Analysis of the Electrical System of the Central Service Unit of the Organizing Unit Numfor Class III Airport

Imam Muiz, Siti Anisah, Ahmad Dani

Abstract

Electricity Laboratory Central *Service* Unit Class III Airport Operator Numfor is a laboratory that provides service-based services for electrical and electronic equipment specifically for Class III Numfor airport equipment. This laboratory uses a lot of equipment that uses electrical energy. The purpose of this study is to analyze the electrical system to the consumption of electrical power in the *Central Service* Unit Laboratory of the Class III Numfor Airport Operator Unit as well as to conduct an analysis between the electrical system of the *Central Service* Laboratory of the Numfor Class III Airport Operator Unitwith General Requirements for Electrical Installation and SPLN. Based on the results of the calculations in the results of the discussion, the total power consumption of equipment was obtained of around 86,637.30 W, from the results of the operation power measurement of 82,606.66 W. Meanwhile, according to the results of the simulation using DIg SILENT Power Factory 15.1.7, the power was 82,604.95 W. The percentage of transformer load was obtained at 44.08%, this includes charging according to SPLN standards, while the percentage of generator load was 89.496% which was declared overloaded. In the results of the simulation of the transformer was 44.08% and the generator was 89.5%. The type of conductors and safeguards installed as well as the grounding resistance of the building have met the General Requirements for Electrical Installations (PUIL) standards. The grounding resistance in the laboratory building is reduced with a hamdabatn value of 2.6 Ω (<5 Ω)

Keywords: *Laboratory Electricity Central Service Numfor Class III Airport Operator Unit*

Imam Muiz[1]
[1]Electrical Engineering, Universitas Pembangunan Panca Budi, Indonesia
e-mail: lubismuis@gmail.com[1]

Siti Anisah[2], Ahmad Dani[3]
[2,3]Electrical Engineering, Universitas Pembangunan Panca Budi, Indonesia
e-mail: sitianisah@dosen.pancabudi.ac.id[2],ahmad.kartasasmita@gmail.com[3]

Introduction

Electricity is one of the energy needed in daily life. This fact triggers an increase in demand for electrical energy from year to year, along with the development of the sector of housing, hotels, shopping centers, companies, and others. With this increase, it must be followed by a good and efficient distribution of electrical energy according to applicable standards. Electrical energy is obtained with a high continuous supply. In addition, estimating power capacity is also very necessary for consumers to avoid some disturbances such as overload[1]. Therefore, an inventory of electrical equipment is also necessary to find out how much electrical capacity a building has or customer needs.

Laboratory *Central Service* Numfor Class III Airport Maintenance Unit is part of the Airport which provides service-based services of special electrical equipment for airport equipment Class III Numfor. Laboratory *Central Service* Numfor Class III Airport Maintenance Unit Supported by facilities complete with the latest laboratory equipment to ensure precision and precision precision. With the amount of electrical power used in the laboratory, the electrical system used will become more and more complicated. However, installation management planning and electricity use are often neglected, resulting in incompatibility of installations with the General Requirements for Electrical Installations (PUIL) and SPLN standards. By reviewing the electrical system and analyzing it with PLN Standards (SPLN) and General Requirements for Electrical Installation standards 2000, 2011 to 2020, it can be known whether the electrical system in this building is suitable or not[2].

Literature Review

Electric Power System

An electric power system is a collection of several power plants with various types of power plants (PLTA, PLTG, PLTD, PLTU, PLTGU, and others) that are interconnected with each other, which are connected through a transmission network or distribution channel to provide and distribute electrical energy to the load/user or from the power center of several parallel generating units to the customer[3]. As seen in Figure 1 below:

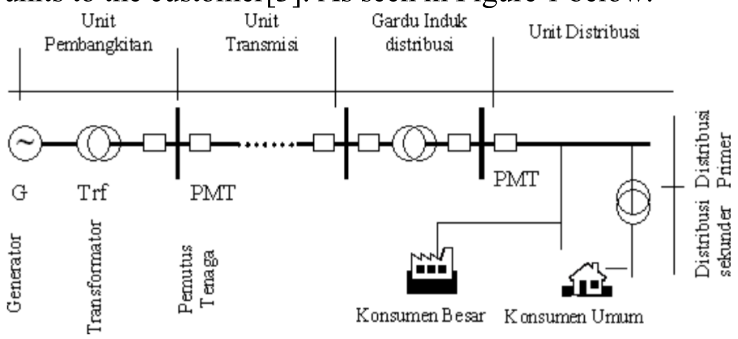

Figure 1. Electric Power System Schematic

The figure above provides information that the direction of the flow of electric current comes from the power center (power plant), the voltage is raised by a step up transformer to the transmission line (TT) then lowered by a step down transformer to the distribution network (TM) and reduced by a step down transformer to low voltage (TR), channeled to the user/customer installation[4].

