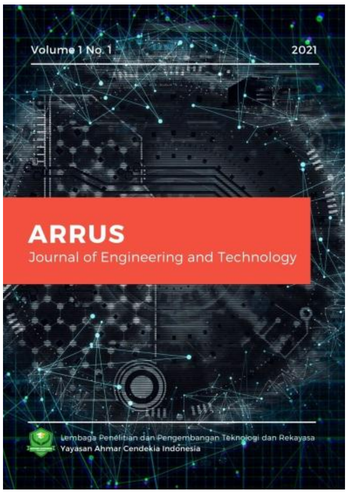
Sihombing, et.al., *ARRUS Journal of Engineering and Technology*, Vol. 4, No. 2 (2024)
https://doi.org/10.35877/jetech3712

OPEN ACCESS

ISSN : 2776-7914 (Print) / 2807-3045 (Online)



RESEARCH ARTICLE

Study Of Potential Disruptions In UHN Electrical Installations Risk Identification And Preventive Measures

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Abstract: Disturbances in electrical installations have the potential to endanger humans and the electrical installation itself, because disturbances that occur are the source of accidents. The occurrence of electrical installation disturbances has the potential to cause electrical hazards, such as electric shock, heat generation in installation components, explosions or hot metal sparks, and even fire. Several types of electrical installation disturbances that can cause electrical hazards are short circuits without safety or with incorrect protection, overloads without safety or with inappropriate protection, local heating that arises due to incorrect selection and use of electrical equipment, systems. Improper grounding of the installation, poor connection conditions, poor installation environmental conditions and arbitrary addition of load to each R, S, T phase will cause several impacts on electrical installation disturbances. To find out the factors that can cause electrical installation disturbances, it is necessary to study the potential for electrical installation disturbances by carrying out, inspecting, testing (commissioning) the electrical installation system visually and identifying potential electrical hazards that may occur, in this way the risk of electrical hazards can be minimized or removed..

Keywords: Installation Disturbances, Potential Electrical Hazards, Commissioning, Risk Identification and Prevention

1. INTRODUCTION

An old electrical installation system may experience disturbances such as increased or decreased load, changed connections, worn cables, damaged electrical components, non-compliance of the electrical installation system with the latest standards, and malfunctioning protection systems or other safety devices. Therefore, identifying potential sources of electrical installation disturbances, risk assessment, developing action plans to mitigate risks, and implementing appropriate preventive measures are very important to carry out.

To identify the factors that can cause electrical installation disturbances, a visual inspection and commissioning of the electrical installation system are first conducted, including transformer grounding, panel grounding, inspection of each panel component, and load installation.

With the identification of the factors causing electrical installation disturbances, it is possible to develop better safety guidelines for electrical installation disturbances and procedures for installation use, as well as to strengthen knowledge about electrical hazards and ways to avoid them.

2. Literature Review

2.1. Electrical Installation Disruption

Disruptions in electrical installations are one of the main causes of electrical accidents. These disturbances can include short circuits, overloads, localized heating due to improper component selection, and grounding system discrepancies. These disturbances can cause electrical hazards such as electric shocks, fires, and explosions. Therefore, understanding the factors causing electrical disturbances is very important in risk mitigation efforts.

2.2. Potential Disruption of Electrical Installations at UHN

A study of the potential electrical installation disruptions at UHN (Universitas HKBP Nommensen) needs to be conducted to identify risk factors specific to the educational environment. According to [Source H], the main factors that can cause electrical installation disturbances in an academic environment include increased electrical load due to the use of electronic devices, aging cable systems, and environmental conditions that do not support an optimal electrical installation system. In addition, the lack of maintenance and routine inspections exacerbates the potential for electrical disturbances.

2.3. Risk Identification in Electrical Installations

Risk identification is the initial stage in mitigating electrical disturbances. According to [Source I], the methods used in risk identification include visual analysis, electrical measurements, and protection system testing. Common risks found in electrical installations in educational institutions such as UHN include: Electrical cables that no longer meet standards. Overload due to uncontrolled electricity usage. Suboptimal grounding system Electrical panel experiencing malfunctions or short circuits

2.4. Efforts to Prevent Electrical Installation Disorders

Preventive measures are an important step in ensuring the safety of the electrical system. According to [Source J], several mitigation measures that can be implemented at UHN include:

Conducting routine inspections and maintenance of electrical installations Using protection systems such as MCB (Miniature Circuit Breaker) and ELCB (Earth Leakage Circuit Breaker) Ensuring that every electrical installation complies with national and international standards Increasing electricity users' awareness of electrical hazards through socialization and training.

