LOADING SYSTEM ANALYSIS OF DIESEL GENERATOR IN PT. INTRACAWOOD MANUFACTURING, TARAKAN CITY, NORTH KALIMANTAN

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ABSTRACT

This research analyzes the loading system of 6 Diesel Power Plant (PLTD) units at PT. Intracawood Manufacturing, Tarakan City, North Kalimantan. PLTD is used to drive the production equipment used in the production of raw materials and main loads. This PLTD is used as a backup power generator when the main source of PT. PLN (Persero) Tarakan experienced operational disruptions or blackouts. The classification of the 6 PLTD units has different power, namely: 3 units (G2, G6, and G7) with a capacity of 1000 KVA each, 2 units (G9 and G11) with a capacity of 1360 KVA each, and 1 unit (G12) with a capacity of 1400 KVA each. The amount of total power generated by the generator is influenced by the amount of production of raw materials produced by the company. Analytical description method based on qualitative measurement data on the generator side is used as a loading analysis. Meanwhile, the parallel generator system is proposed to use a synchronous type mechanism as an improvement over the manual method. After analyzing the load distribution on each generator, the electric load that must be borne by each generator is 4.76 MW of the generator's capable capacity of 7.14 MW or equivalent to 67 percent of the generator's capable power.

***Keywords**: PLTD, Generator, Electrical load, Parallel*

1. INTRODUCTION

The need for electrical energy is very large, in fact it has become a basic need for industry, society, and offices. Electrical energy on a large scale needs to be supported by technological development in electric power operating systems. One of them is the development of IoT-based electrical power consumption monitoring [1]. One of them is the development of IoT-based electrical power consumption monitoring. Also, the electric power system must be supported by an energy audit system in order to maintain economic value[2]. Meanwhile, in terms of operating system reliability, namely, how electrical power can be distributed continuously for consumer needs. The reliability of the electric power operating system is a serious concern in the Kalimantan region, specifically the province of North Kalimantan. In the industrial world in the province of North Kalimantan, the need for electrical energy is not solely supplied from the main source, PT. PLN (Persero). Electrical energy supply also uses additional supplies in the form of reserves through an independent generation system. The existence of a diesel power plant (PLTD) is a backup generator when there is a disruption or power outage. Back up generators in both the industrial sector and economic actors in North Kalimantan are affected by a capacity that is smaller than the peak load in North Kalimantan[3]. For the Tarakan city area, technical problems such as disruptions or technical and maintenance problems disrupted supply [4].

PT. Intracawood Manufacturing, which is located in Tarakan City as a large company, also has several generators or diesel power plants that are used when there is an operational disruption from PLN. The electric power needed to drive all industrial equipment owned by PT.Intracawood Manufacturing is very large. To achieve generator loading performance using a parallel system at PT. Intracawood Manufacturing needs to do an in-depth analysis in order to achieve optimal performance. Loading analysis has been carried out by several researchers in an effort to achieve optimal performance. Ilmi & Ayong (2019) analyzed the economics of the generator operating system by adjusting the generator scheduling at PT. Telecommunications (Tbk) Pontianak uses the Lagrange Multiplier method [5]. Tsauri and Deni (2017) regarding the design of an Automatic Transfer Switch (ATS) generator with a capacity of 1200 VA for the operation of backup electrical energy in emergency conditions. This research is able to integrate the connection between PT. PLN (Persero) as the main source and generator as a backup [6].

Yusniati and Nurcholish (2020) examined the loading system when there was an increase in the demand for electric power which required the generator to carry the overload[7]. Nisa's dissertation research (2023) is carrying out simulations using ETAP to analyze load imbalance. The backup generator set as a backup supply is analyzed to anticipate that electrical energy is maintained. The addition of a capacitor bank is able to increase the voltage and current values without experiencing a decrease in voltage and current [8]. Salamena (2021) researched the reliability of electric power operating systems through backup generator sets. This research calculates the capacity for electrical energy needs in the workshops and laboratories of the Department of Electricity, Ambon State Polytechnic [9]. Riswanto (2021) evaluated the use of generator sets as backup electrical energy at PT. Unilever Indonesia. The analysis carried out is how generators as a substitute energy source can provide optimal support to maintain PT production. Unilever Indonesia remains optimal, especially during peak load conditions [10]. Restu and Ismit (2023) is a research on PLTD loading analysis in the Tana Merah sub-district, Tana Tidung Regency, North Kalimantan province. Qualitative research based on measurement results in the field recommends a parallel loading system with a percentage of 73% of the generating capacity in the area [11].

