CEBU INSTITUTE OF TECHNOLOGY - UNIVERSITY
ELECTRICAL ENGINEERING DEPARTMENT

ENHANCING ENERGY EFFICIENCY THROUGH MODIFICATION OF ELECTRICAL PLANS:

Addressing Power Instability and Improving Power Consumption in SAL, LRAC, Clinic, and T-Room Buildings at Cebu Institute of Technology – University

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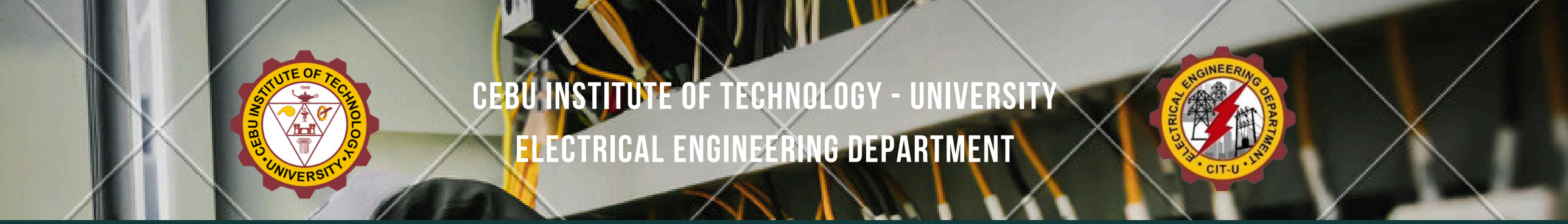

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CHAPTER 1

OBJECTIVES

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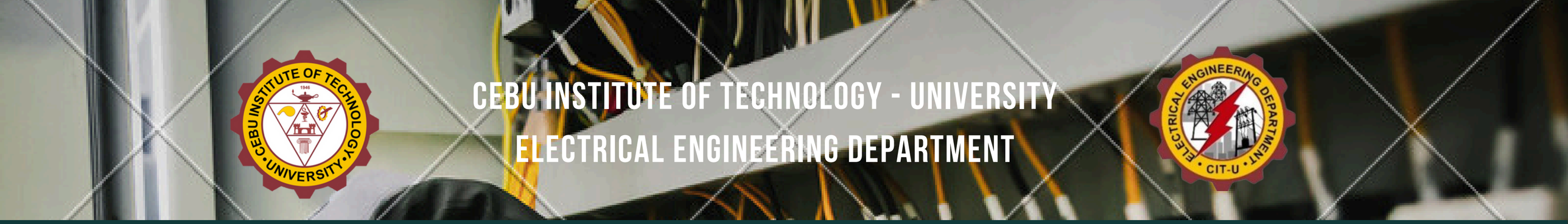
OBJECTIVES

- To construct electrical as-built plans for the SAL, LRAC, and T-Room buildings at Cebu Institute of Technology – University;

- To identify discrepancies and inefficiencies such as outdated wiring practices, improper wire gauges, voltage drops, and power instability through site inspections and performing load flow analysis, short-circuit analysis, voltage drop calculation, and evaluate the overall energy consumption and savings of the constructed electrical layout by utilizing Electrical Transient Analyzer Program (ETAP);

- To update the constructed as-built plan followed by performing load flow analysis, short-circuit analysis, and voltage drop calculations, and evaluate the overall energy consumption and savings by comparing the initial energy usage and voltage drop improvement, and assess the impact of the modifications through the use of ETAP;

- To analyze the current and the updated electrical plans simulated results by compare and contrast.



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CHAPTER 3

METHODOLOGY

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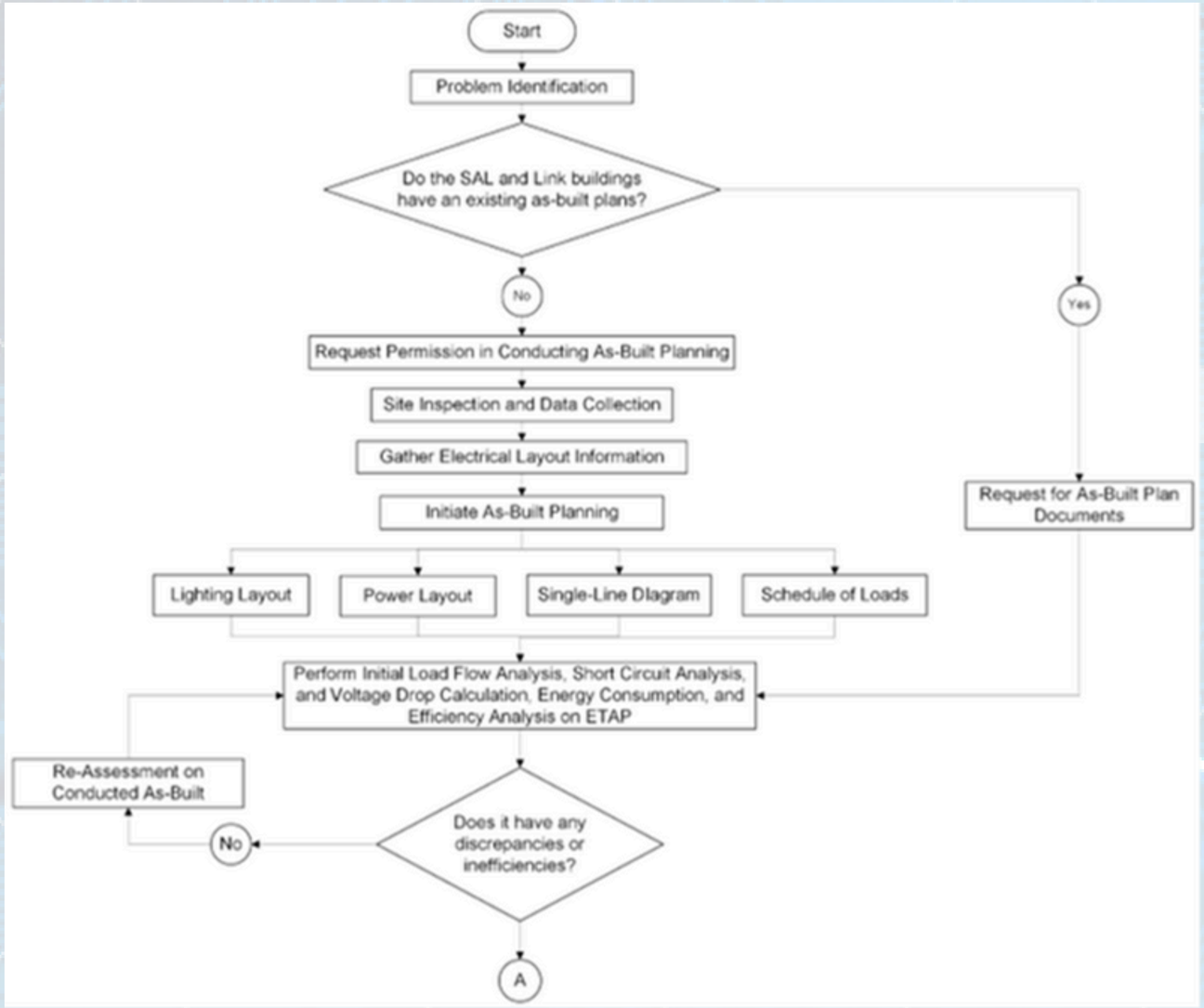
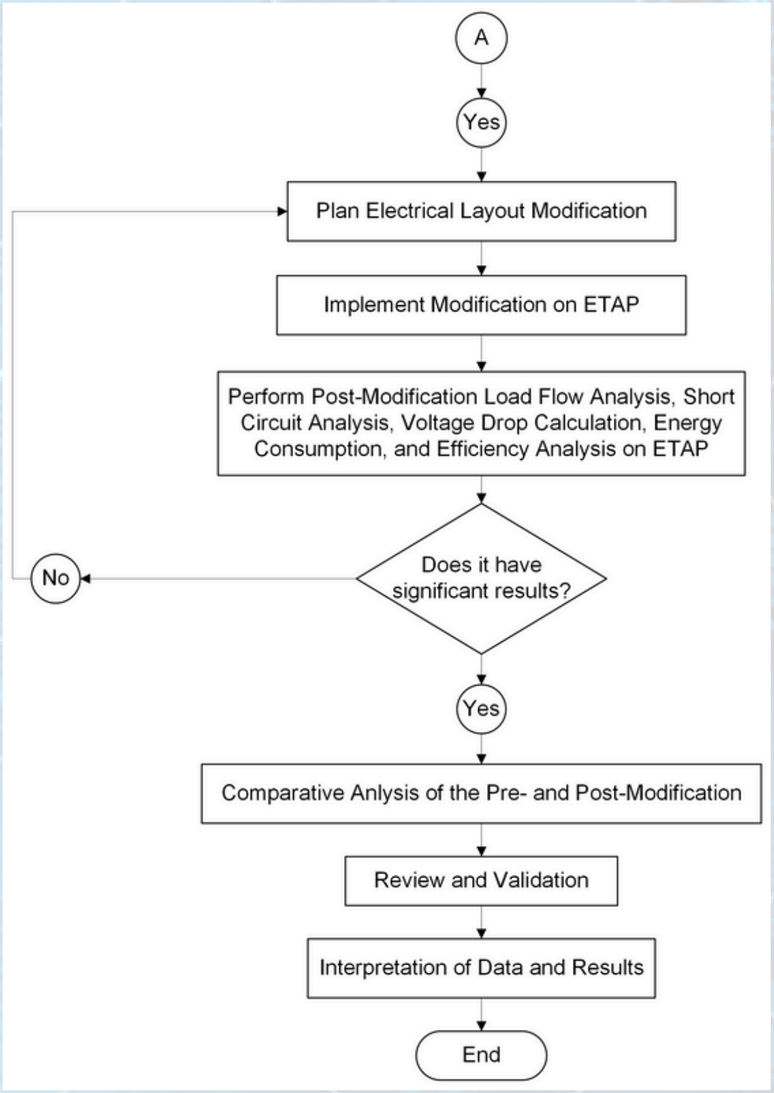
RESEARCH WORKFLOW





