ADITYA COLLEGE OF ENGINEERING & TECHNOLOGY

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Industrial Power System Analysis Internship

Short Circuit Analysis and Circuit Breaker Sizing For Cement Plant Raw Mill Substation

- Internship and Project Guide
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STUDENT DETAILS

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Internship Objectives

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1.	INTRODUCTION	
2.	Power flow studies or load flow analysis using manual method and ETAP	
3.	Per Unit Analysis	
4.	AC-DC load flow analysis	
5.	Fault calculations and analysis using manual method and ETAP	
6.	Power system stability analysis	
7.	Synchronous machine modelling and representation in stability studies	
8.	Voltage enhancement methods	
9.	Internship Project - (Short Circuit analysis of Steel Plant Distribution Plant)	
10.	CONCLUSION	

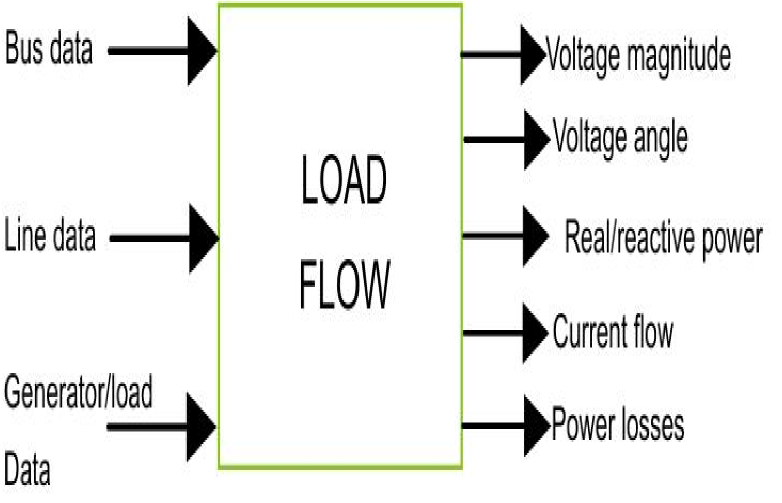
Introduction

- Industrial Power System Analysis focuses on modeling and analyzing electrical systems within industrial facilities to ensure safe, reliable, and efficient operation.

Power Flow Studies

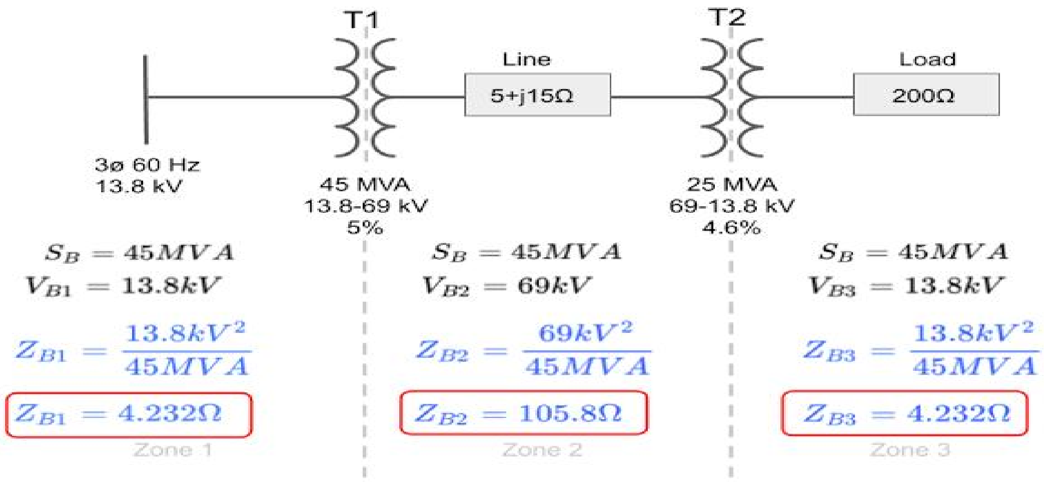
- Manual Methods:
- - Gauss-Seidel Method
- - Newton-Raphson Method

- Using ETAP:
- - Automates calculations and provides visualization
- - Identifies overloaded elements and voltage issues



