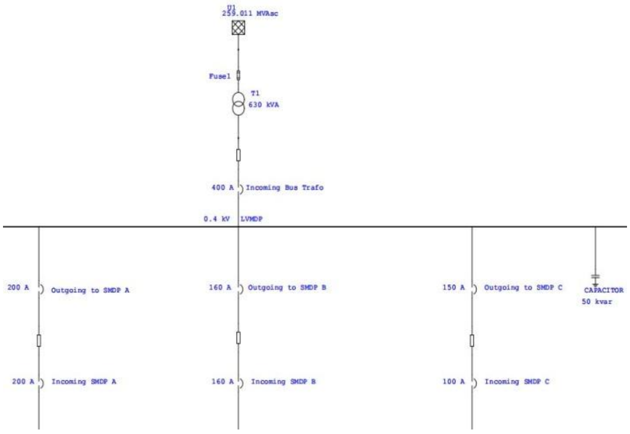

Figure 1. Single Line Diagram LVMDP

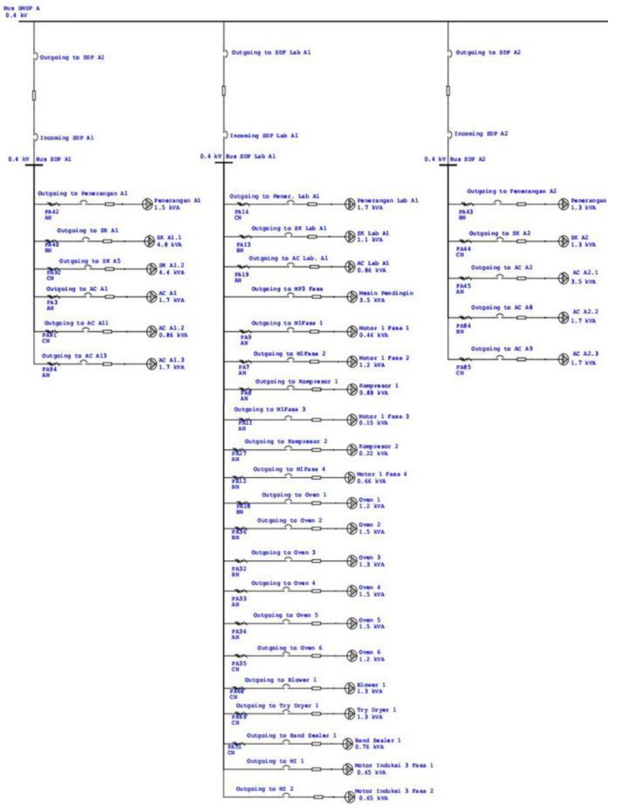

Figure 2. Single Line Diagram SMDP A1

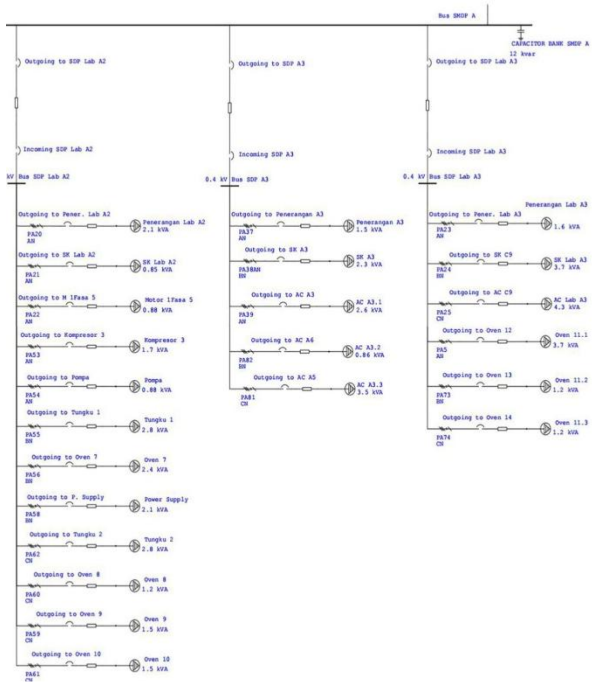

Figure3. Single Line Diagram SMDP A2

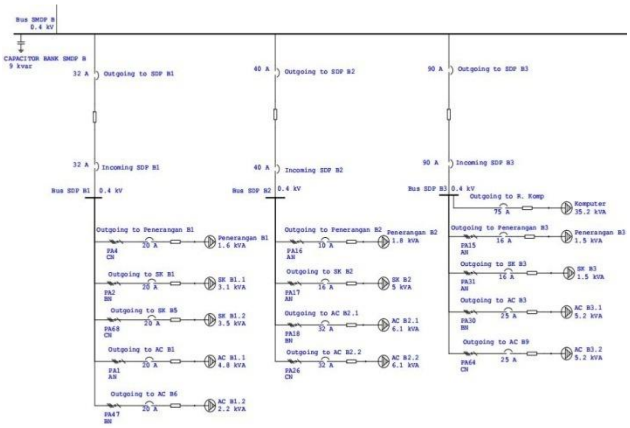

Figure4. Single Line Diagram SMDP B

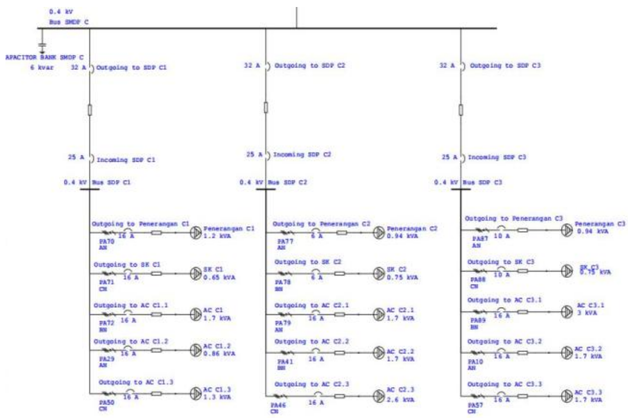

Figure5. Single Line Diagram SMDP C

It can be seen in the Figure above that in LVMDP (Low Voltage Main Distribution Panel), the panel is supplied by 1 transformer and supplies 3 panels namely SMDP (Sub Main Distribution Panel) panels A, SMDP B, and SMDP C. The SMDP A panel supplies 4 panels namely SDP (Sub Distribution Panel) A Floor 1, SDP A Floor 2, SDP A Floor 3, SDP Lab A1, SDP Lab A2, and SDP Lab A3. SMDP B Panel supplies 3 panels namely SDP B 1st Floor, SDP B 2nd Floor, and SDP B 3rd Floor. SMDP C panel supplies 3 panels namely SDP C 1st floor, SDP C 2nd floor, and SDP C 3rd floor.

b. Grid

Resources at the Diponegoro University Chemical Engineering Department Building are connected through the SRL 06 feeder located at Srondol Substation. This substation has a transformer of 60 MVA with a short circuit MVA of 7560.68 MVA and is approximately 2.1 kilometers away from the Chemical Engineering building. Assuming the cable used for distribution channels is 240 mm2 A3C cable (R = 0.1344 Ω and X = 0.3158 Ω). Ihs is 7.477 A. MVAhs on the Chemical Engineering building grid is 259.011 MVA, and X / R is 5.382 Ω so that the source has an impedance of 0.000679508 Ω for positive, negative or zero sequence impedances.

c. Transformer

The transformer used by the Chemical Engineering Department Building in this network system is the Trafindo Perkasa output transformer with a capacity of 630 kVA. The transformer has a primary voltage of 20 kV and a secondary voltage of 400 V with aYNyn-6 group vector and its frequency is 50 Hz. This transformer has an impedance of 4% and uses a cooler with type ONAN (Oil Nature Air Nature).

d. Existing Protection Device

The selection of a good protective device is determined from the rated current and the disconnection current that is in accordance with the current flowing and the short circuit current that can flow on the channel. Fuji, Elitech, Hager, Kiso, Legrand, BBC and Mitsubishi. For the model used, the Merlin Gerin protection device contains Compact C100E, Compact C225E, and Multi9 models. In the ABB protection device the S63 model is used. In the Fuji device the EA103A model is used. In the Legrand protection device the DX3 6000 model is used. In the Mitsubishi protection device the NF100CB and NF50CS models are used. In the BBC protective device the S63 model is used.

e. Cable

All cables used in this network system are PVC and XLPE types. Cable impedance values are shown in the following table.