RESEARCH WORKFLOW

1. Problem Identification
2. As-Built Planning → Get Permission → Site Inspection
   → Create As-Built Plans (Lighting, Single-Line, Power, and Schedule of Loads)
3. Initial Analysis → ETAP Analysis
4. Modification Planning → Post-Modification
5. Comparative Analysis → Review and Validation
6. Conclusion

TRN

THESIS REVISON NOTES

Thesis Title: Enhancing Energy Efficiency Through Modification of Electrical Plans: Addressing Power Instability and Improving Power Consumption in SAL, LRAC, and T-Room Buildings at Cebu Institute of Technology – University

Team Code: EEK2414

Proponents:

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Please check if this TRN is: _____MOR ___/___CAPSTONE 1 _____CAPSTONE 2

COMMENT	REVISION	PAGE NUMBER
Atty. Engr. Julito B. Añora Jr.	**Signature:**	
Comments on manuscript	01/24/25	
Engr. Joker A. Zeta	**Signature:**	
Identify the buildings/connections that are connected in the distribution panels in the powerhouse. Make sure that the readings are nearly close to the data acquired.		

TRN

Engr. Marianne A. Tapayan	Signature:	
Remove hyperlinks and display the data in the paper.		
Make the data look presentable. Don't take screenshots.		
Only focus on the buildings assigned or within the scope		
Make sure to present the comparison between the as-built and the proposed design.		

SAL & LINK ASSESSMENTS

4.1.1. Observation of non-compliance, PEC code violations, hazardous conditions, and inefficient equipment in SAL & LINK

Observation of non-compliance, PEC code violations, hazardous conditions, and inefficient equipment in SAL & LINK			
Assessed Violation	**Pictures**	**PEC Article**	**Corrective Measures**
• Cables exposed outside the panel • Lack of Circuit Identification		1.10.1.3, 1.10.1.13, and 4.8.1.4	• Ensure all conductors are inside appropriate raceways • Label all breakers clearly
• Lack of Circuit Identification		4.8.1.4	• Label all breakers clearly
• Rust and corrosion		1.10.1.11 and 1.10.1.13	• Replace or repaint the panel to prevent further corrosion
• Rusted panel components • Exposed live components • Disorganized and unsecured wiring • Lack of Circuit Identification		1.10.1.3, 1.10.1.11, 2.30.2.1, and 4.8.1.4	• Label all breakers clearly • Cover all exposed conductors with insulated barriers
• Lack of Circuit Identification • Disorganized and unsecured wiring • Corroded panelboard		1.10.1.3, 1.10.1.11, and 4.8.1.4	• Label all breakers clearly • Clean corroded panel • Install a proper enclosure to protect the panel from environmental damage
• Lack of Circuit Identification		4.8.1.4	• Label all breakers clearly

SAL & LINK ASSESSMENTS

4.1.1.1 Assessment Criteria for As-built Power and Lighting Layout in SAL & Link Buildings

Assessment Area	Existing (As-Built) Condition	PEC 2017 Reference	PEC 2017 Description	Compliance (✓/X)
Lamp Type	Some of the lights are outdated and have high wattage	Sec. 1.10.1.3(A)(7)	Fixtures must be classified by type, wattage, and intended use to ensure they're suited for the application/environment.	X
Circuit Label Updated?	All of the circuits are not labeled (see Table	Sec. 4.8.1.4	All circuits must be clearly labeled with a permanent directory on the panel or switchboard to identify load purpose.	X
Circuit Reassignment	Some of the loads on the branch did not reflect the actual sum of loads per circuit	Sec. 2.20.3.1	Load on a feeder or branch must reflect the actual sum of loads per circuit, after applying allowed demand factors.	X
Conductor Routing	MDP-SAL C4 are not routed together	Sec. 3.0.1.3(B)	All conductors (including grounded and grounding) of the same circuit must be routed in the same raceway or path to avoid loop current and ensure safety.	X
Conductor Protection	Most of the conductors does not have conduits	Sec. 2.30.4.11	Conductors must be protected from physical damage using rigid metal conduit, PVC, or other approved methods if above ground and subject to impact.	X
Overloaded Circuits	PB-PO CKT 1 – shared ACU and 6 convenience outlet PB-RO	Sec. 2.20.3.1	Total connected loads must not exceed the circuit breaker capacity; circuits should be calculated and assigned accordingly.	X
Workmanship and Mounting	See table 4.1.1 A lot of the wires are outdated and have been stripped from its insulator due to old age. The panelboards are old and rusty.	Sec. 1.10.1.13	All installations must be performed in a neat, workmanlike manner with securely mounted devices and no exposed or unsupported parts.	X

