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Assessment of Compliance with Electrical Standards in a Selected Public Elementary School in the Philippines

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RESEARCH ARTICLE

Abstract

The study was conducted to determine the current situation of the electrical system of the campus and provide certain recommendations for the betterment of the system. The study aims to determine the present status of the electrical system along with lighting loads, power loads, electrical wiring, and overcurrent protective devices; determine the compliance of the lighting loads, power loads, electrical wiring, and overcurrent protective devices; and formulate recommendations to be the basis for extension activities. The researcher conducted site inspections to check and analyze the electrical system of the campus. This research found that the Nabua Central Pilot School has two supplies from two barangays in Nabua, namely, Barangay San Nicolas and San Roque. The classrooms of this school also have one connection for circuit homerun and do not have protective devices in each classroom. Several violations of the minimum requirements of Philippine Electrical Code were also cited during the on-site inspection. Wires need to be resized, and the installation of circuit breakers in each room is needed. Since it has two sources of supplies, the researcher recommends using three 100 kVA single-phase transformers to accommodate the loads of the school. Thus, the results showed that the school needs to improve its present electrical system.

Keywords: electrical engineering, extension, impact, impact study, implementation, outcomes

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1 INTRODUCTION

Electrical safety should be a primary concern of all electrical practitioners and the whole community [1]. Philippine Electrical Code or PEC [2] must be adhered in the establishments to provide a safe working environment for workers and the community. Every government ensures that this provision is carried out by any establishment. Along this line, the Philippines' Department of Labor and Employment formulated the Occupational Safety and Health Standard (OSHS) in 1978 [3] "in compliance with the constitutional mandate to safeguard the worker's social and economic well-being as well as his physical safety and health". This provision extends to the clients to whom the establishment provides its services within the workplace.

Educational establishments in basic education are aware of this provision. Complying with this, the Department of Education issued an order, DO 64 Series of 2017 [4], establishing performance standards and specifications for DEPED school buildings to guide the Department and other stakeholders in the preparation of plans—architectural, structural, electrical, fire protection, and sanitary—to ensure the comfort and safety of the would-be occupants of the school buildings .

As demand goes up, the actual design of the system becomes inadequate to hold the capacity needed. This is a problem for both the administration and the occupants of the building. This only shows the need for maintenance of the system and applies a periodic assessment of electrical installation to be done by electrical practitioners.

In addition, the Camarines Sur Polytechnic Colleges is a state college created by Batas Pambansa Bilang 512 by then President Ferdinand E. Marcos on June 10, 1983. Its mission is to transform lives to be free of poverty by creating a better future through world-class polytechnic education and technological innovation. Along with this, the college wants to provide quality service through demand-driven and research-based extension programs to the partnered barangays in Rinconada. Sustainable programs are prioritized through research-based extension, which is a way of building an effective relationship with the partnered community. The Commission on Higher Education [5] also mandated the State Universities and Colleges of the Philippines to conduct research, extension and innovation as part of their functions in society.

Similarly, the agenda of Philippine higher education is to accelerate its contribution as a collective resource in achieving goals of social change and nation building. Herrera [6] also explained that Higher education institutions are thus anticipated to address the needs of comprehensive human development and enhance the quality of life for Filipinos, all within the framework of an increasingly interconnected global community and a mindset of borderless global thinking. There is an increasing appreciation of the impact of higher education extension in the teaching and learning process as students apply their disciplinary knowledge to help address real-world problems [7].

The College of Engineering and Architecture is one of the five (5) departments of the college and offers six (6) baccalaureate degrees. Bachelor of Science in Electrical Engineering is one of the programs under the College of Engineering and Architecture. To achieve the goal of the college, the BSEE provides sustainable and relevant community outreach and skills training like electrical installation and maintenance for out-of-school youth in partnered barangays. This activity, as well as the technology transfer, supports the mandate of the college by providing the community with relevant and worthwhile services. Aside from these activities, the program is actively involved in the Brigada Eskwela of various government schools during the opening of the school year. The program's purpose is to ensure that classrooms and offices are free from any electrical risks. The activity usually starts with the assessment of the electrical system and offers services like actual electrical rewiring and formulating recommendations in case of non-compliance with standards, as well as upgrading the electrical system.