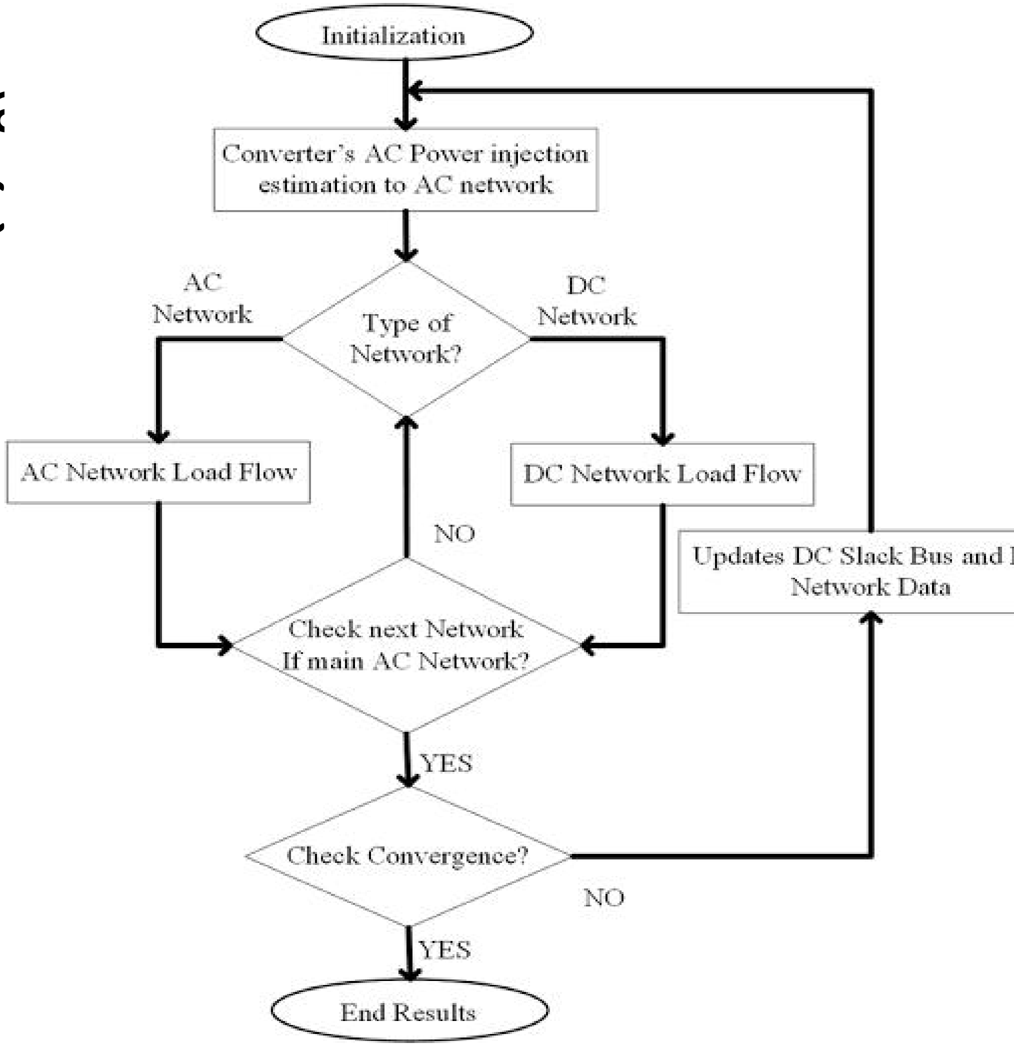
Per Unit Analysis

- - Standardized method to simplify calculations
- - Eliminates unit conversion
- - Applications: Transformer and fault analysis, power flow studies