2.2 State Electricity Company (SPLN) Standards

Distribution Transformer Specifications In addition to the Indonesian National Standard, another standard used in Indonesia is SPLN which is a standard used by PLN. This standard is not much different from SNI because they both refer to international standards. The goal is to provide guidance for orders and production as well as testing of PLN by domestic and foreign manufacturers, sellers, and testing agents. The two standards have the same function, which is to provide protection for consumers, workers and the community in terms of safety and health. Quality assurance by paying attention to related sectors, increasing availability, usability and productivity to achieve quality and/or fulfillment of product standards[5].

Services that enable healthy competition in trade and support environmental sustainability. According to PT. PLN for distribution transformers as specified in SPLN D3.002-1:2007 No.160 (IEC 60076-1 Edition 2.1 2000) must not exceed 80% or below 40%. If it exceeds or falls below that value, then the transformer is said to be overloaded or underloaded. Therefore, efforts are made to maintain the load of the transformer in this range (SPLN, 2007).[6]

2.3 Transformer

Transformer or transformer can be interpreted as an electrical device whose function is to change and transfer electric current from one electrical circuit to another electrical circuit with different voltages without changing the frequency system. The material for making transformers consists of coated iron and two coils, namely the primary coil and the secondary coil. These primary coils are connected to an electrical energy source and the secondary coils are connected to the load/user of electrical energy. The ratio of voltage changes will depend on the ratio of the number of turns on the two coils[5].

2.4 Power Factor

The power factor or commonly called cos can be interpreted as a comparison between active power and pseudo-power. The power factor determines the usable/available power usage value. The optimal power factor is equal to one. The lagging and leading power factors reduce the use value. In general, the electricity used in industry is mostly inductive electricity so the power is left behind[7]

2.5 Electric Power

Power is the amount of change in energy over time in the form of voltage and current. Power is defined as the rate of energy produced or used by different types of electrical equipment. In general, power is divided into 3 powers, namely pseudopower, active power, and reactive power

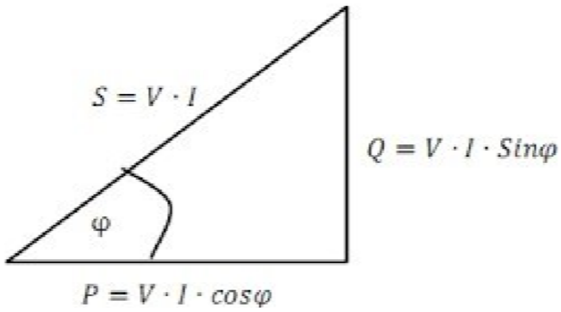

Figure 2. The Power Triangle

2.6 Conveyors/Conductors

Conductors are metallic or nonmetallic objects that have conductive properties. Conductors are electrical properties that are able to conduct current from one point to another. Cables serve as metal conductors that are protected by insulation while cables are conductors that are also made of metal but are not insulated. There are three important parts that are present in the cable, namely[8]:

a. Conductor (Conductor)
b. Isolation
c. Protector

2.7 Current Transmitting Capacity (KHA)

Current carrying capacity (KHA) is the maximum current that can be continuously delivered by a conductor under certain conditions without causing a temperature increase to exceed a certain value. The current carrying capacity of the cable must be greater than the rating of MCB (Miniature Circuit Break) because in principle the MCB must trip before the cable has a problem, one example is a fire. According to PUIL (General Regulations on Electrical Installations) 2011 Chapter 5 article 5.3.1 (Page: 51) states that "A final circuit conductor supplying a single motor must not have a KHA of less than 125% of the full load rated current".[9]

2.8 Safety

Safety is a piece of equipment used in electrical installations that functions to protect humans or equipment connected to the installation in the event of a power outage due to abnormal conditions. The motor GPAL rated current is at least 110% - 115% of the motor rated current (PUIL 2011 Page: 51), which means that the installed circuit breaker should not trip at 1.13 x In (SNI IEC 60898-1:2009) (PUIL 2011).