SAL & LINK ASSESSMENTS

3.3.1.3 Assessment Criteria for Schedule of Loads in SAL & Link Buildings

Assessment Criteria for Schedule of Loads in SAL & Link Buildings			
Assessment Area	**PEC 2017 Reference**	**Criteria Description**	**Indicators / Remarks**
Feeder Branch Circuit Sizing	Art. 2.0.1.2.1, refer to Table 3.10.1.16	Feeder conductors must be sized based on the ampacity required to supply the connected load	The following homeruns does not meet ampacity requirement: PB-PO: C1 PB-PO: C3
Grounding Conductor Size	Art. 2.5.2.2.1, Table 2.50.6.13	Circuits sized and protected per load type and length.	The following panelboards do not have grounding conductors: PB-SAL-R164 PB-SAL-R165 CB-SAL-STAIRS PB-SAL-2F PB-SAL-3F PB-SAL-4F
Breaker Sizing	Art. 2.0.1.2.1, refer to Table 2.40.1.5(A)	Breaker matches wire size and expected load current.	PB-PO: C1: ACU should have its own dedicated circuit PB-RO C2: the demand is higher than the breaker placed on site PB-SAL-R163 C3: the size of the breaker higher than the
			required for its expected load current PB-SAL-R163 C4: the size of the breaker is higher than the required for its expected load current. The following main breakers of each panel is higher than the main breaker in MDP-SAL PB-SAL-2F PB-SAL-3F PB-SAL-4F
Voltage Drop (ETAP simulation)	Art. 2.0.1.1.1 (Note), Good Practice	Voltage drop within recommended limits. ≤3% for branch circuits, ≤5% overall system.	All are within recommended limits.
Load Balacing (3 – Phase)	Art. 2.0.1.1.1 (Feeder Design)	The load shall be balanced as evenly as practicable among the conductors of the system. Imbalance <10%;	The following SOL are imbalanced: PB-SAL-GF PB-PO PB-RO MDP-SAL CB-SAL-STAIRS PB-SAL-4F
Short Circuit Protection	Art. 2.10.1.3.1, Art. 2.1.1.6.2	The overcurrent protective device must have an interrupting rating	The following PB Main breakers have less than

SAL & LINK ASSESSMENTS

		not less than the available fault current at its line terminals.	interrupting rating that the available fault: CB-SAL STAIRS – 10kAIC rating and the available fault is 11kA
Size of Incoming Feeder	Art. 2.0.1.2.1, Art. 2.20.3.1 refer to Table 3.10.1.16	The calculated load on a feeder must be the sum of the branch circuits it supplies, with allowed demand factors applied.	The following incoming feeder from the following panelboards did not meet ampacity requirement: DP-01 – C2
Size of Incoming Feeder Protection	Art. 2.1.1.1.1, Art. 2.1.1.6.2 refer to Table 2.40.1.5(A)	The overcurrent device selected must protect the feeder from both overload and short circuit and be coordinated with conductor size.	The following incoming feeder protection from the following panelboards are overloaded: MDP DNY

COMPARATIVE ASSESSMENT

COMPARATIVE ASSESSMENT FOR PROPOSED DESIGN AND AS-BUILT IN SAL & LINK BUILDINGS

Comparative Assessment Proposed Design and As-built Lighting and Power Layout				
Assessment Area	**Existing (As-Built)**	**Modified (LED Retrofitted/Power Rerouted)**	**PEC2017**	**Compliance (✓/X)**
Lamp Type	Some of the lights are outdated and have high wattage	The lamps being replaced with the equivalent LED type.	Sec. 1.10.1.3(A)(7)	✓
Circuit Label Updated?	All of the circuits are not labeled (see Table	All of the circuits are updated	Sec. 4.8.1.4	✓
Circuit Reassignment	Some of the loads on the branch did not reflect the actual sum of loads per circuit	All of the loads on the branch reflect on the actual sum of loads per circuit	Sec. 2.20.3.1	✓
Conductor Routing	MDP-SAL C4 are not routed together	All of the conductors are routed together	Sec. 3.0.1.3(B)	✓
Conductor Protection	Most of the conductors does not have conduits	All conductors have their assigned conduits	Sec. 2.30.4.11	✓
Overloaded Circuits	PB-PO CKT 1 – shared ACU and 6 convenience outlet PB-RO	All circuits are distributed properly	Sec. 2.20.3.1	✓
Workmanship and Mounting	See table.. A lot of the wires are outdated and have been stripped	All conductors, breakers, panelboards must be upgraded	Sec. 1.10.1.13	✓
	from its insulator due to old age. The panelboards are old and rusty.			

COMPARATIVE ASSESSMENT

3.3.1.3 Comparative Assessment for Schedule of Loads in SAL & Link Buildings

Comparative Assessment for Schedule of Loads			
Assessment Area	**As-Built Condition**	**Proposed Condition**	**Compliance (✓/X)**
Feeder Branch Circuit Sizing	The following homeruns does not meet ampacity requirement: PB-PO: C1 PB-PO: C3	All feeder branch circuit sizes have met their ampacity requirement in accordance to PEC 2017 Table 3.10.1.16.	✓
Grounding Conductor Size	The following panelboards do not have grounding conductors: PB-SAL-R164 PB-SAL-R165 CB-SAL-STAIRS PB-SAL-2F PB-SAL-3F PB-SAL-4F	All grounding conductors have been updated in accordance to PEC 2017 Table 2.50.6.13.	✓
Breaker Sizing	PB-PO: C1: ACU should have its own dedicated circuit PB-RO C2: the demand is higher than the breaker placed on site PB-SAL-R163 C3: the size of the breaker higher than	All breaker sizes have been updated according to its ampacity requirement in accordance to PEC 2017. Table 2.40.1.5(A)	✓
	the required for its expected load current PB-SAL-R163 C4: the size of the breaker is higher than the required for its expected load current. The following main breakers of each panel is higher than the main breaker in MDP-SAL PB-SAL-2F PB-SAL-3F PB-SAL-4F		
Voltage Drop (ETAP simulation)	All are within recommended limits.	All are within recommended limits.	✓
Load Balacing (3 – Phase)	The following SOL are imbalanced: PB-SAL-GF PB-PO PB-RO MDP-SAL CB-SAL-STAIRS PB-SAL-4F	Most of the loads are balanced and some have small imbalances due to fixed loads.	✓
Short Circuit Protection	The following PB Main breakers have less than	All circuit breakers have been updated to its required interrupting capacity	✓