Moreover, Sklodowski [8] wrote that safety is a key benefit of having an electrical assessment performed in a workplace. Once an electrical assessment is performed, an effective electrical safety program may be implemented that will keep the workers safe from life-threatening injuries and death. Also, Hilutin et al. [9] stated that electricity is an essential component of modern life, powering many operations, including academic institutions. Improving the campus by building classrooms would require an increase in the demand for electricity resulting in the incompetence of the present status of the system [9]. In school, protecting students, faculty, and visitors from electrical risks is a critical component of establishing a safe environment. Along these lines, it is critical to grasp some of the most frequent electrical concerns, ranging from fire hazards to safe work practices, to create an electric-friendly workplace [10]. Eisau [11] stated that keeping students, staff, and visitors safe from electrical hazards is a vital part of promoting a safe environment. With that, understanding some of the common electrical risks from fire hazards to safe work practices is essential for an electric-friendly workplace. The present study was guided by the Philippine Electrical Code 2017 [2] which is the governing standard for electrical practitioners in the Philippines.

Thus, this study aims to conduct a conformity assessment to the electrical standards of Nabua Central Pilot School, an educational establishment in Rinconada Area, as a basis for an Extension Program. Specifically, it sought to address the following: (1) determine the present status of the electrical system along with lighting loads, power loads, electrical wiring, and overcurrent protective devices; (2) determine the compliance of the lighting loads, power loads, electrical wiring, and overcurrent protective devices; and (3) formulate recommendations to be the basis for extension activities. This study is does not include measuring the actual load consumption of the school.

2 METHODOLOGY

2.1 Research Method

The methods used in this research were descriptive and documentary analysis. According to Nallaperumal et al. [12], descriptive research entails many types of surveys and fact-finding inquiries. The primary objective of descriptive research is to document the current state of circumstances. The researchers have no control over the variables and can only document what has occurred and what is occurring, which is the primary characteristic of descriptive research. Most research projects of this type employ descriptive investigations in which the researcher aims to quantify variables. This method is used in answering the problem posed by this study on the status of the electrical system in terms of lighting and power loads, and the distribution system.

Documentary analysis is a systematic procedure for reviewing or evaluating documents both printed and electronic (computer-based and Internet-transmitted) material. Document analysis necessitates the examination and interpretation of data to elicit meaning, increase comprehension, and develop empirical knowledge [13]. These methods enabled the researcher to determine whether the existing electrical system complied with applicable regulations and ordinances. Among the documents assessed were the as-built electrical plan of each building and the electrical distribution map.

2.2 The Participants

The participants of this study were the school head, maintenance officer of the school and each teacher assigned to each classroom. The researcher selected these participants because they have the knowledge and experiences of electrical installation of their own classroom or building.

The selection of the participants was made purposively because there is a criterion to follow for the respondents who can participate. Dudovskiy [14] defined purposive sampling as a group of non-probability sampling techniques in which respondents are selected because they have characteristics that the researcher needs in this study. In simpler words, respondents were selected “on purpose” in purposive sampling.

2.3 Research Instruments

The researcher conducted interviews with the participants of this study, focusing on various aspects of the electrical system of the school. The participants were asked detailed questions about the electricity, including monthly power consumption, the connections and layout of each circuit, and the locations of panelboards or circuit breakers. The controls of each switch and the location of primary supply. Additionally, information regarding the placement and functionality of watt meters within the school was gathered. To complement the interview data, the researcher also performed an ocular inspection on the wiring installation of the school. The researcher then conducted hands-on assessment to provide a thorough understanding of the current state or present installation of electrical system and ensure the accuracy and completeness of the collected data. By combining interview responses with direct observations, the researcher aims to create a comprehensive overview of the school’s electrical system.