The definition of grounding or grounding is an effort to distribute electrical current to an electrical installation in a building or house to the earth to prevent electrical surges and lightning strikes. The purpose of installing a grounding system in an installation Electricity flow in a building aims to prevent contact between living things and electrical voltage due to insulation leaks.[10]

Table 1. Resistance types of several soil types according to PUIL

Yes	Soil Type	Resistance Type (Ωm)
1	Swamp soil	30
2	Clay and plantation	100
3	Wet sand	200
4	Wet gravel	500
5	Dry sand and gravel	1000
6	Rocky soil	3000

2.9 Generator Set

Generator set (Genset) is a device that functions to generate electricity. A generator is a set of equipment that is a combination of two different devices, namely an engine and a generator or alternator. The engine is usually a diesel engine in a rotary unit, while a generator or alternator is a unit in a power plant. The engine can be a diesel, diesel or gasoline engine block, while the generator or alternator is a copper coil or coil consisting of a stator (static coil) and a rotor (rotating coil). The main purpose of the generator is to provide backup power

when the electricity supply to PLN suddenly went out. Speaking of generators, the first thing that comes to mind is the tool to turn on the lights when the power goes out, even though that's not the only purpose. To focus on lights or lighting only, there are many other things that require power such as outdoor work that is far from electricity[11].

Research Methodology

Some of the methods used by the author in compiling this final project are as follows:

a. Library Method
   Namely conducting literature studies and studies on supporting textbooks, as well as relevant journals that support research for the preparation of this final project
b. Field Observation
   Carrying out field observation research and data collection at the laboratory of the Kualanamu plantation service center. Then hold a discussion/analysis of the results of the observation and conclude the results of the analysis

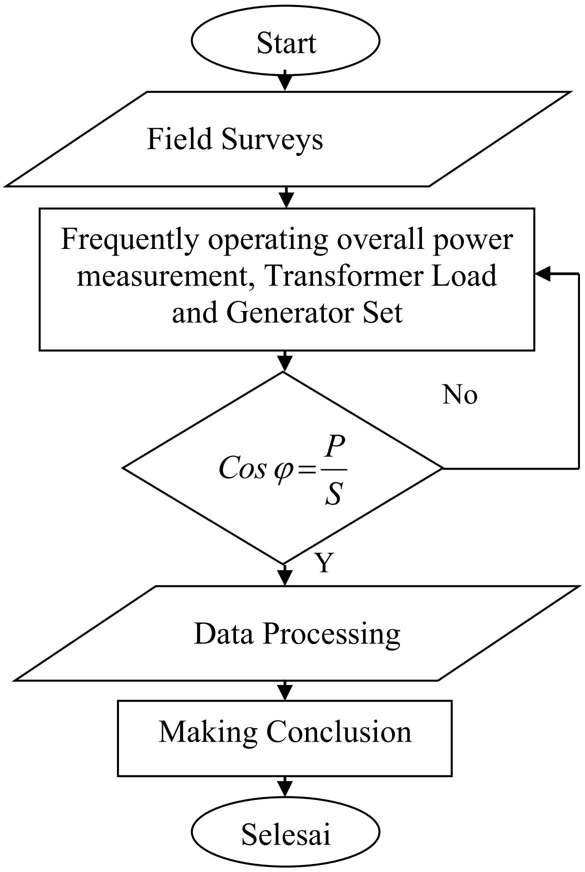

Figure 3. Research Flow

The following data was obtained from field observations starting from research and direct interviews

Table 2. Installed distribution transformer data

1	Voltage	Primary voltage	200 kVA
2	Secondary voltage		20000 V
3	Frequency		230/400 V
4	Current	Mainstream	50 Hz
5		Secondary current	5.77 A
6	Tap position		288.67 A
7	Brand		Mastergreen
8	Phase Transformer		3 peach