COMPARATIVE ASSESSMENT

	schedule of loads where there are no conduits listed.	corresponding conduit sizes, which also adheres to the Philippine Electrical Code.		
Overloaded Circuits	This has been explained in the previous assessment table. The observed panelboards and their associated circuits that do not follow this include: PB1 C10 PB2 C18 PB3 C6 PB3 C13 PB3 C8	The loads in every circuit are calculated in a way that there will be no overloaded circuits and the currents in each phase are within the recommended range.	Sec. 2.20.3.1	✓
Workmanship and Mounting	As documented in Table, visual inspection reveals significant degradation of insulation on numerous wires and several panelboards exhibit poor condition.	This proposed modification includes the replacement of deteriorated wiring and the upgrade of panelboards, with priority given to units exhibiting severe functional or structural deficiencies.	Sec. 1.10.1.13	✓

TROOM AND CLINIC ASSESSMENTS

4.1.1. Observation of non-compliance, PEC code violations, hazardous conditions, and inefficient equipment in T-Room & Clinic

Observation of non-compliance, PEC code violations, hazardous conditions, and inefficient equipment in T-Room & Clinic				
Violation Observed	**Name**	**Picture Reference**	**PEC Article**	**Corrective Measures**
• Exposed and Improperly Secured Wires • Panelboard Cover Missing or Damaged • Improper Mechanical Execution of Work • Lack of Circuit Identification	Beside clinic		1.10.1.3, 1.10.1.13, and 4.8.1.4	• Properly Secure and Route Wires • Perform a Safety Inspection and Replace Panelboard • Label and Document Circuit Breaker
• Exposed and unsecured wiring • Corroded and aged panelboard • Improper Mechanical Execution of Work	T-room panelboard		1.10.1.3, 1.10.1.11, and 1.10.13	• Secure and organize all panelboard wiring • Inspect the panel for overloaded circuits and rebalance loads if necessary • Improve environmental protection
• Improperly Installed or Mismatched Breakers • Corrosion and Deterioration • Lack of Circuit Identification	T-room panelboard		1.10.1.3, 1.10.1.13, and 4.8.1.4	• Replace improperly fitted breakers • Install blank covers • Tighten all connections • Label all breakers clearly
• Exposed Wiring • Mechanical Execution of Work	T-room panelboard		1.10.1.3, 1.10.1.13, and 2.30.2.1	• Replace the damaged wire or enclose exposed wire • Ensure proper circuit protection

TROOM AND CLINIC ASSESSMENTS

3.3.1.3 **Assessment Criteria for Power and Lighting Layout in Clinic & T-Room Buidlings**

Assessment Area	Existing (As-Built) Condition	PEC 2017 Reference	PEC 2017 Description	Compliance (✓/X)
Lamp Type	T-Room building uses outdated bulbs and fluorescent lights that contribute to higher wattage.	Sec. 1.10.1.3(A)(7)	Fixtures must be classified by type, wattage, and intended use to ensure they're suited for the application/environment.	X
Circuit Label Updated?	All circuits in T-Room have not been properly updated	Sec. 4.8.1.4	All circuits must be clearly labeled with a permanent directory on the panel or switchboard to identify load purpose.	X
Circuit Reassignment	PB-TROOM feeders reflect the actual sum of loads per circuit. PB-CLINIC feeders do not reflect actual sum of loads per circuit: PB-CLINIC C2	Sec. 2.20.3.1	Load on a feeder or branch must reflect the actual sum of loads per circuit, after applying allowed demand factors.	X
Conductor Routing	Some of the conductors are not routed in the same raceway.	Sec. 3.0.1.3(B)	All conductors (including grounded and grounding) of the same circuit must be routed in the same raceway or path to avoid loop current and ensure safety.	X
Conductor Protection	All conductors do not have conduits except for PB-CLINIC	Sec. 2.30.4.11	Conductors must be protected from physical damage using rigid metal conduit, PVC, or other approved	X

			methods if above ground and subject to impact.	
Overloaded Circuits	The following circuits have overloaded circuits: PB-CLINIC C2 PB-CLINIC C7	Sec. 2.20.3.1	Total connected loads must not exceed the circuit breaker capacity; circuits should be calculated and assigned accordingly.	X
Workmanship and Mounting	See table.. A lot of the wires are outdated and have been stripped from its insulator due to old age. The panelboards are old and rusty.	Sec. 1.10.1.13	All installations must be performed in a neat, workmanlike manner with securely mounted devices and no exposed or unsupported parts.	X

TROOM AND CLINIC ASSESSMENTS

3.3.1.3 Assessment Criteria for Schedule of Loads in Clinic & T-Room Buidlings

Assessment Criteria for Schedule of Loads in Clinic & T-Room Buildings			
Assessment Area	**PEC 2017 Reference**	**Criteria Description**	**Indicators / Remarks**
Feeder Branch Circuit Sizing	Art. 2.0.1.2.1, refer to Table 3.10.1.16	Feeder conductors must be sized based on the ampacity required to supply the connected load	The following circuits do not meet the ampacity requirement: PB-TROOM C1: Load current is 18.91 with breaker rated at 100 AT and feeder 3-14 mm^2 THHN/THWN
Grounding Conductor Size	Art. 2.5.2.2.1, Table 2.50.6.13	Circuits sized and protected per load type and length.	PB-TROOM and PB-CLINIC do not have grounding conductors
Breaker Sizing	Art. 2.0.1.2.1, refer to Table 2.40.1.5(A)	Breaker matches wire size and expected load current.	PB-TROOM C1: Load current is 18.91 A and the ampere trip for the load is 100 A. C1 is also used as a main in the entire panel. PB-CLINIC C2: load current is 42.77 A and breaker rated at 15AT. The load current exceeds the ampacity rating. PB-CLINIC C7: load current is 33.57 A and breaker rated at 20AT. The load current exceeds the ampacity rating.
Voltage Drop (ETAP simulation)	Art. 2.0.1.1.1 (Note), Good Practice	Voltage drop within recommended limits. ≤3% for branch circuits, ≤5% overall system.	All voltage drop are within limits.
Load Balacing (3 – Phase)	Art. 2.0.1.1.1 (Feeder Design)	The load shall be balanced as evenly as practicable among the conductors of the system. Imbalance <10%;	The following panel boards are not balanced: PB-TROOM: L1 = 59.2 A L2 = 0.55 A L3 = 6.14 A PB-CLINIC L1 = 108.70 A L2 = 27.87 A L3 = 25.13 A
Short Circuit Protection	Art. 2.10.1.3.1, Art. 2.1.1.6.2	The overcurrent protective device must have an interrupting rating not less than the available fault current at its line terminals.	All overcurrent protective device have an interrupting rating not less than the available fault current.
Size of Incoming Feeder	Art. 2.0.1.2.1, Art. 2.20.3.1 refer to Table 3.10.1.16	The calculated load on a feeder must be the sum of the branch circuits it supplies, with allowed demand factors applied.	The size of the incoming feeder on PB-TRoom and PB-Clinic do not match the sum of the branch circuits it supplies.
Size of Incoming Feeder Protection	Art. 2.1.1.1.1, Art. 2.1.1.6.2 refer to Table 2.40.1.5(A)	The overcurrent device selected must protect the feeder from both overload and short circuit and be coordinated with conductor size.	PB-TROOM breaker is properly rated but did not match with the conductor size
			PB-Clinic main should be 225 A based from the calculation and the conductor should be rated at 100mm2.