2.4 Data Gathering Procedures

Figure 1 illustrates the research process used in assessing the compliance of the electrical system of Nabua Central Pilot School with the Philippine Electrical Code(PEC). The study began with interviews to gather relevant information about the existing electrical system. This was followed by an ocular inspection to observe and document the actual condition of the electrical installations. The collected data were then used to establish the present status of the school's electrical system. Based on these findings, the researcher assessed the lead of compliance with the PEC. Then, a proposed electrical system design was developed to address identified deficiencies and improve safety, reliability and code compliance of the school's electrical installation.

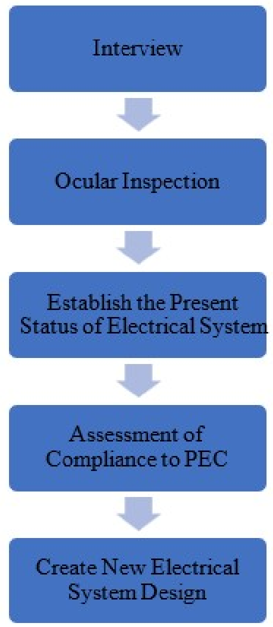

Figure 1. **Research Process**

3 RESULTS AND DISCUSSIONS

3.1 Present Status of the Electrical System

This research aims to ascertain if the Nabua Central Pilot School complies with electrical standards based on the Philippine Electrical Code [2] . From the results of the evaluation conducted by the researcher regarding compliance with the Philippine Electrical Code, the summary of findings and recommendations are presented in a single-line diagram and further explained through the following tables.

Table 1 shows the summary of Branch-Circuit Requirements as per Philippine Electrical Code 2017. This table states that for a lighting load, there must be a minimum of 15 A branch circuit and a maximum rating of 50 A. Branch circuits for non-lighting loads it is rated for more than 50 Amperes [15].

The data presented in Tables 2 to 8 were based on Figure 2. This information shows the existing electrical system of the school and the proper standards of the Philippine Electrical Code.

As shown in Table 2, the principal's office has a panelboard that supplies the kindergarten and Grade 1 from room 1 to room 7. The principal's office, kindergarten, and Grade 1 room are connected to Wattmeter 1. The loads lighting outlets, convenience outlets and ceiling fans is connected to a single circuit. Rooms 1 to 7 of Grade 1 are protected by a single circuit breaker which has a small ampere trip rating; thus, this is also non-compliant to Philippine Electrical Code because the load is greater than the branch circuit rating. The kindergarten rooms 1 to 3 are also protected by one circuit breaker, thus this is non-compliant with the Philippine Electrical Code. Since Grade 1 and kindergarten have only one circuit, the size of the wires is also non-compliant with the Philippine Electrical Code because the greater the loads, the larger amount of current

Table 1. Summary of Branch-Circuit Requirements

Circuit rating	15 A	20 A	30 A	40 A	50 A
Conductors (minimum size): Circuit wires	2.0 sq. mm (1.6 mm dia.)	3.5 sq. mm (2.0 mm dia.)	5.5 sq. mm (2.6 mm dia.)	8.0 sq. mm (3.2 mm dia.)	14 sq. mm
Tap and Fixture wires and cords	2.0 sq. mm (1.6 mm dia.)	2.0 sq. mm (1.6 mm dia.)	2.0 sq. mm (1.6 mm dia.)	3.5 sq. mm (2.0 mm dia.)	3.5 sq. mm (2.0 mm dia.)
Overcurrent Protection	15 A	20 A	30 A	40 A	50 A
Outlet Devices: Lamp holders	Any type	Any type	Heavy duty	Heavy duty	Heavy duty
Receptacle ratings	15 or 20 A	15 or 20 A	30 A	40 or 50 A	50 A
Maximum Load	15 A	20 A	30 A	40 A	50 A
Permissible load	See 2.10.2.6(A)	See 2.10.2.6(A)	See 2.10.2.6(B)	See 2.10.2.6(C)	See 2.10.2.6(C)