2.5. Standardization and Regulation of Electrical Installation Safety

To reduce the potential for electrical installation disturbances, the implementation of safety standards is very important. According to [Source K], standards such as IEC (International Electrotechnical Commission) and SNI (Indonesian National Standard) provide technical guidelines for the installation and maintenance of electrical installations. The implementation of these regulations can enhance the safety and efficiency of the electrical system in academic environments such as UHN.

This literature review shows that electrical installation disturbances have a significant impact on the safety and efficiency of electrical systems. The study of potential disruptions at UHN reveals several key risk factors that must be well managed. Through comprehensive risk identification and the implementation of standard preventive measures, the risk of electrical disruptions can be minimized, thereby creating a safer and more efficient academic environment.

3. Research Method and Materials

ISSN : 2776-7914 (Print) / 2807-3045 (Online)

This research was conducted using the following method: Conduct a survey of the electrical installation system at HKBP Nommensen University with the subject of the electrical installation loaded with 3 units of 197 KVA transformers. Conducting visual inspections and commissioning on: Grounding resistance of 3 transformer units, grounding of the main distribution panel (PHB), visual inspection of each component installed on the main distribution panel (PHB), branch distribution panel (PHB). Visual inspection of the electrical installation, installed load, and installation environment. Next, each finding from the visual inspection and commissioning is documented, and an analysis is conducted on the potential sources of electrical installation disturbances at HKBP Nommensen University, along with risk identification. From the study results, recommendations and preventive measures were provided by adhering to the General Electrical Installation Regulations (PUIL) standards.

3.1. *Provisions for Inspection and Testing of Electrical Installations According to PUIL*

Inspection (visual inspection) and testing of electrical installations are checks of the physical condition of electrical installations and verification of compliance with standards. Periodic inspection of electrical installations is important to maintain the safety and performance of the electrical installations. Some steps that are generally taken are:

(a). Inspect (visual inspection) the physical condition of the installation, such as cables, distribution panels (PHB), and other electrical components. Ensure there is no physical damage that could cause electrical hazards.
(b). Ensuring that all electrical measuring and breaking components such as Mini Circuit Breakers (MCB), Moulded Case Circuit Breakers (MCCB), Ground Fault Circuit Interrupters (GFCI), and other protective systems function properly and comply with safety standards.
(c). Inspection of cables and connections, to ensure there is no excessive heat concentration or corrosion at the connection points. Ensuring the cables are properly installed and well protected.
(d). Inspection of the grounding system to ensure that the ground resistance meets PUIL standards, feasibility, and reliability
(e). Check that the electrical load does not exceed the maximum capacity of the cable, the capacity of the protection components, and whether the installed load is close to balance on each phase (for a 3-phase electrical installation system).
(f). Document inspection, such as previous repair or maintenance records
(g). If problems or deficiencies are found during the inspection, corrective actions should be recommended to be taken.

3.2. *Protection Component (Device)*

In electrical installation systems, it must be ensured that protective devices meet safety standards, such as current carrying capacity (KHA), voltage surges, and must be produced by a trusted brand. The protective devices used to address short circuit current issues that could pose a danger to humans are:

(a). Overcurrent protection device, which functions to detect and disconnect the current flow that exceeds the established normal limit.
(b). Short circuit protection device, functions to detect and cut off the current flow that occurs during a short circuit in the electrical installation system.

Overcurrent and short circuit protection devices are always installed on the electrical distribution panel (PHB), such as mini circuit breakers (MCB), molded case circuit breakers (MCCB), and ground fault circuit interrupters (GFCI).

3.3. *Component (Device)*

Consumers who require a large amount of electrical power use a 3-phase electrical installation system consisting of a transformer, measurement (APP), distribution panel (PHB), protective devices, cables, and grounding. As shown in Figure 1.

https://doi.org/10.35877/jetech3712

ISSN : 2776-7914 (Print) / 2807-3045 (Online)