COMPARATIVE ASSESSMENT

3.3.1.3 Comparative Assessment for Proposed Design and As-built in Clinic & T-Room Buildings

Comparative Assessment Proposed Design and As-built Lighting and Power Layout				
Assessment Area	**Existing (As-Built)**	**Modified (LED Retrofitted/Power Rerouted)**	**PEC2017**	**Compliance (✓/X)**
Lamp Type	T-Room building uses outdated bulbs and fluorescent lights that contribute to higher wattage.	The lamps are being replaced with their equivalent LED ratings.	Sec. 1.10.1.3(A)(7)	✓
Circuit Label Updated?	All circuits in T-Room have not been properly updated	All circuits label are updated. Suggesting that all circuits must be updated.	Sec. 4.8.1.4	✓
Circuit Reassignment	PB-TROOM feeders reflect the actual sum of loads per circuit. PB-CLINIC feeders do not reflect actual sum of loads per circuit: PB-CLINIC C2	Circuits have been reassigned for the ones that are overloaded for even distribution between phases.	Sec. 2.20.3.1	✓
Conductor Routing	Some of the conductors are not routed in the same raceway.	All conductors are routed in the same raceway	Sec. 3.0.1.3(B)	✓
Conductor Protection	All conductors do not have conduits except for PB-CLINIC	All branch circuit conductors have their assigned conduits	Sec. 2.30.4.11	✓
Overloaded Circuits	The following circuits have overloaded circuits: PB-CLINIC C2 PB-CLINIC C7	The proposed design have been updated and have no overloaded circuits.	Sec. 2.20.3.1	✓
Workmanship and Mounting	See table.. A lot of the wires are outdated and have been stripped from its insulator due to old age. The panelboards are old and rusty.	Suggesting that the conductors and the housing panel must be replaced	Sec. 1.10.1.13	✓

COMPARATIVE ASSESSMENT

3.3.1.3 Comparative Assessment for Schedule of Loads in Clinic & T-Room Buildings

Comparative Assessment for Schedule of Loads			
Assessment Area	**As-Built Condition**	**Proposed Condition**	**Compliance (✓/X)**
Feeder Branch Circuit Sizing	The following circuits do not meet the ampacity requirement: PB-TROOM C1: Load current is 18.91 with breaker rated at 100 AT and feeder 3-14 mm^2 THHN/THWN	All feeder branch circuit sizing have been updated to meet the ampacity requirement in accordance to PEC2017 Table 3.10.1.16.	✓
Grounding Conductor Size	PB-TROOM and PB-CLINIC do not have grounding conductors	All panelboards have been updated with their required grounding conductors in accordance to PEC 2017 Table 2.50.6.13.	✓
Breaker Sizing	PB-TROOM C1: Load current is 18.91 A and the ampere trip for the load is 100 A. C1 is also used as a main in the entire panel. PB-CLINIC C2: load current is 42.77 A and breaker rated at 15AT. The load current exceeds the ampacity rating.	All breaker sizes have also been updated to meet its ampacity requirement in accordance to pec 2017 Table 2.40.1.5(A)	✓
	PB-CLINIC C7: load current is 33.57 A and breaker rated at 20AT. The load current exceeds the ampacity rating.		
Voltage Drop (ETAP simulation)	All voltage drop are within limits.	All voltage drop levels are within limits	✓
Load Balacing (3 – Phase)	The following panel boards are not balanced: PB-TROOM: L1 = 59.2 A L2 = 0.55 A L3 = 6.14 A PB-CLINIC L1 = 108.70 A L2 = 27.87 A L3 = 25.13 A	PB-TROOM and PB-Clinic remain slightly imbalanced; however, the imbalance is significantly reduced compared to the as-built condition. This residual imbalance is attributed to the presence of fixed loads that cannot be redistributed.	✓
Short Circuit Protection	All overcurrent protective device have an interrupting rating not less than the available fault current.	Short circuit protection devices must have an interrupting rating not less than the available fault current. Based on the ETAP simulation results, adjustments to the kAIC ratings of certain breakers are necessary to	✓

COMPARATIVE ASSESSMENT

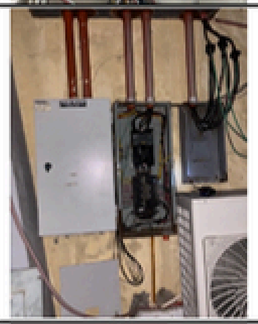
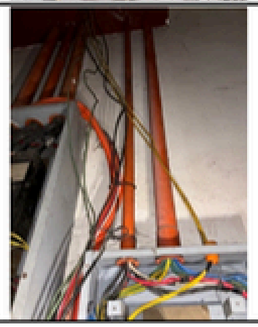
		ensure compliance with this requirement.	
Size of Incoming Feeder	The size of the incoming feeder on PB-TRoom and PB-Clinic do not match the sum of the branch circuits it supplies.	The sizes of the incoming feeders have been recalculated and updated in accordance with PEC 2017, Table 3.10.1.16.	✓
Size of Incoming Feeder Protection	PB-TROOM breaker is properly rated but did not match with the conductor size PB-Clinic main should be 225 A based from the calculation and the conductor should be rated at 100mm2.	The sizes of the incoming feeder protection have been updated in accordance with PEC 2017, Table 2.40.1.5(A).	✓

LRAC ASSESSMENTS

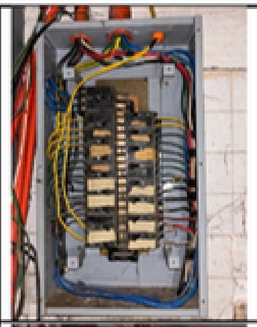
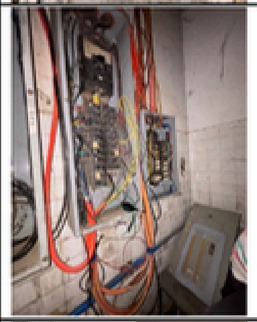
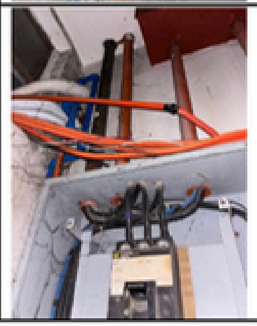
4.1.1. Observation of non-compliance, PEC code violations, hazardous conditions, and inefficient equipment in LRAC