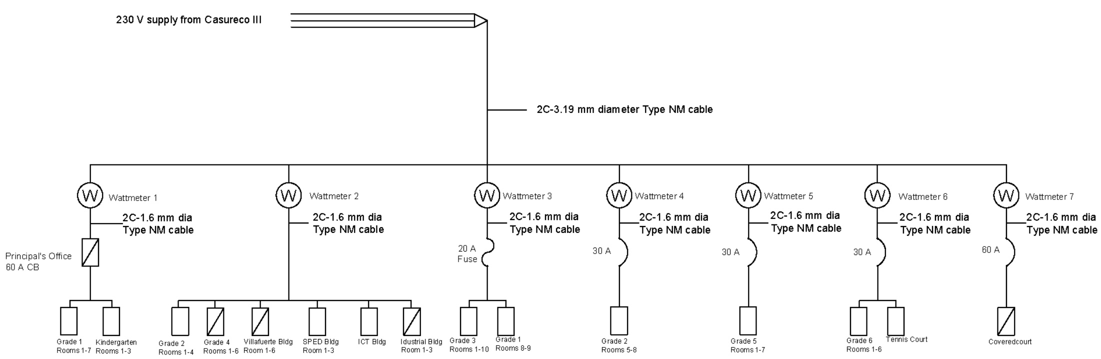

Figure 2. Present Status of Electrical System of Nabua Central Pilot School

needed to supply, thus it needs a larger size of wire to prevent fire. Although the Philippine Electrical Code does allow supplying two different loads in a single circuit, provided that the load served shall not exceed 80 percent of the branch circuit rating and shall not exceed 50 percent of the branch circuit rating [16].

Table 3 provides the loads connected to Wattmeter 2, specifically the Grade 2 rooms 1 to 4, the Multipurpose building or the ICT building, the SPED building, the Two-story building (Villafuerte building), the Industrial building and Grade 4 rooms 1 to 6. From the data gathered, the following rooms are non-compliant regarding the size of the wire. The present installed wires are smaller than the required wire as per the Philippine Electrical Code. The Grade 2 rooms, SPED rooms, Industrial building, and Grade 4 rooms have one circuit, and each is protected by one circuit breaker. For these rooms, the size of wires is non-compliant as well as the ampere ratings of their breakers. For Grade 4, each room has one circuit that controls the lighting, convenience outlets, ceiling fans, and TV. Each room has also only one protective device which has a smaller rating than specified in the Philippine Electrical Code. Additionally, the ICT building is non-compliant only because the lighting, convenience outlets, and ceiling fans are connected to a single circuit and have a large rating than the branch circuit [16]. However, the two-story building is non-compliant

Table 2. Wattmeter 1

Circuit No.	Load				Size of Wire		Protective Device CB/Fuse	
	LO	CO	Ceiling Fans	ACU	Existing	PEC	Existing	PEC
Principal's Office								
1	5				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	15 AT	15 AT or 20 AT
		4			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			2		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
2				2	Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	20 AT	20 AT
Kindergarten (Rooms 1-3)								
3	24				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	20 AT	15 AT or 20 AT
		9			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			12		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
Grade 1 (Rooms 1-7)								
4	21				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	20 AT	15 AT or 20 AT
		28			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			28		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT

only with the size of the wires installed.

Table 3. Wattmeter 2

Circuit No.	Load				Size of Wire		Protective Device CB/Fuse	
	LO	CO	Ceiling Fans	ACU	Existing	PEC	Existing	PEC
Grade 2 (Rooms 1-4)								
1	16				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	15 AT	15 AT or 20 AT
		16			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			16		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
ICT Building								
1	8				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	15 AT	15 AT or 20 AT

Continued on next page

Table 3. Wattmeter 2 (Continued)