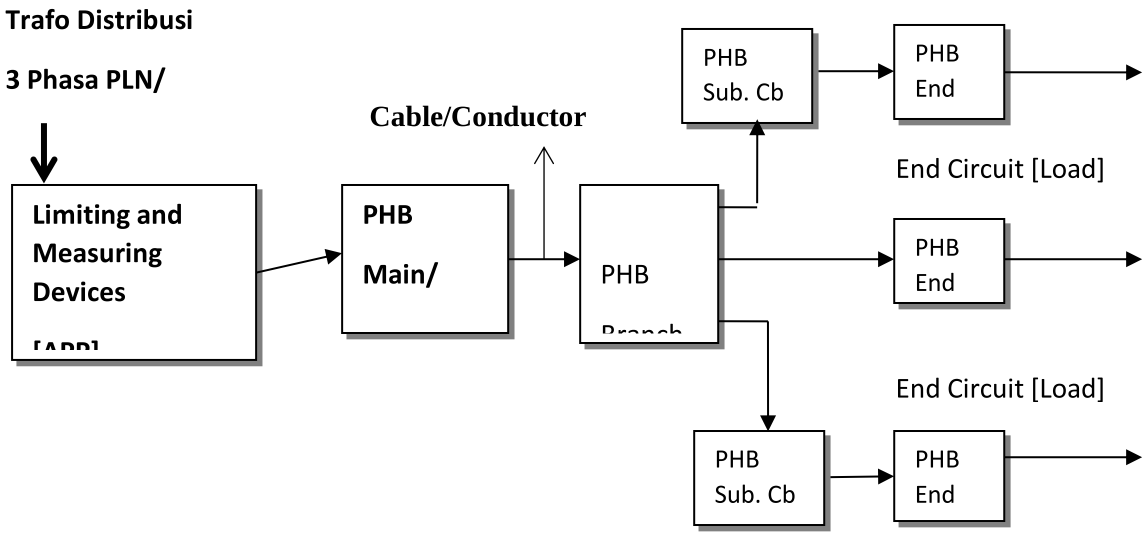

Figure 1. Figure 1. Block Diagram of the Electrical Installation System

3.4. *References and Standards for Electrical Installations*

References and standards for electrical installations are to ensure that electrical installations comply with applicable regulations, the main purpose of which is,

a). Ensuring the safety of users, equipment, and the surrounding environment. This reference includes regulations and guidelines to reduce the risk of fire and electric shock.

b). Establishing performance standards that must be met by electrical installations includes energy efficiency, adequate power, overcurrent protection, and balanced electricity distribution.

c). Ensuring that electrical installations comply with legal requirements set by the relevant regulatory bodies, such as building regulations.

d). Ensuring the selection of the right electrical components, planning cable routes, and meeting the desired power requirements.

e). Ensuring the correct installation method and testing to ensure that the installation functions well and meets the established standards.

f). Regular maintenance to ensure that the installation continues to operate well at all times. Maintenance includes visual inspections, replacement of damaged components, cleaning of each component, and monitoring for wear or damage that could potentially disrupt the electrical installation system.

3.5. *Government Regulation*

There are several government (ministerial) regulations regarding electricity, but in this research, the reference followed is the field of maintenance of electrical equipment as outlined in the General Requirements for Electrical Installations 2000 (PUIL), particularly in section 2.5 (installation and initial verification of electrical installations), section 9.4.3 (inspection and testing of electrical installations), section 9.5 (installation of electrical installations), section 2.6, and section 9.12 (maintenance of electrical installations). Letter from the Director General of Electricity and Energy Utilization Number 6795/04/600.3/1997, dated December 19, 1997, Ir Djuhana Djoekardi, "Measuring and testing instruments as well as procedures and administration for inspection and testing materials in the domestic electrical installation inspector course, Electricity Supporting Business Foundation (YUPTL)."

3.6. *Examination and Testing Provisions According to PUIL*

ISSN : 2776-7914 (Print) / 2807-3045 (Online)

General electrical installation regulations (PUIL) are standards used in Indonesia to regulate the installation, maintenance, and testing of electrical installations. Some provisions related to inspection and testing are:

(a). Visual inspection, conducted to ensure that the electrical installation meets safety requirements. This involves inspecting the physical condition of electrical components, cables, connectors, and other equipment. This inspection must be carried out periodically, especially after any changes or repairs to the electrical installation.
(b). Electrical testing involves measurements and tests to verify that the electrical installation operates according to the established standards.
(c). Protection testing is conducted to ensure that the protection device functions properly.
(d). Inspection and testing of electrical installation components. In addition to testing the electrical installation itself, switches, sockets, and lamps must also be inspected and tested.
(e). Measure the electrical voltage at various points in the installation to ensure that the voltage provided meets PUIL standards.
(f). Insulation testing, to check for any unwanted electrical leakage between conductors and ground or between different conductors.
(g). Continuity testing, by measuring resistance to ensure that there are no breaks or poor connections.
(h). Inspection of maintenance-related documentation.