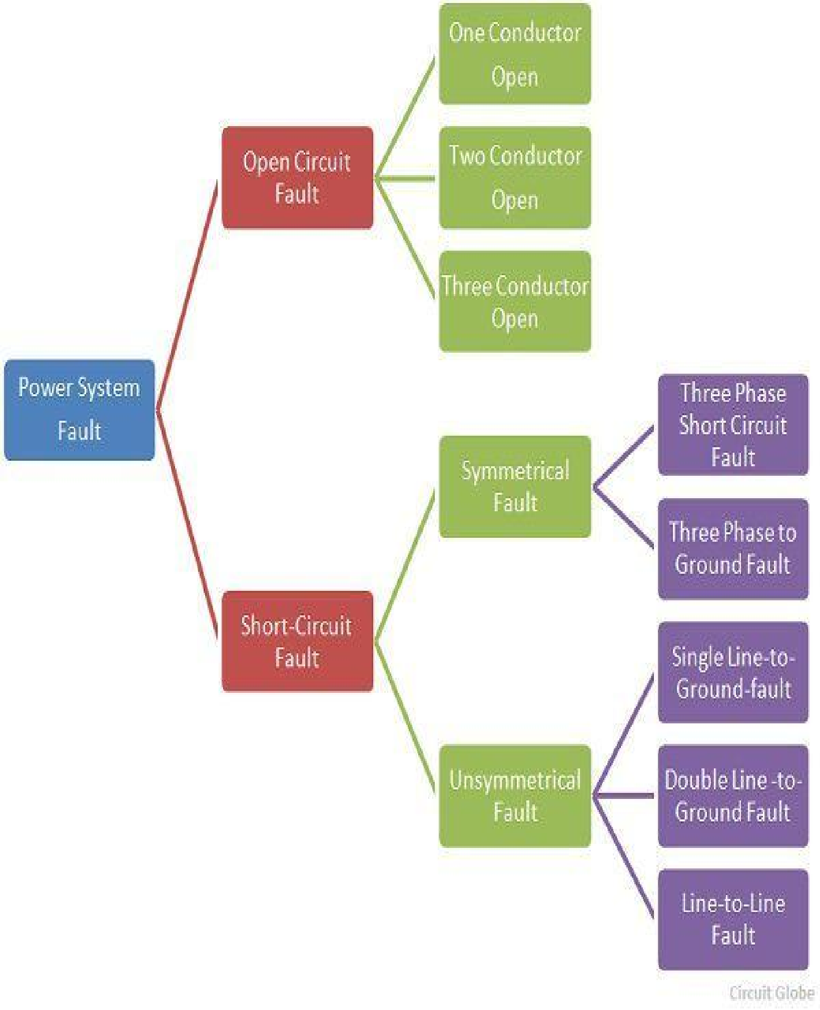
AC-DC Load Flow Analysis

- - Combines traditiona
AC load flow with DC
system calculations
- - Ensures voltage
stability, power
balance, and loss
minimization



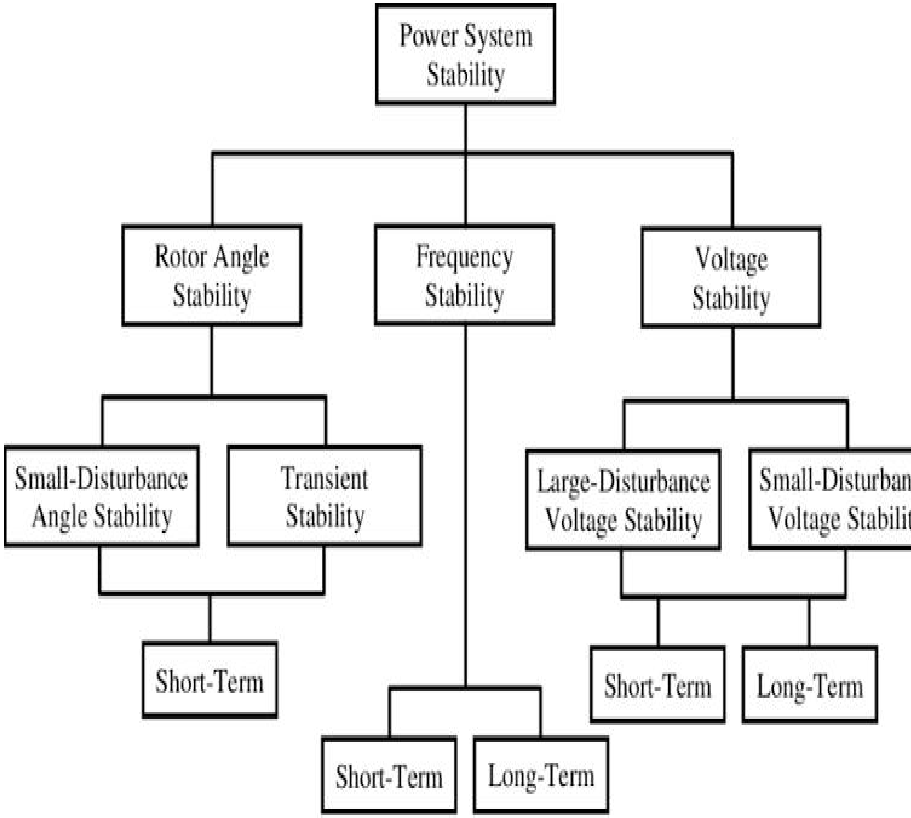
Fault Analysis

- - Types: Symmetrical and unsymmetrical faults
- - Using ETAP: Model syster analyze faults, generate reports