Table 3. Data generator set and installed kWH-Meter

Power generator Set	92.3 kW (100 kVA)
Brand	Lovol
Rated speed	1500 rpm
Phasa Generator Set	3 peach
Power kWH-Meter	147 kVA
Phasa kWH-Meter	3 peach
Voltage	230 / 400 V

Table 4. Current Measurement of Each Load Group

Location	**Load A**			**Total Load(A)**
	R	**S**	**T**	
1st Floor	44,10	40,30	46,40	130,80
Aquantron 1	9,28	9,27	9,27	27,82
Aquantron 2	9,27	9,28	9,28	27,83
Blower	6,80	6,81	6,80	20,41
Oven	7,42	7,42	7,41	22,25
Muffle	21,42	20,35	20,36	62,13
2nd Floor	16,97	12,63	13,10	42,70
3rd Floor	10,67	8,41	7,70	26,78
4th Floor	1,24	1,57	1,43	4,24
Elevator	7,28	7,24	7,25	21,77
Total Current	134,45	123,28	129,00	389,73

Table 5. Voltage measurement in the panels of each floor

Location	**VL-L**			**VL-N**		
	SAR	**R-T**	**S-T**	**R-N**	**S-N**	**T-N**
1st Floor	398.1 V	399.0 V	398.1 V	228.8 V	229.3 V	229.2 V
Aquantron 1	398.2 V	398.4 V	398 .6 V	227.9 V	229.8 V	229.6 V
Aquantron 2	398.1 V	398.7 V	398, 4V	229.3 V	229.5 V	228.5 V
Blower	398.5 V	398.1 V	398.6 V	228.1 V	228.2 V	229.0 V
Oven	398.2 V	398.9 V	398.1 V	227.8 V	230.0 V	229.5 V
Muffle	398.1 V	398.5 V	398.5 V	229.6 V	229.5 V	228.2 V
2nd Floor	396.4 V	397.5 V	396.5 V	224.8 V	226 V	226.3 V
3rd Floor	395.8 V	396.2 V	396.0 V	223.1 V	224.6 V	224.0 V
4th Floor	395.6 V	395.8 V	395.7 V	223.3 V	223.9 V	223.3 V
Elevator	398.5 V	398.1V	398.6 V	229.2 V	228.3 V	229.8 V

Results

Types of Electrical Equipment and Power Capacity

The following is the total power of electrical equipment used in the *Central Service* Unit Laboratory of the Class III Numfor Airport Operator Unit which is divided into 10 groups

Table 6. Total power used frequently

Location	**Power Load (Watts)**
1st Floor	28.636,9
Aquantron 1	6.000
Aquantron 2	6.000
Blower	4.400
Oven	4.800
Muffle	13.340
2nd Floor	11.040
3rd Floor	6.874,4
4th Floor	896
Elevator	4.650
Total Overall Power	86.637,3

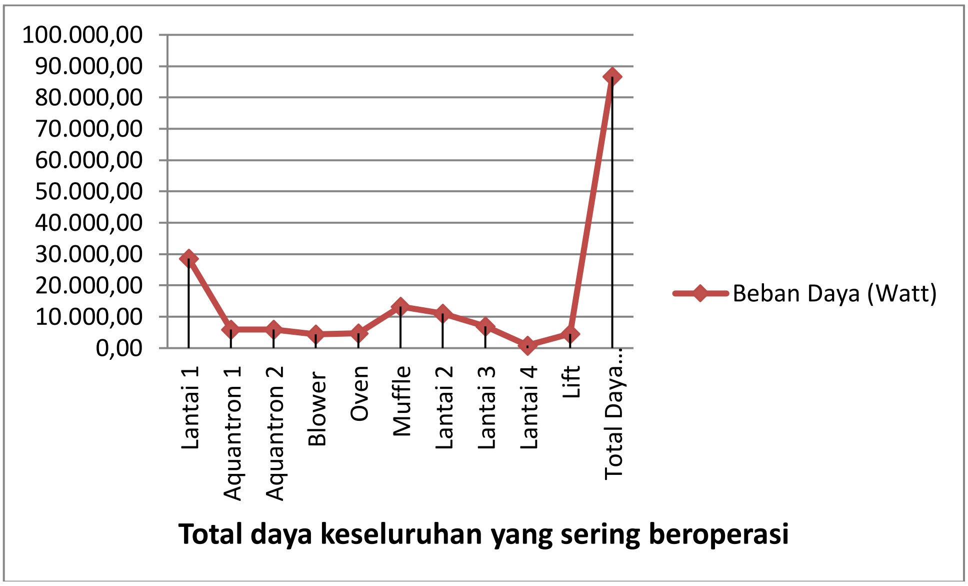

Figure 4. Graph Total power operating frequently

4.2 Power Factor (Cos φ)

Because the panel is not installed Cos φ meters. Measurement results on acid chamber blowers using 3-phase induction motor with Power = 1,100 W

