Generator Set Loading Analysis on The Radio Republik Indonesia Building in Tarakan City, North Kalimantan Province

Martinus Herbertus Eman[1*], Nurliya[2], Ismit Mado[3]

{ bertuseman@gmail.com[1], 05nurliya@gmail.com[2], ismitmado@borneo.ac.id[3] }

Departement of Electrical Engineering, Universitas Borneo Tarakan[1,2,3]

Abstract. The study was conducted to compare the capacity of the generator set installed in the Radio Republic of Indonesia Building in Tarakan City with the Ecodial Software calculation and determine the capacity and voltage of the generator, the safety rating, and the appropriate cross-sectional cable for the generator to supply the installed load. To determine the capacity and voltage, data collection of equipment is carried out. Ecodial Advance Calculation 4.7 software is used to simulate a single line diagram, by entering the load data and the power factor will be known. The simulation results of Ecodial Advance Calculation 4.7 obtained the power capacity of the generator set of 65 kVA, 380 V, 3 phase with a power factor of 0.8. The result of calculating the total power load on the main building of RRI Tarakan is 22,632 Watt which consists of 2 floors. For the 1st floor the load power is 11,281 Watt and for the 2nd floor the load power is 11,351 Watt. With a maximum KHA of 75 A for the 2nd floor design in the HR room with the type of security iC60N. For the cable, it is recommended to use a cable containing copper with a size of 1x6 Cu and 1x25Cu with a current-carrying cable of 63 A and 75 A.

Keywords: Genset, Load capacity, Ecodial advance, Tarakan city

1 Introduction

National electricity supply is managed by PT. PLN in meeting the electricity needs of society and users. However, in reality it is experiencing problems, especially in several border areas, such as in Tarakan City, North Kalimantan. Based on media reports in July 2022, one of the fundamental causes was the blackout of one of the Independent Power Plants connected to the 20 KV distribution network[1]. Tarakan City, a small island with a high population density, is affected by the supply of electrical energy at the peak load threshold. The conditions of this area greatly affect the performance of the community, which in this case will also affect the performance of Radio Republik Indonesia (RRI) in Tarakan City.

RRI in Tarakan City plays a very important role in conveying information and reporting both on a local and national scale. In supporting its performance, RRI provides a generator set as a back-up for a continuous supply of electrical energy.

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Generator power capacity as a backup electrical equipment is needed to achieve optimal power supply. In addition, optimizing the use of fuel as previous researchers [2]. The generator as a backup for the supply of electric power has been examined. Analysis of power supply for various needs, both buildings and public facilities, which is of course very much needed in the continuity of the supply of electric power for the convenience of the community [3-5].

This study raises the theme of loading analysis at the RRI Main Building in Tarakan City so that it can provide optimal information for the public in the event of a sudden interruption or power outage. Besides that, to maintain the reliability of the system, it is necessary to analyze the safety rating, and the generator cable cross-section that is suitable for supplying the installed load.

2 Scope Research

The aims and objectives of this research are as follows:

a) How to find out the condition of the total electrical load on the Radio Republik Indonesia Building in Tarakan City?
b) How to calculate electrical energy Radio Republik Indonesia Building in Tarakan City using Ecodial Advance Calculation 4.7 software?

3 Research Methodology

3.1 Power Triangle

Power is defined as the rate of energy that is generated or consumed. The units of power are joules/second or watts. The power triangle diagram can be described as follows.

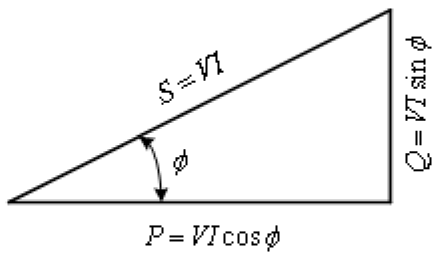

Fig. 1. Power triangle vector

If depicted in the form of a power triangle, then the apparent power is represented by the slanted side and the active and reactive power is represented by the sides of the triangle which are perpendicular to each other. From the picture above it can be seen that the greater the value of reactive power (Q) will leave the angle between the real power and apparent power or it can be called the power factor/cos φ.