Observation of non-compliance, PEC code violations, hazardous conditions, and inefficient equipment in LRAC			
Assessed Violation	**Pictures**	**PEC Article**	**Corrective Measures**
• Exposed and Poorly Secured Wires • Improper Cable Routing • Mechanical Execution of Work		1.10.1.3, 1.10.1.13, and 3.0.1.3	• Use proper fasteners and supports to prevent wires from sagging • Place them in conduits to avoid potential harm
• Lack of Circuit Identification • Overcrowded and Poorly Organized Wiring		1.10.1.3, 1.10.1.13, 3.0.1.3, and 4.8.1.4	• Organize and bundle wires properly outside and inside the panel • Label all breakers clearly

LRAC ASSESSMENTS

• Lack of Circuit Identification • Overcrowded and Poorly Organized Wiring		1.10.1.3, 1.10.1.13, 3.0.1.3, and 4.8.1.4	• Organize and bundle wires properly outside and inside the panel • Label all breakers clearly
• Corroded panelboard • Exposed Wiring • Lack of Circuit Identification		1.10.1.3, 1.10.1.11, 1.10.1.13, and 4.8.1.4	• Ensure all panel doors remain secured • Properly install conduits to enclose and protect wiring • Label all breakers clearly
• Lack of Proper Conduit Support • Exposed and Unprotected Wiring • Improper Bending Radius of Cables • Improper Mechanical Execution of Work		1.10.1.3, 1.10.1.13, 3.0.2.4, and 4.8.1.4	• Secure conduits properly with appropriate fasteners at required intervals • Ensure all cables are enclosed • Maintain the required bending radius for cables

LRAC ASSESSMENTS

• Overcrowding of Conductors • Missing Panel Cover • Improper Mechanical Execution of Work		1.10.1.3, 1.10.1.13, and 4.8.1.4	• Arrange wiring properly to allow air circulation and avoid overheating • Install a properly secured panelboard cover
• Improper Cable Routing and Hanging Wires • Improper Bending Radius of Cables • Lack of Circuit Identification • Improper Mechanical Execution of Work		1.10.1.3, 1.10.1.13, 3.0.2.4, and 4.8.1.4	• Secure all the panel covers to enclose • Organize and properly fasten cables to avoid entanglement and mechanical strain • Install a proper grounding system • Label all breakers clearly
• Improper Bending Radius of Cables • Improper Mechanical Execution of Work		1.10.1.13 and 3.0.2.4	• Organize and properly fasten cables

LRAC ASSESSMENTS

• Lack of Circuit Identification		4.8.1.4	• Label all breakers clearly
• Lack of Circuit Identification • Expose live parts		1.10.1.3, 1.10.1.11, 1.10.1.13, and 4.8.1.4	• Install proper covers to prevent exposure • Label all breakers clearly
• Lack of Circuit Identification		4.8.1.4	• Label all breakers clearly

• Lack of Circuit Identification • Improper conduit and cable entry		3.0.1.1 4.8.1.4	• Label all breakers clearly • Use appropriate cable glands or conduit fittings

LRAC ASSESSMENTS

Assessment Criteria for As-built Lighting and Power Layout				
Assessment Area	**Existing (As-Built) Condition**	**PEC 2017 Reference**	**PEC 2017 Description**	**Compliance (✓/X)**
Lamp Type	The lighting system currently utilizes fluorescent fixtures with higher-than-standard wattage ratings.	Sec. 1.10.1.3(A)(7)	Fixtures must be classified by type, wattage, and intended use to ensure they're suited for the application/environment.	X
Circuit Label Updated?	There is currently no readily available electrical layouts in the Library Resources and Activity Center.	Sec. 4.8.1.4	All circuits must be clearly labeled with a permanent directory on the panel or switchboard to identify load purpose.	X
Circuit Reassignment	The calculated load per circuit aligns with the actual connected loads.	Sec. 2.20.3.1	Load on a feeder or branch must reflect the actual sum of loads per circuit, after applying allowed demand factors.	✓
Conductor Routing	Initial inspection revealed non-compliant conductor installations, with some circuits improperly routed in separate raceways and others lacking conduit protection entirely.	Sec. 3.0.1.3(B)	All conductors (including grounded and grounding) of the same circuit must be routed in the same raceway or path to avoid loop current and ensure safety.	X
Conductor Protection	Some of the installed conductors are not enclosed within conduit systems, as per the initial	Sec. 2.30.4.11	Conductors must be protected from physical damage using rigid metal conduit, PVC, or other	X

	schedule of loads where there are no conduits listed.		approved methods if above ground and subject to impact.	
Overloaded Circuits	This has been explained in the previous assessment table. The observed panelboards and their associated circuits that do not follow this include: PB1 C10 PB2 C18 PB3 C6 PB3 C13 PB3 C8	Sec. 2.20.3.1	Total connected loads must not exceed the circuit breaker capacity; circuits should be calculated and assigned accordingly.	X
Workmanship and Mounting	As documented in Table, visual inspection reveals significant degradation of insulation on numerous wires and several panelboards exhibit poor condition.	Sec. 1.10.1.13	All installations must be performed in a neat, workmanlike manner with securely mounted devices and no exposed or unsupported parts.	X

LRAC ASSESSMENTS

			1.25. Therefore, the recommended ampere-trip to be used is 60AT. PB3 C6: The current flowing through the circuit is higher than the ampere-trip. PB3 C13: Same as the previous circuit, the current flowing through the circuit is more than the ampacity of the breaker. PB6 C8: The same concerns with PB1 C10. Two ACUs are tapped in the same circuit, while the recommended is for motor loads to have their designated circuits. The following sizes of incoming feeder based on calculations are lower than the recommended values in the table: PB1: 130A with 3-22mm2 wire gauge. The recommended size for this current is 38mm2-50mm2. PB2: 227.553696A with 3-22mm2 wire gauge. The recommended size for this current is 100mm2. PBLG1:

			120.979056A with 3-22mm2 wire gauge. The recommended size for this current is 38mm2.
Voltage Drop (ETAP simulation)	Art. 2.0.1.1.1 (Note), Good Practice	Voltage drop within recommended limits. ≤3% for branch circuits, ≤5% overall system.	The results of the initial ETAP simulations shows these voltage drop values per panel boards. It can be noticed that PB5, PB6, and DP-ML exceeds the recommended ≤5% voltage drop. PB1: 1.08% PB2: 0.135% PB3: 0.058% PB4: 0.441% PB5: 6.44% PB6: 5.25% PBLG1: 0.19% PBLG2: 0.107% DP-ML: 7.2%
Load Balacing (3 – Phase)	Art. 2.0.1.1.1 (Feeder Design)	The load shall be balanced as evenly as practicable among the conductors of the system. Imbalance <10%;	The following panelboards are imbalanced: PB1: L1: 4.39A L2: 0.00A L3: 58.31A PB3: L1: 31.76A L2: 38.98A L3: 9.11A