Table 7. Blower Voltage Measurement

Measurement	SAR	T-T	S-T	VL-LRata-rata
Blower Voltage	398.1 V	398.4 V	398.7 V	398.4 V

Measurement = 1.7 A

So to find out the Cos φ according to the equation formula (1) can be calculated

$$Cos\ \varphi = \frac{P}{S}$$

$$= \frac{P}{V.I.\sqrt{3}}$$

$$= \frac{1100}{398,4\,x\,1,7\,x\,\sqrt{3}} = 0,937$$

4.3 Determining Apparent Power and Active Power

To find out the amount of apparent power and electrical active power used on each floor, the following is the amount of apparent power and active power on each floor according to the results of current and voltage measurements, namely:

Table 8. Pseudo-Power and Active Power

Location	**Load (VA)**			**Total Load (VA)**	**Total Load (W)**
	R	S	T		
1st Floor	10.103,31	9.232,73	10.630,24	29.966,28	28.078,40
Aquantron 1	2.126,04	2.123,75	2.123,75	6.373,56	5.972,02
Aquantron 2	2.123,75	2.126,04	2.126,04	6.375,85	5.974,17
Blower	1.557,88	1.560,17	1.557,88	4.675,93	4.381,34
Oven	1.699,92	1.699,92	1.697,63	5.097,47	4.776,33
Muffle	4.907,32	4.662,18	4.664,47	14.233,98	13.337,24
2nd Floor	3.830,13	2.850,60	2.956,67	9.637,40	9.030,24
3rd Floor	2.380,05	1.883.00	1.724,03	5.987,08	5.609,89
4th Floor	277,14	350,89	319,60	947,64	887,93
Elevator	1.627,08	1.618,14	1.620,37	4.865,59	4.559,06

Total	30.632,63	28.107,40	29.420,71	88.160,79	82.606,66

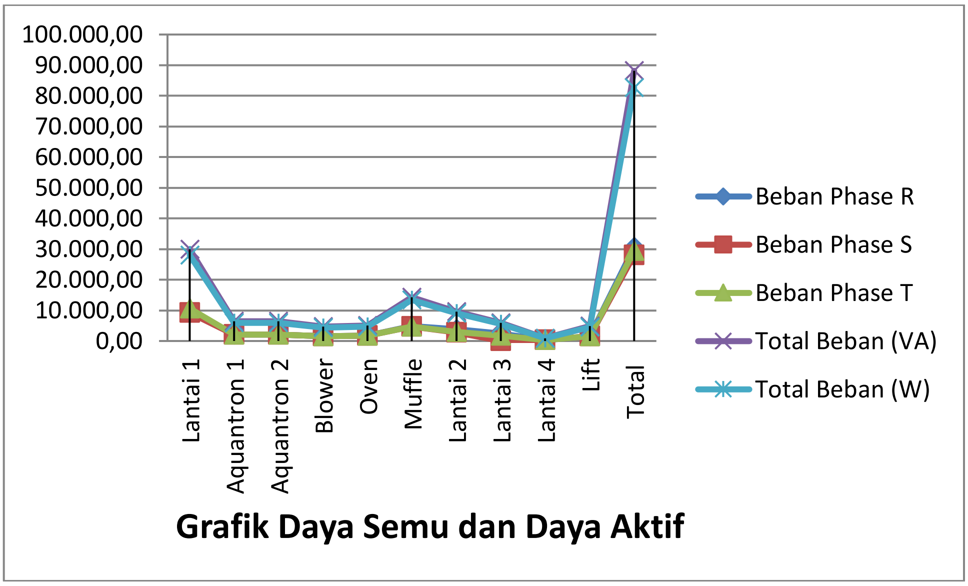

Figure 5. Pseudo-Power and Active Power Graph

4.4 Transformer Charging and Generator Set

After obtaining the results of the measured power measurement, charge the transformer and generator