3.7. *Electrical Installation Disruptions and Their Understanding According to PUIL*

Some types of electrical installation disturbances that often occur in electrical installation systems are,

(a). Short circuit current is an excess current caused by an impedance disturbance that approaches zero between two active conductors that normally have different voltages. According to technicians, short circuit current is a disturbance that occurs in an electrical system where two conductors with a voltage difference are connected under conditions of low electrical resistance.
(b). Ground fault is a phenomenon of a short circuit from a phase (or one of the phases) to the ground.
(c). Leakage current is the current that flows outside the conductor.
(d). Electrical transients are sudden and temporary changes in voltage and current in an electrical installation system caused by lightning (external).
(e). Overload, is the amount of installed power exceeding the maximum capacity
(f). Voltage drop, is the decrease in voltage of phases R, S, T when the load increases significantly.
(g). Load imbalance on Phases R, S, T. If the load is added to a specific phase unevenly compared to the other phases.
(h). Overload current is the excess current that occurs when there is no electrical disturbance.
(i). Current carrying capacity (KHA) is the maximum current that can be conducted by a conductor/device under certain conditions, without causing a temperature rise.

3.8. *Potential Electrical Hazards Definition according to PUIL*

The electrical hazards that often occur due to disturbances in the electrical installation system are,

(a). Electric Shock, caused by contact with voltage/current. It is a serious condition that can result in severe injury or even death. Voltage/current can disrupt the human nervous system and heart. Several factors that influence the level of danger from electric shock are the voltage level, the current level, the duration of exposure to the electric flow, and how the electric current flows through the body (for example, through the heart).
(b). Fires caused by short circuit disturbances can produce sparks that can quickly trigger a fire. Fires caused by electrical conductors with frayed insulation can lead to direct contact between the charged conductor and surrounding flammable materials.

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ISSN : 2776-7914 (Print) / 2807-3045 (Online)

(c). Heat, excessive heat can potentially damage the insulation of electrical cables. Some heat hazards that can damage electrical cable insulation include: overheating of cables or electrical components caused by excessively high electrical loads, poor insulation quality, and mismatched cable sizes with the installed electrical load. Degradation of insulation due to heat can cause physical and chemical degradation of the cable insulation material. Continuous exposure to high temperatures will alter the physical properties of the insulation, such as hardening, peeling, or cracking. This will increase the risk of cable failure, such as the risk of a short circuit.
(d). Explosion or hot metal sparks. Several factors that can cause an explosion are short circuits and shorting in cables and components, which can result in uncontrolled currents generating sufficiently high heat, and if there are flammable materials nearby, such as gas leaks, it can lead to an explosion.

3.9. *Maintenance of Electrical Installations*

Maintenance of electrical installations according to PUIL 2000 section 2.6 includes inspection, maintenance, repair, and retesting programs based on the specified maintenance guidelines, so that the electrical installations function properly as expected.

The general steps taken for periodic inspection of electrical installations according to PUIL section 9.12 are:

(a). Inspection of the overall physical condition of the electrical installation. Ensure there is no physical damage to the cables and components of the electrical installation system.
(b). Inspection of the grounding system. It must be ensured that the grounding is properly connected and complies with the standards set in PUIL.
(c). Inspection of overcurrent protection components (devices). Checking the circuit breaker that matches the load capacity and ensuring it works properly.
(d). Inspection of cables (conductors) and their connections, ensuring there are no pinched, frayed, loose, or rusted connections that could cause electrical installation disruptions.
(e). Inspection of the fire protection system, to ensure it is functioning properly and in a ready-to-use condition.
(f). Inspection of signs and labels, ensuring all electrical installation components have easily readable labels, such as load capacity, voltage, and allowed current.
(g). Testing and maintenance of components, to ensure they function properly.
(h). Documentation, after the inspection is completed, records the inspection results, findings, and recommendations for corrective actions, serving as a reference for the next periodic inspection.

3.10. *Occupational Safety and Health (OSH)*

The implementation of electrical K3 as referred to in Article 3 of the Minister of Manpower of the Republic of Indonesia Regulation No. 12 of 2015 concerning electrical safety and health at the workplace, aims to:

(a). Protecting the safety and health of workers and others within the workplace environment from potential electrical hazards
(b). Creating electrical installations that are safe, reliable, and provide safety for the building and its contents.
(c). Creating a safe and healthy workplace to encourage productivity Everyone who is responsible for the design, installation, inspection, testing, and maintenance of electrical installations must understand K3 and have a work permit. One of the objectives of K-3 is to protect workers and others in the workplace (both formal and informal). Every use of 200 KVA electrical energy should have a K-3 organization specifically responsible for the installation, inspection, testing, and maintenance of electrical installations.

https://doi.org/10.35877/jetech3712

ISSN : 2776-7914 (Print) / 2807-3045 (Online)

4. Results and Discussion

4.1. Introduction

The electrical energy source of HKBP Nommensen University is served by 5 (five) special PLN transformer units, consisting of 3 transformer units with a capacity of 197 KVA (Portal Substation), and each transformer has a main panel to serve the load, which are the research locations because they are old. For 1 (one) unit of 340 KVA transformer in the medical faculty building and 1 (one) unit of 197 KVA transformer in the auditorium building, they are not included in this study because their installation systems are still relatively new.