LRAC ASSESSMENTS

			PBLG2: L1: 13.57A L2:0.00A L3: 2.05A
Short Circuit Protection	Art. 2.10.1.3.1, Art. 2.1.1.6.2	The overcurrent protective device must have an interrupting rating not less than the available fault current at its line terminals.	All panelboards successfully passed the short-circuit analysis, confirming their compliance with the required withstand ratings per PEC.
Size of Incoming Feeder	Art. 2.0.1.2.1, Art. 2.20.3.1 refer to Table 3.10.1.16	The calculated load on a feeder must be the sum of the branch circuits it supplies, with allowed demand factors applied.	The following panelboards were found with improperly sized incoming feeders: PB1 PB2 PBLG1
Size of Incoming Feeder Protection	Art. 2.1.1.1.1, Art. 2.1.1.6.2 refer to Table 2.40.1.5(A)	The overcurrent device selected must protect the feeder from both overload and short circuit and be coordinated with conductor size.	The following panelboards were found with improperly sized feeder protection: PB1 PB2 PB6

LRAC ASSESSMENTS

Assessment Criteria for Schedule of Loads in LRAC			
Assessment Area	**PEC 2017 Reference**	**Criteria Description**	**Indicators / Remarks**
Feeder Branch Circuit Sizing	Art. 2.0.1.2.1, refer to Table 3.10.1.16	Feeder conductors must be sized based on the ampacity required to supply the connected load	The following circuits do not meet ampacity requirement: PB2 C1, C4, C6, C7, C8, C10, C12: The load current is 24.60A, 50AT, and 2-5.5mm2 wires. Since is a single motor load, the recommended feeder branch conductor is 1.75% of the load current. Therefore, 8.0mm2 wire gauge is more preferred. PB2 C18: The load current is 48.32A with a 50AT breaker and 5.5mm2 conductor size. Since majority of the loads in LRAC is continuous, the feeder branch wire is the equivalent of 1.25% of the load current. It is mush recommended to use 14mm2 in this case. PB3 C6: This circuit has the same scenario as the previous one. The peak load current of 34.89A is higher than the 20AT in the panelboard. It is recommended to use 50AT and 8.0mm2 wire gauge in this scenario. PB3 C13:
			The load current is higher than the ampere trip. 30AT is recommended in this case. PB4 C8: The load here is an ACU, which is a motor load. Motor load feeder branch should be 1.75% of the load. PB6 C8: Two motor loads are connected in this circuit, which is not recommended as motor loads should have their designated circuit.
Grounding Conductor Size	Art. 2.5.2.2.1, Table 2.50.6.13	Circuits sized and protected per load type and length.	The following panelboards doesn't have grounding conductors: PB1 PB2 PB3 PB4 PBLG1 PBLG2
Breaker Sizing	Art. 2.0.1.2.1, refer to Table 2.40.1.5(A)	Breaker matches wire size and expected load current.	PB1 C10: Two air-conditioning units are tapped in one circuit breaker. It is recommended for motor loads to have their designated circuit. PB2 C18: Upon calculation, this circuit is overloaded since the ampere trip in this is 50AT, while the connected loads are 48.32A. Since the building's loads are continuous, this current is multiplied by

COMPARATIVE ASSESSMENT

3.3.1.3 Comparative Assessment for Proposed Design and As-built in LRAC Building

Comparative Assessment Modified and As-built Lighting and Power Layout				
Assessment Area	**Existing (As-Built)**	**Modified (LED Retrofitted/Power Rerouted)**	**PEC2017**	**Compliance (✓/X)**
Lamp Type	The lighting system currently utilizes fluorescent fixtures with higher-than-standard wattage ratings.	To improve energy efficiency while maintaining equivalent illumination levels, we have proposed retrofitting these fixtures with LED alternatives, which offer significantly lower wattage consumption.	Sec. 1.10.1.3(A)(7)	✓
Circuit Label Updated?	There is no prior as-built documentation existed before the creation of the current as-built plan. As a result, circuit labels in panelboards were neither documented nor updated.	With the implementation of the as-built and modified plans, all circuits and their corresponding loads are now clearly labeled and traceable, ensuring accurate identification and maintenance.	Sec. 4.8.1.4	✓
Circuit Reassignment	The calculated load per circuit aligns with the actual connected loads.	The calculated load per circuit a aligns with the actual connected loads.	Sec. 2.20.3.1	✓
Conductor Routing			Sec. 3.0.1.3(B)	✓
Conductor Protection	Some of the installed conductors are not enclosed within conduit systems, as per the initial	In the proposed modification, branch circuits until the main distribution panels are assigned with their	Sec. 2.30.4.11	✓
	schedule of loads where there are no conduits listed.	corresponding conduit sizes, which also adheres to the Philippine Electrical Code.		
Overloaded Circuits	This has been explained in the previous assessment table. The observed panelboards and their associated circuits that do not follow this include: PB1 C10 PB2 C18 PB3 C6 PB3 C13 PB3 C8	The loads in every circuit are calculated in a way that there will be no overloaded circuits and the currents in each phase are within the recommended range.	Sec. 2.20.3.1	✓
Workmanship and Mounting	As documented in Table, visual inspection reveals significant degradation of insulation on numerous wires and several panelboards exhibit poor condition.	This proposed modification includes the replacement of deteriorated wiring and the upgrade of panelboards, with priority given to units exhibiting severe functional or structural deficiencies.	Sec. 1.10.1.13	✓

COMPARATIVE ASSESSMENT

3.3.1.3 Comparative Assessment for Schedule of Loads in LRAC Building

Comparative Assessment for Schedule of Loads			
Assessment Area	**As-Built Condition**	**Modified Condition**	**Indicators / Remarks**
Feeder Branch Circuit Sizing	The feeder branch circuits mentioned in the previous table showed a mismatch of current flowing and wire sizes.	The feeder branch circuits in the modified schedule of loads are adjusted in accordance to the Art. 2.0.1.2.1, refer to Table 3.10.1.16 of PEC.	✓
Grounding Conductor Size	Some panelboards in LRAC are without grounding conductors, as mentioned in the previous table.	Every circuit, as well as the main branch, is assigned with appropriate sizes of grounding conductors.	✓
Breaker Sizing	In the assessment criteria, the mentioned circuits do not follow the 1.25% and 1.75% sizing of wires, which lead to improper breaker sizing.	The modified LRAC schedule of loads are with properly calculated and rated according to the tables provided by PEC.	✓
Voltage Drop (ETAP simulation)	The initial ETAP simulation shows that DP-ML, PB5, and PB6 do not meet that ≤5% voltage drop. PB1: 1.08% PB2: 0.135% PB3: 0.058% PB4: 0.441% PB5: 6.44% PB6: 5.25% PBLG1: 0.19% PBLG2: 0.107% MDP-ML: 7.2%	The proposed ETAP simulation shows that every panelboard are within the recommended ≤5% voltage drop. PB1: 1.05% PB2: 0.035% PB3: 0.053% PB4: 0.304% PB5: 1.34% PB6: 0.95% PBLG1: 0.116% PBLG2: 0.1% MDP-ML: 1.08%	✓
Load Balacing (3 – Phase)	The panelboards mentioned in the table above are unbalanced, which means that the phases have more than ±10% difference between their values.	The difference between the phases of the panelboards are reduced to less than 10%. For those with fixed loads, the loads are adjusted as much as possible to bring the phase differences closer to the standard allowable limit.	✓
Short Circuit Protection	All panelboards successfully passed the short-circuit	All panelboards successfully passed the short-circuit analysis, confirming their	✓
	analysis, confirming their compliance with the required withstand ratings per PEC.	compliance with the required withstand ratings per PEC.	
Size of Incoming Feeder	The following panelboards were found with improperly sized incoming feeders: PB1 PB2 PBLG1	Size of incoming feeder is calculated and assigned aligning with the tables provided by the Philippine Electrical Code.	✓
Size of Incoming Feeder Protection	The following panelboards were found with improperly sized feeder protection: PB1 PB2 PB6	Size of feeder protection is calculated and assigned aligning with the tables provided by the Philippine Electrical Code.	✓