Table 9. Group Load Analysis

Name	Power	Load Percentage
Transformer	200 kVA	44,08 %
Generator Set	92.3 kW	89,49 %

Table 10. Transformer and Generator Load Analysis

Load Percentage			
Name	Load	Transformer Percentage	Percentage Generator Set
1st Floor	29,966.28 VA	14,983 %	30,420 %
Aquantron 1	6,373.56 VA	3,186 %	6,470 %
Aquantron 2	6,375.85 VA	3,187 %	6,472 %
Blower	4,675.93 VA	2,337 %	4,746 %
Oven	5,097.47 VA	2,548 %	5,174 %
Muffle	14,233.98 VA	7,116 %	14,449 %
2nd Floor	9,637.40 VA	4,818 %	9,783 %
3rd Floor	5,987.08 VA	2,993 %	6,077 %
4th Floor	947.64 VA	0,473 %	9,620 %
Elevator	4,865.59 VA	2,432 %	4,939 %

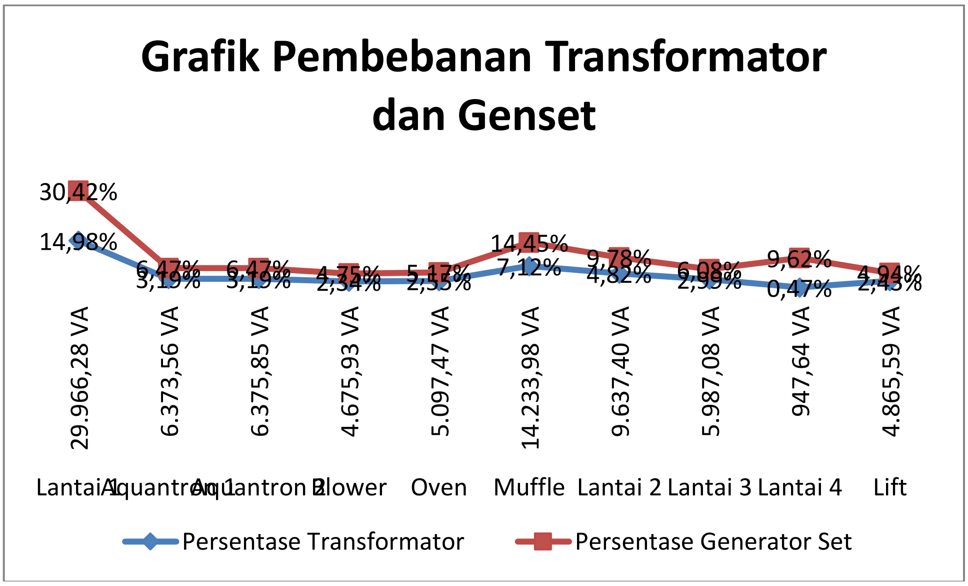

Figure 6. Load Graph of Transformers and Generators

4.5 Electrical Safety

Table 11. Built-in Safeguards and Their Standards

Uses of 3phasa Safeguards	Installed Type and Size	In Perphasa	PUIL 2011 Standards (SNI IEC 60898- 1:2009)
KWH Meter	MCCB 225 A	213.03 A	MCCB 225 A
Generator Set	MCCB 160 A	144.91 A	MCCB 160 A
Master Panel	MCCB 250 A	131.18 A	MCCB 160 A
Oven	MCCB 20 A	7.42 A	MCB 10 A
Aquatron 1	MCCB 50 A	9.27 A	MCB 10 A
Aquatron 2	MCCB 50 A	9.27 A	MCB 10 A
Smoking Blower	MCCB 25 A	6.80 A	MCB 10 A
Muffle	MCCB 25 A	20.70 A	MCB 25 A
1st Floor	MCCB 100 A	43.60 A	MCCB 50 A
2nd Floor	MCB 32 A	14.20 A	MCB 16 A
3rd Floor	MCB 25 A	8.90 A	MCB 10 A
4th Floor	MCB 20 A	1.40 A	MCB 2 A
Elevator	MCB 20 A	7.26 A	MCB 10 A