Circuit No.	Load				Size of Wire		Protective Device CB/Fuse	
	LO	CO	Ceiling Fans	ACU	Existing	PEC	Existing	PEC
		4			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			4		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	20 AT	20 AT
2				1	Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	20 AT	30 AT
SPED Building (Rooms 1-3)								
1	12				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	15 AT	15 AT or 20 AT
		9			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			12		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
Two-Story Building (Rooms 1-6)								
1	24				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	15 AT	15 AT or 20 AT
2		18			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	20 AT	20 AT
3			24		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	15 AT	20 AT
Industrial Building (Rooms 1-3)								
1	12				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	60 AT	15 AT or 20 AT
		12			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			24		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
Grade 4 (Rooms 1-6)								
1	24				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	20 AT	15 AT or 20 AT
		18			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			36		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT

Table 4 shows only two loads, the Grade 3 rooms 1 to 10 and Grade 1 rooms 1 to 2. This wattmeter is protected by 20 A Fuse, the Grade 1 rooms are separated from the previous rooms of Grade 1 connected in Wattmeter 1. From the data, Grade 3 has only one branch circuit and one 20 A fuse that protects the circuit. This circuit holds the three loads such as lighting, convenience outlets, and ceiling fans of Grade 3. On the other hand, Grade 1 rooms 1 and 2 also have one circuit and without a protective device like a circuit breaker. This installation is non-compliant as per the Philippine Electrical Code. The sizes of the wires are also non-compliant because it did not follow the minimum standard of PEC 2017. Additionally, the loads connected to these two circuits are overloaded as far as PEC is concerned, therefore, this is non-compliant [16].

Table 4. Wattmeter 3

Circuit No.	Load				Size of Wire		Protective Device CB/Fuse	
	LO	CO	Ceiling Fans	ACU	Existing	PEC	Existing	PEC
Grade 3 (Rooms 1-10)								
1	40				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	20 A(Fuse)	15 AT or 20 AT
		30			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			40		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
Grade 1 (Rooms 1-2)								
2	8				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	None	15 AT
		6			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			8		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	20 AT	20 AT

Table 5 shows the load connected to the Wattmeter 4. The Grade 2 rooms 5 to 8 are separated rooms from the previous rooms for Grade 2 that are connected to Wattmeter 2. Grade 2 rooms 5 to 8 are connected to a single circuit with one overcurrent protective device which is 30 amperes. According to Philippine Electrical Code (Article 2.10.2.6) [16], it is allowed to supply a combination of lighting units and any other utilization if its shall not exceed the rating of branch circuit [16]. Thus, the loads in wattmeter 4 is compliant with the Philippine Electrical Code. However, the size of the wires of these loads is smaller than the required size as per the Philippine Electrical Code because the convenience outlets and ceiling fans must have 3.5 sq. mm wires [17]. Thus, this is non-compliant with the PEC 2017.

Table 5. Wattmeter 4

Circuit No.	Load				Size of Wire		Protective Device CB/Fuse	
	LO	CO	Ceiling Fans	ACU	Existing	PEC	Existing	PEC
Grade 2 (Rooms 5-8)								
1	16				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	30 AT	15 AT or 20 AT
		12			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			24		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT

Table 6 shows the load connected to the Wattmeter 5. The Grade 5 rooms 1 to 7. These rooms are the only ones connected to Wattmeter 5 which has a 30 A circuit breaker. The breaker protects three kinds of loads: the lighting, convenience outlet, and ceiling fans. The size of the wires of these loads is smaller than the required size of the Philippine Electrical Code. According to PEC 2017, it is allowed to supply lighting units and other utilization equipment, but it must not exceed the rating of the branch circuit [16]. The lighting loads, convenience outlets and ceiling fans exceeded the rating of the branch circuit, thus this is non-compliant with the PEC 2017. Also, each type of load must have a circuit breaker with a proper rating. According to the Philippine Electrical Code, each lighting load must have a minimum of 15 amperes and convenience outlets must have a minimum of 20 amperes circuit breaker. Ceiling fans are also required to have a minimum of 15-ampere rating of circuit breakers. Therefore, this data is non-compliance with the Philippine Electrical Code [17].