4.2. Measurement of Ground Resistance of Distribution Transformers

The measurement of grounding resistance from 3 (three) units of 197 KVA transformers was conducted with three measurements on different days to obtain accurate resistance. The measurement results are shown in table 1

Table 1. Grounding Measurement Results of 3 PLN Distribution Transformer Units

<table>
<tr><th colspan="7">Measurement of Transformer Ground Resistance and
The comparison with PUIL 2000 is less than 5 Ohms.</th></tr>
<tr><td rowspan="2">Day</td><td colspan="2">Trafo I</td><td colspan="2">Trafo 2</td><td colspan="2">Trafo 3</td></tr>
<tr><td>Resistansi (Ohm)</td><td>Study</td><td>Resistansi (Ohm)</td><td>Study</td><td>Resistansi (Ohm)</td><td>Study</td></tr>
<tr><td>1</td><td>3,84</td><td rowspan="4">good</td><td>1,21</td><td rowspan="4">good</td><td>5,78</td><td rowspan="4">Not Good</td></tr>
<tr><td>2</td><td>4,30</td><td>0,79</td><td>5,44</td></tr>
<tr><td>3</td><td>4,97</td><td>0,30</td><td>5,57</td></tr>
<tr><td>Average</td><td>4,37</td><td>0,76</td><td>5,59</td></tr>
<tr><td></td><td colspan="6">Conclusion Table 1: There is a potential disturbance in the electrical installation loaded by Transformer 3, the transformer grounding resistance is poor (less than 5 Ohm).</td></tr>
</table>

Measurement of Ground Resistance of Distribution Transformers

Inspection and commissioning of the grounding resistance of 3 (three) main busbar panel units, with results shown in table 2.

Table 2. Measurement Results of Ground Resistance for the Panel Hubung Bagi (PHB)

<table>
<tr><th colspan="7">Measurement of Main PHB Grounding Resistance [A][B][C]
The comparison with PUIL 2000 is less than 5 Ohms.</th></tr>
<tr><td rowspan="2">Hari</td><td colspan="2">PHB [A]</td><td colspan="2">PHB [B]</td><td colspan="2">PHB [C]</td></tr>
<tr><td>Resistansi (ohm)</td><td>Study</td><td>Resistansi (ohm)</td><td>Study</td><td>Resistansi (ohm)</td><td>Study</td></tr>
<tr><td>1</td><td>0,56</td><td rowspan="4">Good</td><td rowspan="4">Tidak ada Pentanahan (Grounding)</td><td rowspan="4">Bad</td><td rowspan="4">Tidak ada Pentanahan (Grounding)</td><td rowspan="4">Bad</td></tr>
<tr><td>2</td><td>0,41</td></tr>
<tr><td>3</td><td>1,37</td></tr>
<tr><td>Average</td><td>0,78</td></tr>
<tr><td></td><td colspan="6">Conclusion Table 2: There is a potential for electrical installation interference at PHB [B] and PHB [C] due to the absence of grounding in both panels.</td></tr>
</table>

4.3. Measurement of Ground Resistance of Distribution Transformers

Inspection and commissioning of the installed components of the 3 (three) main PHB units was carried out to ensure that each component was up to standard and to identify potential electrical installation faults. The results of inspection and measurement are shown in table 3.