SUMMARY OF INEFFICIENCIES IN ETAP

3.3.1.2 Summary of Inefficiencies and Discrepancies in ETAP As-Built Load Flow and Short Circuit Results

3.3.1.2 Summary of Inefficiencies and Discrepancies in ETAP

Summary of Observed Issues, ETAP Simulation Results, and Proposed Redesign Measures					
Observed issue	**Pec 2017 reference**	**ETAP Simulation Result**	**Preliminary Findings**	**Proposed Corrective action**	**Redesign Plan**
Excessive Voltage Drop	2.15.1.2(a)	Voltage drop exceeds allowable 5% limit	Feeder of the following PBs exceed the allowable limit: PB-06	Upsize conductors or install intermediate distribution panels	Upsize the feeder conductors for PB-06 from the existing size to a larger cross-sectional area based on new ampacity and voltage drop calculations. Alternatively, install intermediate distribution panels to shorten the length of branch circuits and feeders, thus minimizing voltage drop.
Insufficient Short Circuit Rating on Breakers	2.30.6.4	ETAP short circuit analysis exceeds breaker interrupting capacity	CB-SAL STAIRS	Replace breakers with higher interrupting capacity models	Replace the CB-SAL STAIRS breaker with a higher interrupting capacity unit rated at a minimum of 15 kAIC (or the next available standard rating above the calculated available fault current) to safely interrupt fault currents without device failure.
Overloaded Feeder Cables	3.10.2.2 and 3.10.2.3	Cable ampacity exceeded by 20%	MAIN C LINK C MAIN LIB C DP-02 C	Replace feeders with cables of larger cross-sectional area	Replace the feeders MAIN C, LINK C, MAIN LIB C, and DP-02 C with cables of higher ampacity according to Table 3.10.1.16 of the PEC 2017. Properly size the replacement conductors to meet the 125% of continuous load rule and provide allowance for future load expansion.
Overloaded Circuit breakers	2.30.6.4 and 2.10.2.1	Breakers operating at 95%–105% of rated current	The following main breakers operating at 95% - 105% of rated current: DP-02 MAIN MAIN DP-3F MDP DNY MAIN	Replace breakers with appropriate ampere rating and redistribute circuits	Replace the existing breakers in DP-02 MAIN, MAIN, DP-3F, and MDP DNY MAIN with breakers rated for at least 125% of the actual load current. Additionally, redistribute circuits across available panels or install new panels if necessary to balance the loading more efficiently.
Critical Bus Undervoltage (below 90%)	2.10.1.6 and 2.30.2.1	Bus voltage drops to 88% under full load conditions	The following buses are undervoltage MDP DNY	Reinforce feeders or reduce load on critical buses	Reinforce the feeders supplying MDP DNY, LINK3F4F, DP3FF, and MDP-SAL by upsizing the conductors or installing
			LINK3F4F DP3FF MDP-SAL		parallel feeders to reduce impedance. If necessary, install voltage regulators or adjust the main transformer tap settings to raise the bus voltages to within the acceptable range (95%–105%).
Bus Overvoltage (above 110%)	2.10.1.6 and 3.10.2.2	Bus voltage drops to 88% under full load conditions	The following buses operating overvoltage: DP ML PB-LG	Adjust transformer taps or install automatic voltage regulator	Adjust the tap settings on the main transformer to lower the output voltage for buses DP ML and PB-LG, ensuring they fall within the normal operating range (95%–105%). If needed, install automatic voltage regulators (AVRs) on the feeder circuits supplying these buses to maintain proper voltage stability.

TOTAL CALCULATED KVA SAVINGS

4.1.5 Total Calculated kVA savings (As-Built vs Proposed) from all Buildings

Comparison of As-built and Redesigned kVA Demand for Each Building				
Building	**Original kVA (As-Built)**	**Redesgined kVA (Proposed Design)**	**Percent Reduction (%)**	**Remarks (Acceptable/Optimal/ Excellent)**
T-Room & Clinic	102.8565298	100.33753	2.45	ACCEPTABLE
SAL & Link	212.3408	185.335	12.72	OPTIMAL
LRAC	304.741	278.586	8.58	ACCEPTABLE
TOTAL	**619.9383298**	**564.26**	**23.75**	**EXCELLENT**

CONCLUSION

The study successfully achieved its objectives by developing as-built electrical plans, pinpointing existing inefficiencies, and recommending effective modifications for the electrical system of CIT-U's SAL, Link, T-Room, and LRAC buildings. Proposed improvements addressed load balancing, LED retrofitting, updating feeders, and adjusting overcurrent protection devices according to the Philippine Electrical Code (PEC) 2017 standards. The redesign resulted in a significant 23.75% reduction in total kVA demand, improving efficiency and performance. However, further upgrades, including transformer replacement and feeder cable reinforcement, are still recommended to enhance reliability, safety, and scalability.

CONCLUSION

- Constructed as-built electrical plans for CIT-U (SAL, Link, T-Room, LRAC buildings).
- Identified inefficiencies and discrepancies in the existing electrical system.
- Proposed modifications for load balancing, LED retrofitting, feeder upgrades, and compliance with PEC 2017 standards.
- Developed detailed layouts (electrical, lighting, power), load schedules, and single-line diagrams.
- Achieved 23.75% reduction in total kVA demand across evaluated buildings.
- Improved overall efficiency and performance of electrical system.
- Recommended further upgrades:
  - Transformer replacement
  - Main feeder cable reinforcement

RECOMMENDATION

- Basis for Future Studies:
  - Utilize findings for continuous improvement in load balancing, equipment sizing, and efficiency across SAL, Link, T-Room, and LRAC buildings.
- Load Tracing Accuracy:
  - Conduct investigations during regular operational hours to accurately capture daytime-specific and intermittent loads.
  - Ensure room accessibility during inspections for comprehensive load tracing.
- Thermal Management:
  - Perform thermal scanning on DP1, DP2, and Main Distribution Panel.
  - Implement corrective actions such as load redistribution, cable upsizing, and improved panelboard ventilation.

RECOMMENDATION

- Load Balancing:
  - Conduct periodic reviews to further optimize load balancing, especially for panelboards with fixed loads.

  - Air Conditioning Units (ACUs):
- Document and reconfigure five three-phase ACUs currently tapped directly into DP1 C1 with properly sized feeders and protective devices.

- Campus-wide Expansion:
  - Extend the applied methodology and recommendations to additional buildings for comprehensive campus-wide improvements.

END

THANK YOU!

THE FLOOR IS NOW OPEN FOR QUESTIONS AND COMMENTS