The active power used in the following calculation analysis is the following formula[6]:

$$P = \sqrt{3} \times V \times I_{rata-rata} \times cos\varphi \quad (1)$$

where, P is generator active power (Watts), V is generator voltage (Volt), $I_{average}$ is generator average current (Ampere), and $\cos\varphi$ is power factor.

3.2 Generator Set Loading System

The percentage of generator set loading is carried out through the stages of calculating the generator load current and the average generator load current, as follows:

Calculating full-load current can use the following equation:

$$PI_{FL} = \frac{S}{\sqrt{3} \times V} \quad (2)$$

where, I_{FL} is generator full-load current (Ampere), and S is generator power (Watts).

To find out the average current in the morning and evening, you can use the following equation:

$$I_{average} = \frac{I_R + I_S + I_T}{3} \quad (3)$$

where, $I_{r,s,t}$ is phase current (Ampere)

To find out the percentage of loading contained in the generator, you can use the following formula:

$$\frac{I_{rata-rata}}{I_{FL}} \times 100\% \quad (4)$$

3.3 Ecodial Advance Calculation 4.7 Software

Ecodial is a software owned by Schneider Electric which is used to simulate low voltage electrical installations in buildings (both workshops, office buildings, to residential households).

Ecodial is used to calculate how much Circuit Breaker (MCB) capacity should be used in each installation network when planning. Ecodial can function to calculate the value of the power factor for each load, short circuit currents that may occur, and system wiring. Ecodial also provides a graphical curve for each MCB that we use, so that we can easily find out the maximum short circuit voltage and current of each installed circuit breaker.

The screen on Ecodial 4.7 is divided into three sections: 1). Project parameters 2). Design and Sizing 3). Report.

There are several basic steps that must be taken in using Ecodial 4.7 software, such as: Ecodial has a general character, namely being able to define the parameters as a whole (voltage, earthing system, etc.); Analyzed through Single-line diagram as the basic principles regarding the installation; defines the circuit parameters of the last load and cable length; Calculation of the required electric power and current in the circuit; Cable size calculation; Short circuit calculation; Equipment selection; Result execution; and print out the results[7-8].

4 Result and Discussion

4.1 Generator set

In the early stages of the research, the researcher conducted a literature study related to the generator set. Furthermore, field visits at RRI Tarakan City with the aim of processing data and evaluating the use of generators. This research is a follow-up to Field Work activities in analyzing periodic maintenance of RRI generators in Tarakan City.

The generator used by RRI Tarakan City with a diesel engine drive as shown in **Figure 2** below.

Fig. 2. Generator set on RRI Tarakan City.

The generator set on RRI Tarakan city has the following models and specifications.

Table 1. Generator Set Models

Generator	Parameters
Model	HT – 65p
Serial Number	090513-S-026A
Engine	P E R K I N S
Engine type	1104A -44TG1
Engine S/n	U 475573 S
Generator	STAMFOP.D
Generator type	UCI 224 F1
Generator S/n	X08L480901

Table 2. Generator Set Specifications

Specifications	Parameters
Output	65 KVA
Voltage	220 / 380
Current	99 Amp
Pf/ Phase	0.8 / 3

Specifications	Parameters
Speed	1 500 Rpm
Frekuensi	50 Hz
Rating Cons	80%
Reference	DIW/318/HPL1

4.2 Load Data on RRI Main Building

To find out the electric power used by a generator, a load calculation must be carried out. The need for electrical power for the RRI Main Building, Tarakan City, is a building with 2 floors. After going through an analysis of the calculation of the electrical power requirements for each room, the total power of the RRI Main Building, Tarakan City, is obtained, as follows:

- On the 1st Floor consists of PRO 1 room, PRO 2 room, Reporting room, Editing Room, Broadcast Room, LPU Room, and Corridor Room. The calculation of electric power on the 1st floor is 11,281 Watts.
- On the 2nd floor consists of the Station Head room, Accounting room, Administrative Office room, Administration Room, Meeting Room, Head of Broadcast Room, Human Resources Room, and Corridor Room. The calculation of electric power on the 2nd floor is 11,351 Watts.

So that the total electrical power used to meet the needs of the Main Building on RRI Tarakan City is 22,632 Watts.

4.3 Model Simulation

The first thing to do in the Ecodial software simulation is to input load data. Next, carry out the simulation creation instructions and finally run the program. After the data obtained from the simulation results, then the data is processed and analyzed again

A Generator

Generator parameter input based on the data presented in Table 1 as input generator set parameters is shown in **Figure 3** below.