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Table 3. Main PHB Panel Inspection Results [A][B][C]

Inpeksi Panel Hubung Bagi (PHB) Main Panel Location: Genset Building [Indoor]					
No	Uraian Pekerjaan (Description Work)	Status/State Findings	Main Panel Name		
1	Type	Main panel	[A]	[B]	[C]
	Ukuran dan Kapasitas Panel (watt)	Three doors: 200 cm/70/70/70 157.6 KW (197 kva x 0.8)	Yes		Ya
		Two doors: 200 cm/70/70, 157.6 KW	No	Yes	No
	Type of Ground Cable Connecting to GI branch Panel, FT	NYY 4×50 mm cable (according to table 7.3-5a PUIL KHA 185 A)	Yes	Yes	No
	Type of cable connecting to branch panel: (FBS, FE, GY/PASCA, GPUS/FH)	Twisted / JTR NFA2X.T 3 × 75+50 mm NFA2X 3 × 70+50 mm (according to table 7.3-12a KHA = 196 A)	No	No	Yes
	Voltage	380/220 Volt	Yes	Yes	Yes
	Number of Phases	3 phasa	Yes	Yes	Yes
	Panel Mounted Capacitor Bank		Ya	No	Yes/Bad
	Check the cleanliness of the panel room area	Dusty	Yes	Yes	Yes
2.	Physical Examination				
	State of the Panel	There are signs of physical damage.	No	No	No
		There is corrosion or leakage on the panel	No	No	No
		Other objects blocking access to the panel	No	No	There's
		The panel is well closed and locked.	Yes	Yes	Yes
3	Terminals and Cables				
		Terminals and wires do not overheat.	Yes	Yes	Yes
		There are signs of burning on the terminals and wires.	No	No	No
		There are signs of overheating or melting of the cable.	No	No	No
4	Component Inspection				
	Main Panel [A] MCCB Sneider Electrik 350 A Main Panel [B] MCCB Sneider Electrik 200 A	Main switch functioning properly Incoming Circuit: KHA of switch/MCCB (at least equal to KHA of conductor)	Yes	Yes	Yes
		There are signs of damage to the main switch.	No	No	No
	Main Panel [C]				
	MCCB to FBS Merlingerin 100 A	Main switch functioning properly Incoming Circuit: KHA switch / MCCB (at least equal to KHA conductor) There are signs of damage to the main switch.	Yes	Yes	Yes
	MCCB to FE 250 A electric sneider		Yes	Yes	Yes
	MCCB to Foundation/Postgraduate Merlingerin 250 A		Yes	Yes	Yes
	MCCB to Library / FH Easy pact 250 A		No	No	No

	Phase Voltage to Netral		As per PUIL standard		
	Phasa R-N	PUIL Standard, Voltage 220 Volt With a tolerance of +5% and -10% of the service voltage value)	228 V	230 V	231 V
	Phasa S-N		228 V	232 V	229 V
	Phasa T-N		225 V	228 V	232 V
	Phase to Phase Voltage		there are those that do not comply with PUIL standards, namely Voltage 402 V		
	Phasa R-S	PUIL Standard 380 Volt Voltage With +5% and -10% tolerance of service voltage value	398 V	402 V	398 V
	Phasa S-T		395 V	402 V	398 V
	Phasa T-R		392 V	398 V	399 V
	Inflow		Unbalanced Load		
	Phasa R	The load current flowing in each phase must be symmetrical or close to symmetrical (Balanced)	135 A	49 A	71 A
	Phasa S		105 A	37 A	197 A
	Phasa T		160 A	52 A	157 A
	Secondary switch check				
	phasa R	There are signs of overheating or burning on the secondary switch of phase R	No	No	No
	phasa S	There are signs of overheating or burning at the secondary switch of phase S	No	No	No
	Saklar phasa T	There are signs of overheating or burning at the secondary switch of phase T	No	No	No
5	Grounding	Installed Grounding Panel	Yes	No	No
6	CAPASITOR BANK				
	Check the Power factor / Cos Phi Indicator	0,85 sd 1,0	0,98 Yes	Broken	Don't know
	Check Indicator Light function	a). Lit b). flashing c) Broken	a	a	a
	Check the function of the on/off button (PB)	a). Functioning b). Not working	a	a	a
	Cable connection	Works well	Yes	Yes	Yes
	Physically check the capacitor	Normal (not inflated, no capacitor impurities)	Yes	Yes	Yes
	Conclusion Table 3: There is a potential for electrical installation disturbances due to unbalanced (Symmetrical) loads installed in each phase: R, S, T				

4.4. *Measurement of Ground Resistance of Distribution Transformers*

Visual inspection and commissioning of the installed components of each branch panel installed in each building, is carried out to ensure whether each component is up to standard and to find out whether there is a potential electrical installation disturbance in each branch panel. The results of the inspection and commissioning are shown in table 4. In this case, the name of each building in the table is, A.E Manihuruk Building (FT), Fak. Economics (FE), Fak. Law (FH), Library Building (GP), Foundation Building (GY), Postgraduate Building (GPS), Prof. Amudi Pasaribu Building (GI).