Table 1. Cable Impedance

No	Cable	R (□)		jX (□)		Distance (m)	Number of Conductor
		R1=R2	R0	jX1=jX2	jX0		
1	SumberPLN LVMDP	0,128	0,204	0,095	0,241	60	3
2	SMDP A	0,494	0,785	0,079	0,201	60	2
3	SMDP B	0,494	0,785	0,079	0,201	80	2
4	SMDP C	0,669	1,064	0,080	0,203	150	2

It can be seen in table 1. That the X and R values for each cable are influenced by the number of conductors per phase, the cross-sectional area of the conductor, and the length of the conductor.

3. Result and Analysis

The condition of the results of the redesign of the Chemical Engineering Department building was designed using ETAP 12.6.0 software. Changes are made to the amount of load causing a change in the full load current and the selection of new cables that are adjusted to the needs and adjustments to the applicable regulations so that the new cable impedance also arises. As for the selection of new cables, it causes a new cable impedance and allows for changes in the number of conductors used as well.

a. Calculation of Current and Strong Current Conductivity

Calculation of the rated current under redesign conditions is required to determine the protective device in the network system. The rated current used is the result of the calculation of the full load current (FLA) in the Chemical Engineering Department's building network system. The current conductivity (KHA) of a cable is based on the specifications of the cable itself.

Table 2. Current Identifier and Strong Conductivity of Cable Current

No.	Bus Name	*FLA* (A)	Cable KHA (A)
1	Sumber PLN	245,19	434
	LVMDP		
2	SMDP A	129,26	201
3	SMDP B	109,80	201
4	SMDP C	27,50	170

Table 2 shows that the cable CRC value is greater than the value of the full load current of each bus.

b. Calculation of Short Circuit Current

In this electrical system redesign there is a change of cable so that it causes a change in the value of the impedance in the electricity system network, causing a new short circuit current. Short-circuit current is used to determine the breaking capacity of the protective device.

Table 3. Short Circuit Current

No	Bus Name	Calculation			
		L-L-L	L-L	L-L-G	L-G
1	Sumber PLN	17,53	15,19	15,57	16,49
	LVMDP				
2	SMDP A	9,06	7,84	7,02	7,91
3	SMDP B	7,70	6,67	5,86	6,66
4	SMDP C	3,98	3,44	2,92	3,37

table 3 shows the calculated value of the short circuit current on each bus. The value of the short circuit current is the 3 phase short circuit (L-L-L), 2 phase (L-L), 2 ground-phase (L-L-G), and 1 phase-ground (L-G).

c. Determination of Redesign Protection Device

The protection device can be determined by using the full load current as the rated current and the short circuit current as the protective device termination current. The choice of the protective device capacity must be greater than the full load current and smaller than the strong conductivity of the cable current. As for the disconnection capacity, it must be greater than the largest short-circuit current on the bus.Protection devices used in this redesign are Merlin Gerin, Mitsubishi, ABB, and Schneider Electric. There are two types of protection devices chosen, namely solid state drive type and thermal magnetic type. Types of solid state drives are Mitsubishi brand NSX400-N, NSX250-F, and NSX160-F models. The types of thermal magntic are Merlin Gerin brand with multi9 NC45a, multi9 C45, Compact C225E and Compact C100E models, while ABB brand with S200 model. The Mitsubishi brand uses the NF100SP and NF125SV models. The basis for the selection is taking into account the protection devices already installed in the Chemical Engineering Building today, the availability of ETAP 12.6.0 software, and the availability of protective devices on the market.

d. LVCB Simulation

LVCB coordination simulation is carried out using ETAP 12.6.0 tools. with the Star - Protective Device Coordination menu. To determine the LVCB coordination, it is necessary to simulate the curve plot on the Create Star View menu and the disconnection time contained in the Sequence Viewer menu. The following is an example of a curve plot and break time on the SMDP A bus.