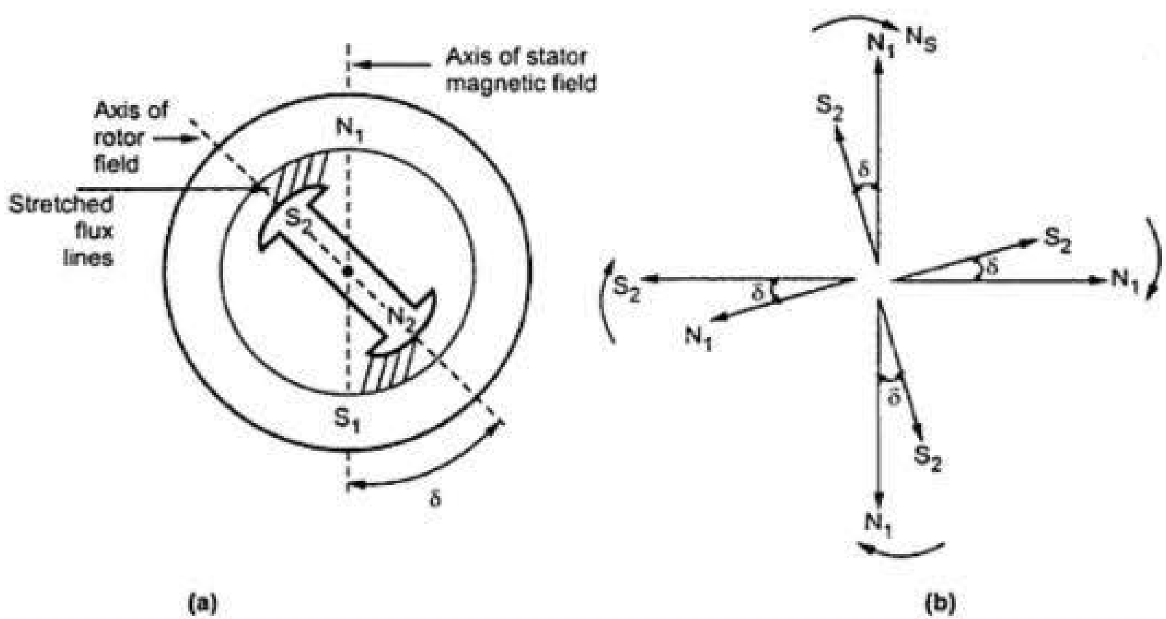
Power System Stability

- - Types: Rotor angle, frequency, and voltage stability
- - Methods: Time-domain simulation, steady-state analysis, energy function methods