Table 6. Wattmeter 5

Circuit No.	Load				Size of Wire		Protective Device CB/Fuse	
	LO	CO	Ceiling Fans	ACU	Existing	PEC	Existing	PEC
Grade 5 (Rooms 1-7)								
1	28				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	30 AT	15 AT or 20 AT
		14			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			28		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT

Table 7 shows the loads are connected to Wattmeter 6; specifically, the Grade 6 rooms 1 to 6 and the tennis court. The Grade 6 rooms are protected by a single 60-ampere circuit breaker. The circuit breaker is the protective device for all the loads such as lighting, convenience outlets, and ceiling fans. This is compliant with the code since the load does not exceed the rating of the branch circuit. However, the installed wires are smaller than the required size by the Philippine Electrical Code [17]. Thus, for Grade 6 rooms, it is non-compliant only because of the size of wires and because it does not have circuit breaker for each branch circuit. Additionally, the tennis court is non-compliant because it does not have a circuit breaker.

Table 7. Wattmeter 6

Circuit No.	Load				Size of Wire		Protective Device CB/Fuse	
	LO	CO	Ceiling Fans	ACU	Existing	PEC	Existing	PEC
Grade 6 (Rooms 1-6)								
1	24				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	60 AT	15 AT
		12			Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
			24		Type NM cable 1.6 mm dia.	3.5 mm^2 THHN	None	20 AT
Tennis Court								
2	8				Type NM cable 1.6 mm dia.	2.0 mm^2 THHN	None	15 AT

The covered court loads are shown in Table 8 which is connected to Wattmeter 7. This building is newly constructed and has its panelboard. As shown in Table 10, the size of installed wires is the same as the sizes given by the Philippine Electrical Code. It is compliant also with the circuit breakers.

The summary of compliance of existing electrical system is presented in Appendix A and the

Table 8. Wattmeter 7

Circuit No.	Load				Size of Wire		Protective Device CB/Fuse	
	LO	CO	Ceiling Fans	ACU	Existing	PEC	Existing	PEC
Covered Court								
1	7				3.5 mm^2 THHN	3.5 mm^2 THHN	15 AT	15 AT
2	7				3.5 mm^2 THHN	3.5 mm^2 THHN	15 AT	15 AT
3	7				3.5 mm^2 THHN	3.5 mm^2 THHN	15 AT	15 AT
4		8			3.5 mm^2 THHN	3.5 mm^2 THHN	20 AT	20 AT
5		8			3.5 mm^2 THHN	3.5 mm^2 THHN	20 AT	20 AT

proposed new electrical system of Nabua Central Pilot School is shown in Appendix B.

4 CONCLUSIONS

The study is beneficial to the school because it can recommend creating new electrical designs for the benefit of the school and its constituents. The school utilized Type NM 1.6 mm diameter wire for feeder and branch circuit conductors, which is undersized for connecting lighting outlets, convenience outlets, and ceiling fans. Some rooms or buildings lack their own circuit breakers and panelboards. The circuits are overloaded because of multiple loads that are connected to a single branch circuit. Due to the extensive area of the school premises, significant power is required. The school is non-compliant regarding the size of wire. As per Philippine Electrical Code 2017 the minimum size of wire for lighting outlets is 2.0 sq.mm or 1.6 mm. diameter. The school used 1.6 mm diameter for lighting outlets, convenience outlets and ceilings; therefore, it is non-compliant to Philippine Electrical Code. For convenience outlet, the school used 1.6 mm diameter while the Philippine Electrical Code prescribed to use 3.5 sq. mm or 2.11 mm diameter, thus, the school is non-compliant. Ceiling fans are using 3.5 sq. mm wires, but the school used 1.6 mm diameter, therefore, this is also non-compliant to Philippine Electrical Code. The protective device such as circuit breakers have minimum rating while it protects several loads. The researcher found out that most circuits breakers have 15 amperes or 20 amperes, or 30 amperes but protecting lightings, convenience outlets and ceiling fans. Although it is allowed for multiple loads in a single circuit, some loads exceeded the rating of branch circuit, thus, these are clearly violations from the code. The researcher found that the school does not have its own transformer to sustain the large demand of electricity.