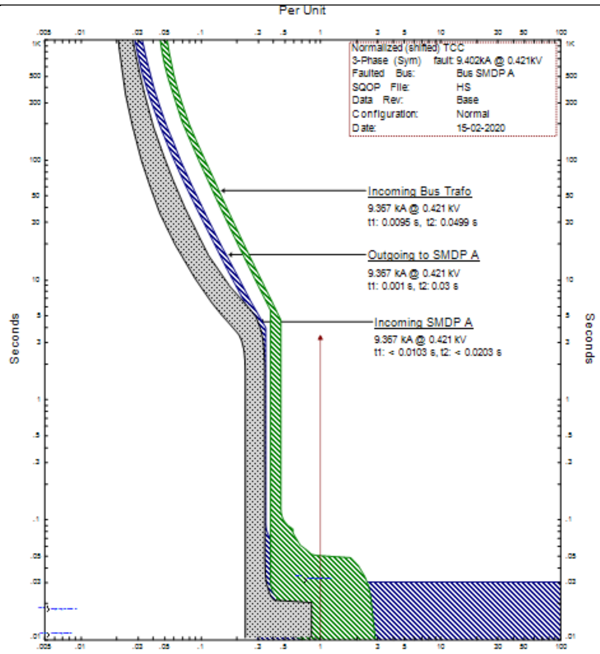

Figure6. Curve Plot Bus SMDP A

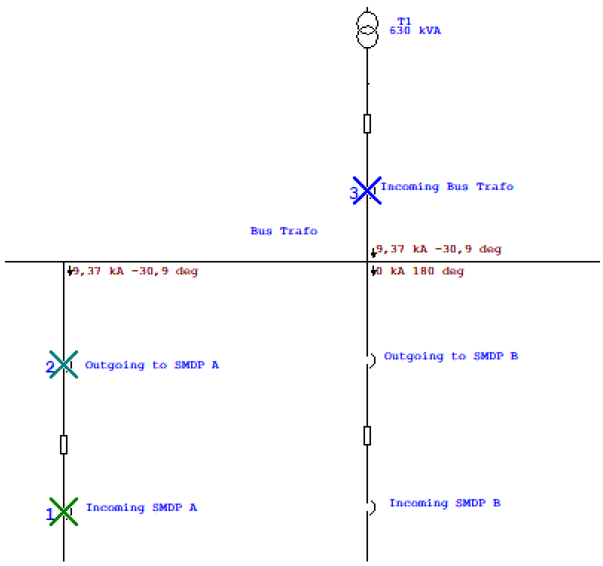

Figure7. Order of Termination in the Protection Device

3-Phase (Symmetrical) fault on bus: Bus SMDP A

Data Rev.: Base Config: Normal Date: 15-02-2020

Time (ms)	ID	If (kA)	T1 (ms)	T2 (ms)	Condition
20.3	Incoming S...	9.367	< 10.3	< 20.3	
30.0	Outgoing to ...	9.367	1.0	30.0	Phase
49.9	Incoming Bu...	9.367	9.5	49.9	Phase

Figure8. Timing of Termination in the Protection Device.

It can be seen in Figure 6. that when a fault occurs on the SMDP A bus, the three protective devices work, namely the transformer Bus incoming device, the Outgoing to SMDP A device, and the incoming SMDP A. This is due to the large short-circuit current that has exceeded the instantaneous limit of each protective device. In Figure 7. you can see the cross symbol along with the numbers that are signs of the protective devices working and the order in which the protection devices work. Whereas in Figure 3c. shows the actual time it takes for the protection device to work. It also shows the value of the short circuit current that occurs on the bus.

4. Conclusion

1. Short-circuit current that occurs in the Chemical Engineering Department Building under redesign conditions has an average difference of 4.3% in 3-phase interference, 4.75% in 2-phase interference, 4.65% in 2-phase ground disturbance, and 12.31% in phase-soil disturbance.
2. The protection device must have a sensor current that must not be smaller than its full load current, in the Incoming Bus Transformer circuit breaker with a full load current of 245.19 A using a sensor current of 400 A.
3. Outgoing to SMDP A protection device uses solid state drive type. The parameters on the protection device that can be set are Isensor, Ir (Long Time Pickup), and Isd (Short Time Pickup), namely 200 A on Isensor, 200 A on Ir, and 1400 A on Isd. Whereas tr (Long Time Band) and Ii (Short-Circuit Instanteneous) cannot be set.
4. Incoming protection devices of SMDP A use a type of thermal magnetic circuit breaker. The protective device used in the redesign condition is fixed which cannot be regulated by Isensor, Ir, and Im.
5. The trip sequence of the circuit breaker starts from the circuit breaker that is closest to the fault.

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