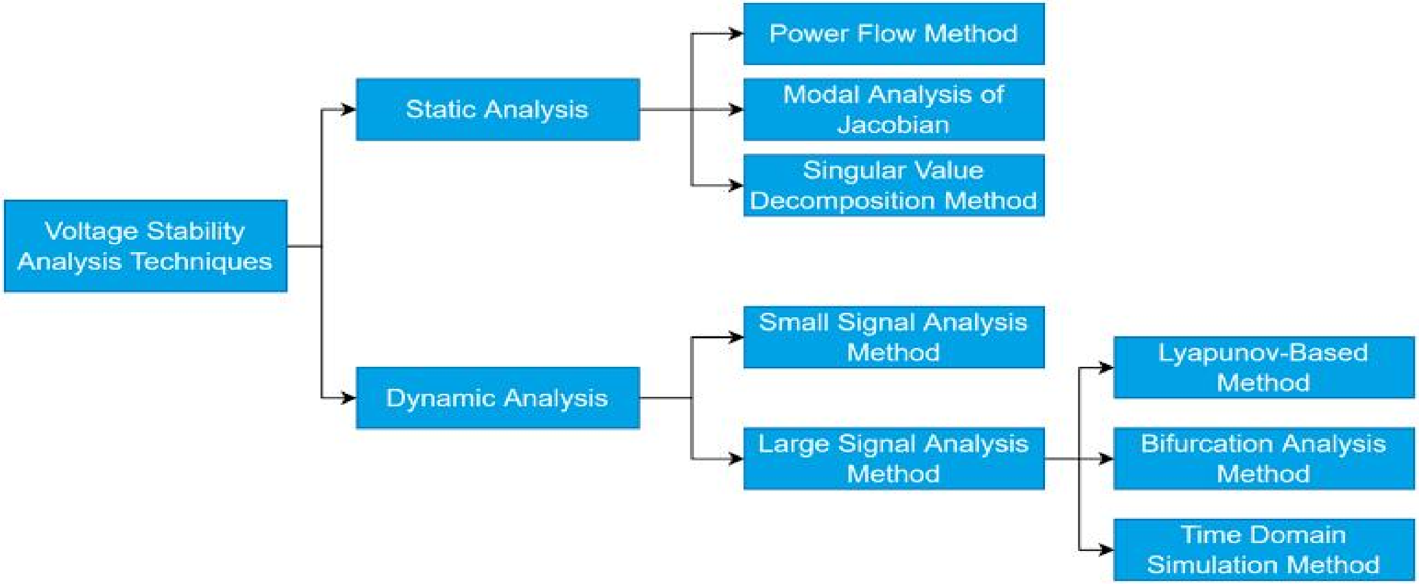
Synchronous Machine Modeling

- - Represents dynamic behavior of generators
- - Types: Detailed, transient, simplified, and classical models
- - Tools: ETAP for advanced modeling and simulation



Voltage Enhancement Methods

- - Techniques: Capacitor banks, synchronous condensers, FACTS devices
- - Benefits: Improved power factor, reduced losses, enhanced stability



INTERNSHIP PROJECT

Short-Circuit Analysis and Circuit Breaker Sizing for Cement Plant Raw Mill Substation

Detailed Project Overview

Introduction

- The short circuit analysis and circuit breaker seizing in regard to cement plant raw mill substation highlights the importance of these processes in ensuring the safety, reliability, and efficiency of industrial power systems.
- Reliable power distribution is essential in industrial systems.
- Alongside short-circuit analysis, circuit breaker sizing plays a crucial role in safeguarding the plant.
- This project focuses on analyzing fault conditions and selecting appropriate circuit breakers.
- Both manual calculations and simulation methods were utilized.

Data Collection and System Description

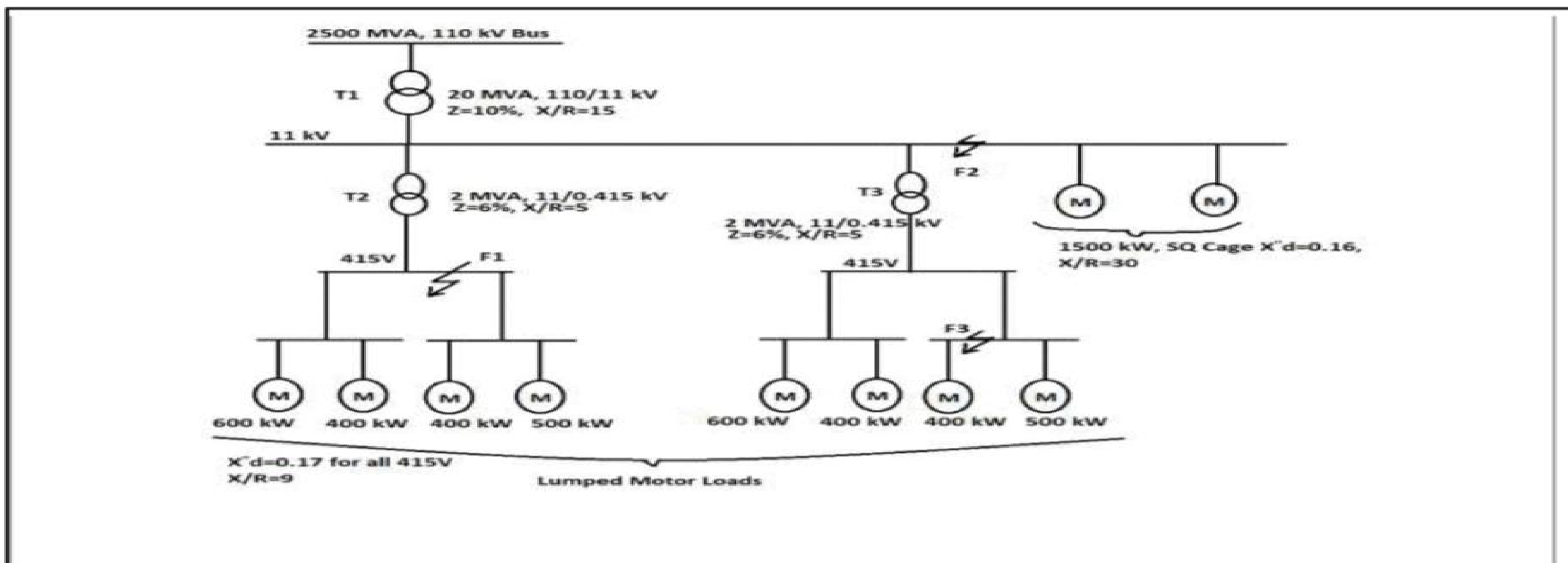
- Network includes:
- - Transformers (T1: 20 MVA, 110/11 kV; T2/T3: 2 MVA, 11/0.415 kV).
- - Motor loads: Lumped (3.4 MW) and Squirrel Cage Motor (1.5 MW).
- Base values for analysis:
- - S_base = 2500 MVA, V_base = 11 kV (high voltage), 415 V (low voltage).