5 RECOMMENDATIONS

Since the school is non-compliant with the size of wires, rating of circuit breakers, and does not have a transformer, the researcher recommends to redesign the electrical system of the school. The researcher also recommends installing a three-single phase 100 kVA transformer to supply the right power for the school. By providing the right size of a transformer, the researcher also proposes to rewire the wirings of the school by installing proper wires with the right sizes, and brands and installing panelboards to each building. The lighting loads, convenience outlets, ceiling fans, and other loads must have separate circuits with proper circuit breakers as per the Philippine Electrical Code.

APPENDIX A
SUMMARY OF COMPLIANCE WITH ELECTRICAL STANDARDS

Wattmeter number	Name of Bldg.	Panelboard or Circuit Breaker	No. of Circuits	Status of Compliance			Recommendations
				Total Loads	Size of Wires	Rating of C.B.	
1	Principal's Office	PB1	3	C	NC	C	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Provide each building with a panelboard andappropriate circuit breaker.
1	Kindergarten (Room 1–3)	None	1	NC	NC	NC	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the wire type from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker.
1	Grade 1 (Room 1-7)	None	1	NC	NC	NC	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker.

Continued on next page

Wattmeter number	Name of Bldg.	Panelboard or Circuit Breaker	No. of Circuits	Status of Compliance			Recommendations
				Total Loads	Size of Wires	Rating of C.B.	
2	Grade 2 (Room 1-4)	Circuit Breaker	1	NC	NC	NC	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the wire type from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker.
2	Multi-purpose Building (ICT Bldg.)	Circuit Breaker	3	C	NC	C	• Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker.
2	SPED Rooms	Circuit Breaker	1	NC	NC	NC	• Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker.
2	Two-Story (Villafuerte Building)	Circuit Breaker	2	C	NC	C	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Use 30 A CB for the motor pump.

Continued on next page

Wattmeter number	Name of Bldg.	Panelboard or Circuit Breaker	No. of Circuits	Status of Compliance			Recommendations
				Total Loads	Size of Wires	Rating of C.B.	
							• Relocate the panelboard inside the building where it is readily accessible. • Provide each building with a panelboard and appropriate circuit breaker.
2	Industrial building	Circuit Breaker	1	NC	NC	NC	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker. • Use the 60 AT CB for the main, not for lighting and convenience outlets.
2	Grade 4 (Room 1-6)	Circuit Breaker	6	C	NC	NC	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker. • Use the 60 AT CB for the main circuit breaker.
3	Grade 3 (Room 1-10)	Fuse 1	1	NC	NC	NC	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans.

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Wattmeter number	Name of Bldg.	Panelboard or Circuit Breaker	No. of Circuits	Status of Compliance			Recommendations
				Total Loads	Size of Wires	Rating of C.B.	
							• Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker. • Use the 60 AT CB for the main circuit breaker. • Change the fuse to the circuit breaker.
3	Grade 1 (Room 1-2)	None	1	NC	NC	NC	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker.
4	Grade 2 (Room 5-8)	Circuit Breaker	1	C	NC	C	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker. • Use the 60 AT CB for the main circuit breaker.
5	Grade 5 (Rooms 1-7)	Circuit Breaker	1	NC	NC	NC	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans.