In the operation of electric power systems, apart from efforts to minimize system failures, another important factor is the maintenance of electricity supply. If at any time there is an unexpected increase or decrease in load. These load fluctuations result in an imbalance between the supply and demand of electric power. This problem can also be caused by disturbances, whether caused by power distribution disturbances, generator parallel systems or network systems that drive other generators to be loaded. The loading system due to load dynamics needs analysis to determine generator reliability and can make it easier for the company to find out the power used while the PLTD is in operation.

2. RESEARCH METHODS

2.1 Research Flowchart

The place that is used as the research object is the generator set loading system of PT. Intracawood Manufacturing Tarakan. The research was carried out in approximately 6 months to collect data. The research flow chart is presented in Figure 1.

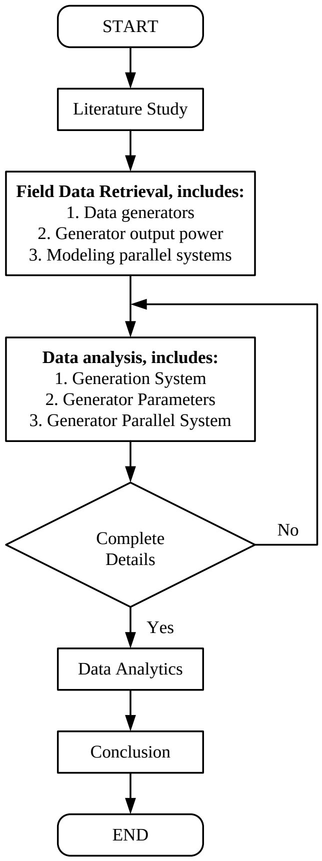

Figure 1. Research flowchart

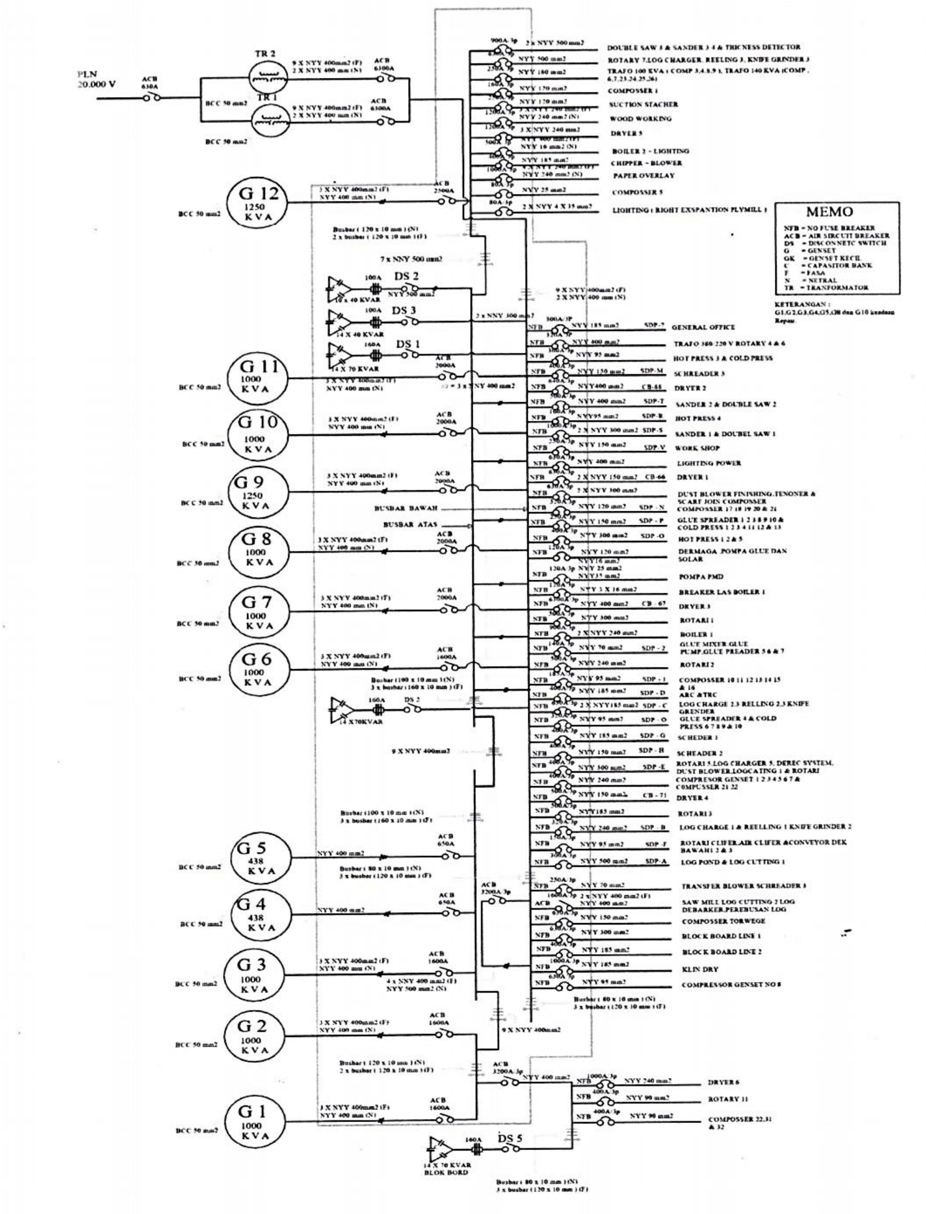

Figure 2. Single line of electrical backup system

Based on Figure 1, the generator data is in the form of nameplate data. Meanwhile, the generator output data is in the form of measurement data. The parallel generator system modeling refers to the research of Khvatov, O.S. and Kobyakov, D.S., (2020) in the form of MATLAB/Simulink simulation [12].

2.2 Single Line Generator PT. Intracawood Manufacturing Tarakan