Data and Parameters

- Transformer Impedance (Z):
- - T1: 10%, T2/T3: 6%.
- Motor Reactance (X_d''):
- - Lumped Load: 0.17 pu, Squirrel Cage Motor: 0.16 pu.
- Per-unit (pu) values calculated for standardization.

3. Equivalent Reactance Diagrams and Mathematical Models

- Fault Points:
- - F1: Near Transformer T2.
- - F2: Near Squirrel Cage Motor.
- - F3: Near Transformer T3.
- Equivalent Reactances (pu):
- - F1: 0.33 pu, F2: 0.26 pu, F3: 0.33 pu.



4. Short Circuit Analysis at Selected Fault Points

- Formula: I_fault = V_base / X_eq.
- Results:
- - F1: 33.33 kA (415V).
- - F2: 42.31 kA (11 kV).
- - F3: 33.33 kA (415V).

5. Simulation in ETAP/MATLAB

- Tools: ETAP and MATLAB.
- Network Modeling:
- - Components: Transformers, buses, and motor loads.
- - Parameters: Impedance values, reactances.
- Fault simulations performed at F1, F2, and F3.

Simulation Results

- Fault Current Values:
- - F1: 33.33 kA, F2: 42.31 kA, F3: 33.33 kA.
- Comparison:
- - Manual and simulation results closely match.
- - Minor discrepancies due to modeling assumptions.

Circuit Breaker Selection

- Recommended Ratings:
- - F1: 36 kA at 415V.
- - F2: 45 kA at 11 kV.
- - F3: 36 kA at 415V.
- Selection ensures safe operation under fault conditions.

Conclusion

- Industrial Power System Analysis ensures reliability, efficiency, and safety in industrial electrical systems. It provides critical insights for optimization, compliance, and future expansion.
- Short-Circuit Analysis and Circuit Breaker Sizing are critical processes for ensuring the reliable and safe operation of electrical systems in industrial settings, such as a cement plant's raw mill substation. By performing a detailed short-circuit analysis, engineers can determine fault currents and ensure that appropriate protection devices, such as circuit breakers, are selected to handle these fault conditions effectively.

References

- IEEE Standard 142-2007: "IEEE Green Book - Recommended Practice for Grounding of Industrial and Commercial Power Systems"
- Key Takeaways: This standard offers guidelines for understanding and managing electrical fault conditions in industrial systems, including grounding, short-circuit behavior, and fault current calculations.
- Link: IEEE 142-2007 Standard
- IEC 60909: "Short-Circuit Currents in Three-Phase AC Systems"
- Key Takeaways: This international standard provides detailed guidelines for the calculation of short-circuit currents in electrical systems.
- Link: IEC 60909
- "Electrical Power Systems Technology" by Dale R. Patrick and Stephen W. Fardo
- Key Takeaways: This book provides a thorough understanding of power systems and includes sections dedicated to fault analysis, including fault current calculation and the selection of protection devices.
- Relevance: Ideal for cement plant engineers or those working in heavy industrial facilities, as it provides both theory and practical insights.
- Link: Electrical Power Systems Technology

Thank you