Table 4. Results of Inspection and Measurement of Branch Panel (PHB)

	Branch PHB Inspection and Measurement								
	PUIL Standard Voltage 220 Volts With a tolerance of +5% and - 10% of the service voltage value and KHA MCCB at least equal to the KHA conductor								
No	**Commissioning Description**	**Findings**	**FT**	**FE**	**FH**	**GP**	**GY**	**GPS**	**GI**
1	**Right. Incoming (Volt)**								

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	Phasa R-N	As per PUIL standard	230	231	232	232	231	231	230
	Phasa S-N		232	229	229	219	229	229	232
	Phasa T-N		228	232	206	210	232	232	228
2	**Right. Out (Volt)**								
	Phasa R-N	As per PUIL standard	203	225	220	225	225	228	215
	Phasa S-N		224	224	220	225	225	220	228
	Phasa T-N		215	228	220	220	220	221	225
3	**Outgoing Current (Amperes)**								
	Phasa R	As per PUIL standard	49	38	57	9	8	3	135
	Phasa S		37	68	77	47	20	6	105
	Phasa T		52	46	25	44	17	12	160
4	**Physical Examination**								
	Panel Condition	There are signs of physical damage	No	No	No	No	No	No	No
		There is corrosion or leakage	No	No	No	No	No	No	No
		Other objects blocking access	No	No	No	No	No	No	No
		There are signs of burning on the terminals	No	No	No	No	No	No	No
5	**Component Inspection**								
	Main Switch	The main switch works well.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	**Secondary switch check**								
	Phasa R,S,T	There are signs of overheating or burning	No	No	No	No	No	No	No
7	**Panel Condition**	a). Good b).Damaged	a	a	a	a	a	a	a
8	**Check the cleanliness of l**	Dusty	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Conclusion Table 4: No potential electrical installation faults found								

4.5. *Visual Inspection of Electrical Installations*

Inspection of the installed electrical installations in each building supplied by each of the 3 197 KVA transformer units is carried out to identify whether the installed electrical installations comply with safety standards and whether there are signs of electrical installation problems that have the potential to cause electrical hazards. The results of these inspections and measurements are shown in table 5

Table 5 Results of Visual Inspection of Electrical Installation

Visual inspection of electrical installations Installation Location: UHN Building				
Date of Inspection: Date of Inspection: June 21 - 23, 2023				
No	**Uraian Pekerjaan (Description Work)**	**Condition/State Findings**		
	Type of Usage of Lecture Building			
	RISK ASSESSMENT			
1	**Does the electrical installation comply with applicable safety standards?**	[√] Yes	[ ] No	[ ] Unknown
2	**Are there any indications of damage or wear on electrical equipment**	[ ] Yes	[ ] No	[ ] Unknown
3	**Are there signs of current leakage or short-circuiting?**	[ ] Yes	[ ] No	[ ] Unknown
4	**Is the overcurrent protection (MCB) working properly?**	[√] Yes	[ ] No	[ ] Unknown
5	**Is the grounding system working properly?**	[√] Yes	[ ] No	[ ] Unknown
6	**Whether the cable is damaged (the wrapping layer of the cable starts to peel off, risking an electrical short circuit).**	[ ] Yes	[ ] No	[ ] Unknown
7	**Is the cable pinched by an object**	[ ] Yes	[ ] No	[ ] Unknown
8	**Are there any tangled wires**	[ ] Yes	[ ] No	[ ] Unknown
9	**Is there any use of cables that are not in accordance with their designation?**	[ ] Yes	[ ] No	[ ] Unknown
10	**Conductor connections Are the terminations electrically and mechanically good? Is insulation and sheathing only removed to a minimum to allow satisfactory termination?**	[√] Yes	[ ] No	[ ] Unknown
11	**Whether the conductor has been correctly identified in accordance with the applicable provisions**	[√] Yes	[ ] No	[ ] Unknown
	Conclusion Table 3e: No potential electrical installation faults found			

4.6. *Phase Voltage Measurement at Power Stations*

Voltage measurements in each phase of electricity installed in each building are carried out to determine whether the service voltage is in accordance with PUIL standards. Inspection and measurement results are shown in table 6. Phase voltage measurements at several sockets as samples were carried out at Amudi Pasaribu Building: Justin meeting room (RJ), room I.2.5, room I.3.14, room I.4.5, FBS Building, Faculty of Law Building (FH), Library Building (GP), and Faculty of Economics Building (FE).