Single line of electrical backup system of PT. Intracawood Manufacturing Tarakan is presented in Figure 2.

3. RESULTS AND DISCUSSION

3.1 Calculation Analysis of the Average Power $(P_{average})$ of Generator

Data Generator 1 (G2) January 04/01/2022 to 29/01/2022, as follows[13]:

$$P_{average} = \frac{P_{total\,(on\,January)}}{n} \tag{1}$$

$$= \frac{(592.361 + 592.361 + 592.361 + 651.598\ )}{4}$$

$$= 607.170\ watt$$

Table 1. Average power of Generator 1 (G2)

$P_{average}$ (Watt)		
No	**Month**	$P_{average}$ **(Watt)**
1	January	607.170

Table 2. Average Power of Generator 2 (G6)

$P_{average}$ (Watt)		
No	**Month**	$P_{average}$ **(Watt)**
1	January	621.979
2	February	651.598
3	March	562.743
4	April	581.831
5	May	592.361
6	June	574.939
7	July	566.228

Table 3. Average Power of Generator 3 (G7)

$P_{average}$ (Watt)		
No	**Month**	$P_{average}$ **(Watt)**
1	January	651.598
2	February	651.598
3	March	621.979
4	April	523.253
5	May	596.918
6	June	571.454
7	July	541.836

Based on the calculation analysis above, the calculation table is obtained as presented in Table 1.
Furthermore, the analysis of the calculation of the Average Power of Generator 2 (G6) is presented in Table 2.
Analysis of the calculation of the Average Power of Generator 3 (G7) is presented in Table 3.
Analysis of the calculation of the Average Power of Generator 4 (G9) is presented in Table 4.
Analysis of the calculation of the Average Power of Generator 5 (G11) is presented in Table 5.