LV generator	G 0
Rated power	65 kVA
Subtransient reactance x"d	20 %
Transient reactance x'd	30 %
Zero sequence reactance x0	6 %
System earthing arrangement	TN-S
Ur	380 V
Rb (neutral grounding)	NA
Ra (mass grounding)	NA

Fig. 3. Generator data input on Ecodial software models

B 1st Floor

On the 1st Floor consists of PRO 1 room, PRO 2 room, Reporting room, Editing Room, Broadcast Room, LPU Room, and Corridor Room. Next, the calculation analysis data and input data for PRO 1 room 1 floor 1 are shown as samples for the discussion of this paper.

The following is an example of calculating the load on the PRO 1 room.

Table 3. Load on PRO 1 room

No	Loads	Sum	Units (Watts)	P (Watts)
1	**Lampu**	4	8	32
2	**AC**	1	840	840
3	**Monitor**	2	100	200
4	**CPU**	1	300	300

The load data that is used as input data in the ecodial program is as follows:

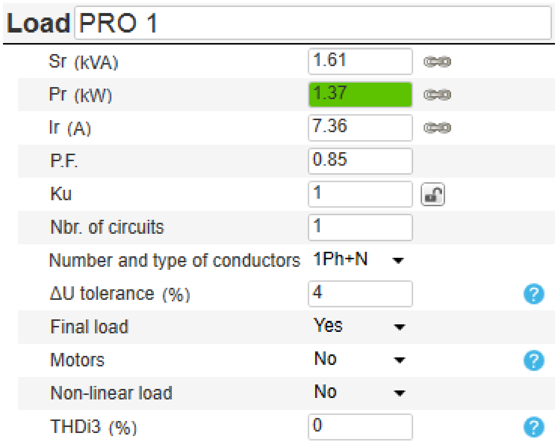

Fig. 4. Load on PRO 1 room

4.4 Single-line diagrams

A Load Capacity Analysis on 1st Floor

Based on the room plan and the calculation of the load requirements for each room. Input the load parameters for each room to form a single line diagram for the 1st floor, as follows:

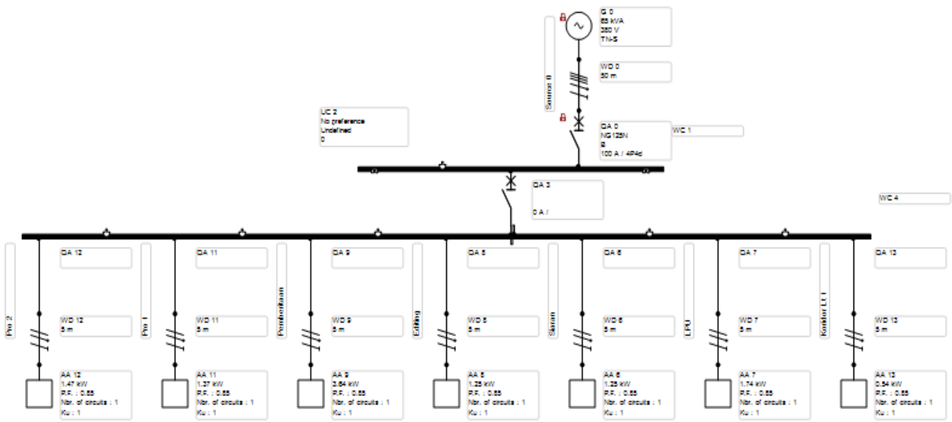

Fig. 5. Single-line diagram of the 1st floor of the Main Building on RRI Tarakan

The results of the single-line diagram simulation are presented in Table 4 below:

Table 4. Program simulation results on the 1st floor

Rooms	Load	Cable		KHA	Short Circuit	
		Ph	Ne		Ik1Max	Ik1min
Pro 2	1472	1x6 Cu	1x6 Cu	63 A	0.481	0.412
Pro 1	1372	1x10 Cu	1x10 Cu	70 A	0.481	0.412
Reporting	3642	1x6 Cu	1x6 Cu	63 A	0.481	0.412
Editing	1255	1x6 Cu	1x6 Cu	63 A	0.481	0.412
Broadcasting	1255	1x6 Cu	1x6 Cu	63 A	0.481	0.412
LPU	1745	1x6 Cu	1x6 Cu	63 A	0.481	0.412
Corridor	540	1x6 Cu	1x6 Cu	63 A	0.481	0.412

Table 4 is the simulation result of the ecodial application. On the 1st floor the recommended safety with a load of 63 Amperes with this type of safety is iC60N. For cables, it is recommended to use copper cables with sizes 1x6 Cu and 1x10Cu with current-carrying cables of 63 A and 70 A. The short circuit current values are Ik1Max with a value of 0.481 and Ik1min with a value of 0.412.