Table 6. Results of Inspection and Measurement of Phase Voltage at Contact Stops

	Inspection and Measurement of Phase Voltage at Power Stops PUIL compliant Voltage 220 Volts With tolerance +5% and - 10%								
No	**Job Description (Description Work)**	**RJ**	**I.2,5**	**I.3.14**	**I.4.5**	**FBS**	**FH**	**GP**	**FE**
	Measurements Voltage on								
	VPhasa R – Neutral	223	222	220	230	225	224	253	223
	VPhasa S – Neutral	223	222	220	230	225	224	253	223
	VPhasa T – Neutral	223	222	220	230	225	224	253	223

	VPhasa – Ground	223	216	220	229	401	227	224	46
	VNetral – Ground	0,06	0,02	1,2	0,04	Rusak	0,3	0,3	0,04
	Conclusion Table 3f: There are potential electrical installation faults in GP Building and FBS Building								

4.7. *Assessment of Potential Disturbance of UHN Electrical Installation Risk Identification and Recommendation of Preventive Measures*

The inspection of potential electrical installations has the objective of identifying risks that may occur in UHN's electrical installations, so that appropriate prevention efforts can be planned to maintain the safety, performance and continuity of electricity supply at UHN. There were thirteen (13) findings, which are potential faults, the results of visual inspection and commissioning are shown in table 7

Table 7. Findings of Visual Inspection and Commissioning of Potential Electrical Installation Disorders

	Findings	**Study**		**Recommendation Preventive Measures**
		Potential Disruption	**Risk**	
1	**Grounding Transformer Body 3. 5.59 (not good)**	Excessive heat occurs	Reduced transformer cooling efficiency	Perform Maintenance, sprinkle salt, or parallelize electrodes
2	**No grounding installation monitoring location found**	Difficult to maintain the grounding installation	Earthing system is not functioning properly	Locate the grounding electrode point.
3	**Panels in Dusty condition**	Impaired performance of each component	Electroshock	Perform maintenance and cleaning of PHB
		Leakage current or short circuit	fire	
4	**2 Main PHB Units Not Installed Grounding Installation**	If there is a leakage current there will be an electric shock current	Electroshock, Burning	Perform grounding.
5	**PHB Position [C] Obstructed by Other Objects**	Difficult to perform inspections	Difficult to carry out Security and maintenance measures	Provide an inspection room
6	**Capacitor Bank at PHB [C] is not working, and at PHB [B] no capacitor bank is installed.**	Low power factor	negative impact on energy efficiency, electricity costs will be higher	Repair Capacitor Bank Panel [C] and Install Capacitor Bank in Panel [B]
7	**The 3 transformers are loaded with unbalanced load conditions in each phase.**	Voltage drops, Resistance increases, Occurs current spikes on certain phases	Energy losses, (power lost). Reduced equipment life	Solve the problem of load imbalance
8	**Significant difference in current flowing in each phase**	Overheating occurs	Damage to cables and equipment (downtime). Fire, Power loss	Identify and resolve significant current differences,
9	**A large current flows on the Main Panel [A]. To Amudi Pasaribu Building**	Overheating occurs	Will damage the conductivity of cables and equipment	Memperbesar diameter kabel penghubung. Menambah MCB
10	**The same path between: electrical installation cables, air conditioning installations, and telecommunications installations**	Generates electro magnetic fields that can interfere with telecommunication signals	Electrical short circuit. Difficult to identify problems and maintenance	Jalur kabel dipisahkan secara fisik dan diatur terpisah sedemikian rupa

https://doi.org/10.35877/jetech3712

ISSN : 2776-7914 (Print) / 2807-3045 (Online)

11	**Not energy efficient**	Karyawan kurang peduli penghematan energi dan uang	Electrical installation system malfunction	If not necessary, turn off the electricity (discipline of saving electricity energy)
12	**Unknown position of grounding electrodes in each branch panel (load)**	Grounding maintenance cannot be performed	Difficult to perform grounding maintenance	Locate the grounding electrode point
13	**No organization K-3 at UHN**	Electricity department employees do not work according to PUIL standards	No one is specifically responsible for electrical installations	K-3 Organization Form

5. Conclusion

5.1. Conclusion

The UHN electrical installation system is due for maintenance, at least considering the findings of visual inspection and commissioning of potential UHN Electrical Installation disturbances Risk Identification and Preventive Measures Review/Recommendations shown in tables: 3a, 3b, 3c, 3f, 3g, which are part of the conclusions of this study.

5.2. Suggestions

To consistently apply the PUIL guidelines, and pay attention to the follow-up preventive recommendations given in table 3g and for UHN to establish an Occupational Safety and Health (K-3) unit to create electrical installations that are safe, reliable and provide safety for the building and its contents.

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