4.6 Landings

Table 12. Soil Measurement Results

Range	Reading		Results	PUIL 2000 Standard
x 20 Ω	0,13 Ω	2,6 Ω	<5 Ω	

Figure 7. Resistance Measurement Results

Determine the value of the grounding resistance of the building, then obtain the grounding resistance according to the type of clay used in the field

Conclusion

a. After research and measurements were carried out at the Central Service Laboratory of *the Central Service* Unit of the Class III Numfor Airport Operator, the results of calculation and measurement of total power consumption were obtained. The result of the power calculation is 88,160.79 VA (pseudo-power), then converted to active power equivalent to 82,606.66 W (active power)
b. The electrical system of the Central Service Laboratory *of the Central Service* Unit of the Class III Airport Operator Unit Numfor starts from the percentage of transformer load in accordance with SPLN D3.002-1:2007 No.160, the carrying capacity of the conducting current in accordance with PUIL 2011 in chapter 5 article 5.3.1 (Page: 51), circuit breakers/electrical safety in accordance with PUIL 2011 (Page 51) and grounding resistance in this building in accordance with PUIL 2000 (Page: 68). For generator loads that exceed PLN standards, this generator will only be operated in emergency conditions (off grid) on PT PLN's network system. For this reason, the fulfillment of load needs is carried out by the priority scale method so as not to interfere with the company's operations. The results of the load simulation on transformers and generators were 44.08% and 89.5%, while the measurement results were 44.08% and 89.49%
c. For the generator power capacity that is already overloaded, the generator power must be increased so that the generator works properly and avoids the short life of the transformer that results in damage to the generator can be avoided and if there is a disturbance so that the generator can work optimally without any disturbance to carry out the priority scale of the Laboratory electrical system.

References

[1] E. Ginting *et al.*, "LABORATORIUM CENTRAL SERVICE KUALA," vol. 13, no. 1, pp. 52–57, 2024.

[2] S. N. Indonesia and B. S. Nasional, "Persyaratan Umum Instalasi Listrik 2011," vol. 2011, no. Puil, 2011.

[3] "Analisis Voltage Drop Dan Power Losses Pada Saluran Transmisi 275 Kv Dengan 5 Bus Menggunakan Simulasi Matlab," vol. 4, no. 2, pp. 1392–1399, 2025.

[4] Z. Tharo, A. Tarigan, S. Anisah, and K. T. Yuda, "PENGGUNAAN KAPASITOR BANK SEBAGAI SOLUSI DROP TEGANGAN PADA JARINGAN 20 KV," 2020.

[5] D. Teknik, D. A. N. Lingkungan, P. Teknis, and I. Ketenagalistrikan, *Direktorat jenderal ketenagalistrikan*. 2015.

[6] L. Wakidi, F. Amrinsani, O. Natan, and R. Nashichah, "Penerapan Sistem Pemantauan Kelistrikan dan SOP Pemeliharaan Autoklaf di Puskesmas Tarik 2 , Kabupaten

Sidoarjo , Jawa Timur," vol. 5, no. 5, pp. 1156–1168, 2025.

[7] T. F. Yannita, M. E. Dalimunthe, P. Studi, T. Elektro, and K. Medan, "Analisis Utilisasi Generator Set (GENSET) Dengan Kapasitas 65 kVA Di Klinik Adisma Husada Medan," vol. 14, no. 2, pp. 85–88, 2025.

[8] R. Saputra, M. S. Al Amin, and Y. Irwansi, "Evaluasi Instalasi Kelistrikan Sesuai Standar Puil di CV Multi Teknik Perkasa Palembang," vol. 2, no. 3, 2024.

[9] R. Fadilah, S. Yahya, S. M. Ilman, and K. Kunci, "Analisis Pengaruh Pembebanan Terhadap Efisiensi Generator 55 MW Unit 3 di PLN Indonesia Power UBP Kamojang," pp. 24–25, 2024.

[10] A. Wirayuda, Z. Tharo, and P. Siagian, "Analisis Kinerja Lightning Arrester (LA) pada Pemancar Radio Di Gedung RRI Medan," vol. 5, pp. 376–385, 2025.

[11] N. Standar *et al.*, "STANDAR NASIONAL INDONESIA KOMITE TEKNIS PERSYARATAN UMUM INSTALASI LISTRIK," pp. 5–9, 2020.