Table 4. Average Power of Generator 4 (G9)

$P_{average}$ (Watt)		
No	**Month**	$P_{average}$ **(Watt)**
1	May	614.871
2	June	668.938
3	July	596.433

Table 5. Average Power of Generator 5 (G11)

$P_{average}$ (Watt)		
No	**Month**	$P_{average}$ **(Watt)**
1	January	651.598
2	February	651.598
3	March	562.743
4	April	617.043
5	May	580.021
6	June	573.197
7	July	527.201

Table 6. Average Power of Generator 6 (G12)

$P_{average}$ (Watt)		
No	**Month**	**$P_{average}$ (Watt)**
1	January	724.606
2	February	710.834
3	March	562.743
4	April	779.117
5	May	775.253
6	June	730.835
7	July	734.454

Analysis of the calculation of the Average Power of Generator 6 (G12) is presented in Table 6.

3.2 Calculation of Generator Load Current (I_{load})

The data used is January data from 04/01/2022 to 29/01/2022.
I_{load} is obtained through the equation, as follows[14]:

$$P_{total} = PG_1 + PG_2 + PG_3 + PG_4 + PG_5 + PG_6 \quad (2)$$
$$= 607.170 + 621.979 + 651.598 + 651.598 + 734.454 = 3.266.799\ watt$$

If,

$$P_{total} = \sqrt{3}.\sum I_{Beban.V.Cos\ \varphi}$$

$$\sum I_{beban} = \frac{P_{total}}{\sqrt{3}.V.Cos\varphi} = \frac{3.266.799}{\sqrt{3}.219,3931.0,9} = 9552.324\ ampere$$

Thus, the load current for each generator is:

$$I_{beban} = \frac{\sum I_{beban}}{NG} = \frac{9552,324}{6} = 1.592.054\ ampere$$

Thus, from the calculation results above, the I_{load} calculation results are obtained in the form of Table 7.

3.3 Calculation of The Load Borne by Each Generator

To calculate the load borne by each Generator, use the following formula:
Thus, the load borne by each generator is [15]:

$$P = \sqrt{3}.V\ .I_{beban}\ .Cos\varphi \quad (3)$$

Table 7. Calculation of I_{load}

I_{load}				
Month	**Cos phi**	**V**	**I_{load} (Ampere)**	**Calculation of active power *P* (Watt)**
January	0,9	219,3931	1.592,054	544,466
February	0,9	219,3931	1.299,076	444,466
March	0,9	219,3931	1,134,286	387,914
April	0,9	219,3931	1,218,965	416,873
May	0,9	219,3931	1.539,725	526,570
June	0,9	219,3931	1.520,202	519,893
July	0,9	219,3931	1.445,54	494,358

Table 8. Power load by each generator

P perhitungan				
Bulan	**Cos phi**	**V**	I_{load} **(Ampere)**	**P Perhitungan (Watt)**
Januari	0,9	219,3931	9552,324	544.466,49
Februari	0,9	219,3931	7794,457	444.271,03
Maret	0,9	219,3931	6805,716	387.914,42
April	0,9	219,3931	7313,790	416.873,82
Mei	0,9	219,3931	9238,353	526.570,65
Juni	0,9	219,3931	9121,210	519.893,72
Juli	0,9	219,3931	8.673,22	494.358,96
Data Hasil Perhitungan Daya Generator				476.335,58

With January data from 04/01/2022 to 29/01/2022, obtained:

$$= \sqrt{3}\,.\,219.393{,}1\,.\,1.592.054\,.\,0.9 = 544.455\ watt$$

The power data carried by each generator is presented in Table 8.

4. CONCLUSION

Load sharing based on the analysis performed, shows the results of calculating the power needed to supply the load during generator operation every month. During the 7 months there was an increase in expenses. This is due to the amount of production of raw materials which is increasing every month and added to the energy needed by consumers every hour. The electric load that must be borne by the generator when it is parallel, on average is 4.76 MW of the generator's capable capacity of 7.12 MW or equivalent to 67 percent of the generator's capable power.

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