B Load Capacity Analysis on 2nd Floor

Based on the room plan and the calculation of the load requirements for each room. Input the load parameters for each room to form a single line diagram for the 2nd floor, as follows:

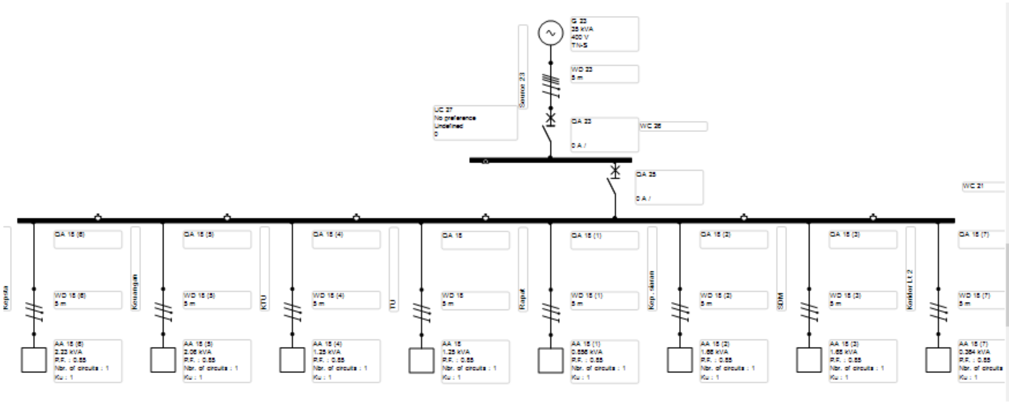

Fig. 6. Single-line diagram of the 2nd floor of the Main Building on RRI Tarakan.

The results of the single-line diagram simulation are presented in Table 4 below:

Table 5. Program simulation results on the 2nd floor

Rooms	Load	Cable		KHA	Short Circuit	
		Ph	Ne		Ik1Max	Ik1min
Station Head	2232	1x6 Cu	1x6 Cu	63 A	0.481	0.412
Accounting	2055	1x6 Cu	1x6 Cu	63 A	0.481	0.412
Administrative Office	1255	1x6 Cu	1x6 Cu	63 A	0.481	0.412
Administrative	1255	1x6 Cu	1x6 Cu	63 A	0.481	0.412
Meeting	856	1x6 Cu	1x6 Cu	63 A	0.481	0.412
Head of Broadcast	1656	1x6 Cu	1x6 Cu	63 A	0.481	0.412
Human Resources	1678	1x25 Cu	1x25 Cu	75 A	0.481	0.412
Corridor	364	1x6 Cu	1x6 Cu	63 A	0.481	0.412

Table 5 is the simulation result of the ecodial application. On the 2nd floor, the recommended safety with a load of 63 Amperes with the safety name is iC60N. For the cables, it is recommended to use copper cables with sizes 1x6 Cu and 1x25 Cu with current-carrying cables of 63 A and 75 A. For short circuit current values equal to floor 1 are Ik1Max with a value of 0.481 and Ik1min with a value of 0.412

5 Conclusion

Based on the results of the calculations and analysis performed, the following conclusions can be drawn:

1. Generator Set at the RRI Tarakan Building with the following specifications: type Hartech Diesel Genset with a power of 65 kVA, 380 V, 3Phase, and a power factor of 0.8.
2. The calculation results of the total power load on the main building of RRI Tarakan is 22,632 Watt which consists of 2 floors. For the 1st floor the load power is 11,281 Watt and for the 2nd floor the load power is 11,351 Watt.

The safety rating on the simulation results for ecodial applications is that for the generator it is 100 A, which corresponds to the CB already installed on the generator. For the 1st floor and 2nd floor the recommended safety is 63 A

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