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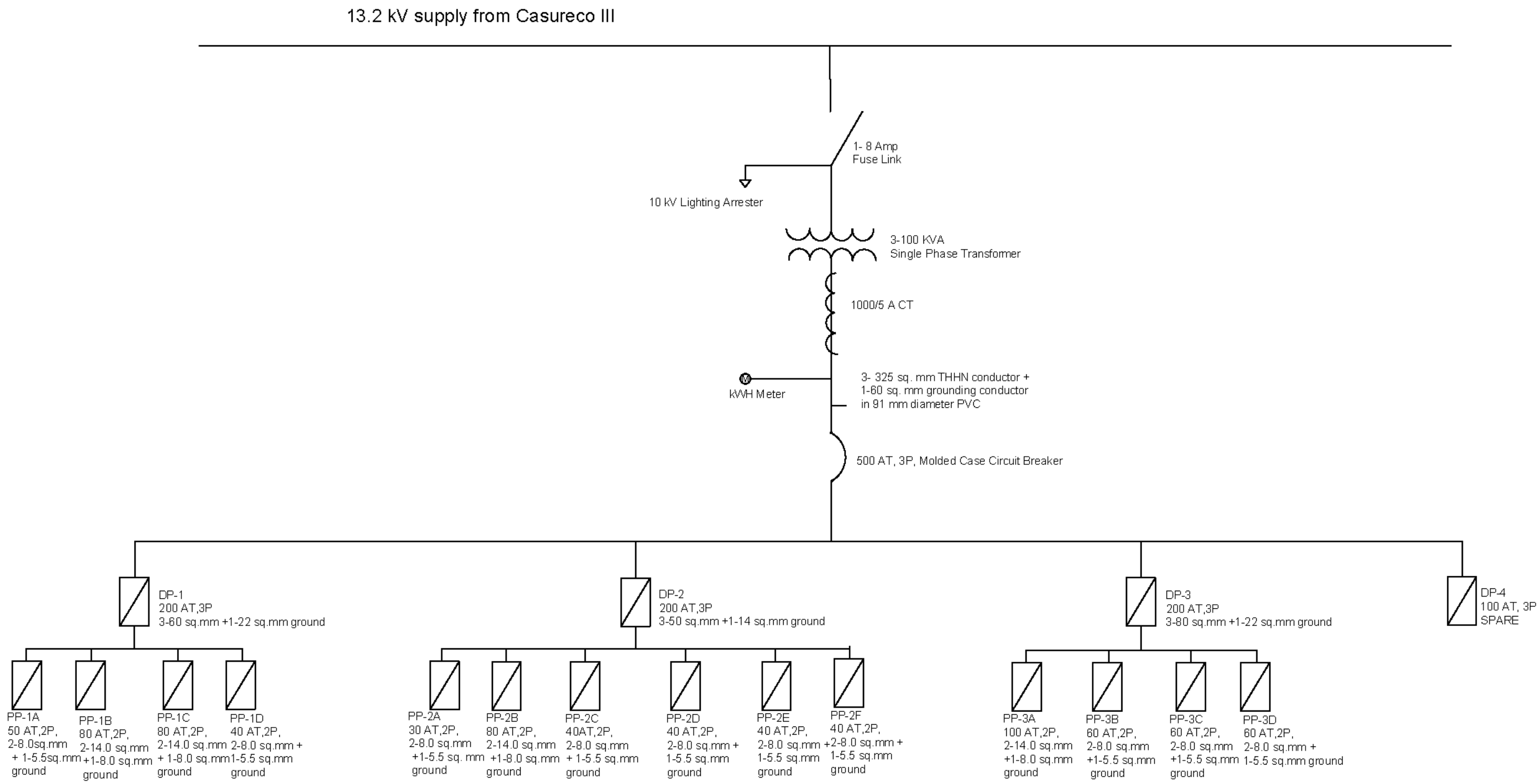
Wattmeter number	Name of Bldg.	Panelboard or Circuit Breaker	No. of Circuits	Status of Compliance			Recommendations
				Total Loads	Size of Wires	Rating of C.B.	
							• Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker.
6	Grade 6 (Rooms 1-6)	Circuit Breaker	1	C	NC	C	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker.
6	Tennis Court	None	1	C	NC	NC	• Separate the circuits for lighting, convenience outlets, and ceiling fans. • Provide also a 3.5 mm^2 THHN wire for convenience outlet and fans. • Change the type of wire from Type NM to THHN. • Provide each building with a panelboard and appropriate circuit breaker.
7	Covered Court	PB	5	C	C	C	• None

C – Compliant; NC – Non-compliant

APPENDIX B
PROPOSED NEW ELECTRICAL SYSTEM OF NABUA CENTRAL PILOT SCHOOL



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