1000KVA SUBSTATION DESIGN AND LOAD CALCULATION

A Project report is submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

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MARCH, 2024

DECLARATION

I hereby declare that this project "**1000kVA Substation design and load calculation**" represents my own work which has been done in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications. I have attempted to identify all the risks related to this research that may arise in conducting this research, obtained the relevant ethical or safety approval and acknowledged my obligations and the rights of the participants.

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APPROVAL

The project entitled **"1000kVA Substation design and load calculation"** submitted by **Papon Chandra Barman (201-33-1095) , Sabit Hasan Dip (201-33-1307), Md. Ismail Hossain (201-33-1191) and Md. Roki Mondal(201-33-1142)** has been done under my supervision and accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** in **July, 2024.**

Signed

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Dr. Fahmida Hossain Tithi
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Dedicated

To

My Parents

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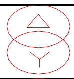
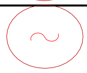
LIST OF ABBREVIATIONS

MDB	Main Distribution Board
LA	Lighting Arrestor
DOF	Drop Out Fuse
DG	Diesel Generator
HT Switchgear	High Tension Switchgear
LT Switchgear	Low Tension Switchgear
BBT	Busbar Trunking System
VCB	Vacuum Circuit Breaker
ACB	Air Circuit Breaker
OCB	Oil Type Circuit Breaker
PDB	Power Distribution Board
CB	Circuit Breaker
PFI	Power Factor Improvement
MCCB	Molded Case Circuit Breaker
MCB	Miniature Circuit Breaker
VCB	Vacuum Circuit Breaker
SF6 Circuit breaker	Sulphur Hexafluoride Circuit Breaker
PT	Potential Transformer
CT	Current Transformer
LBS	Load break switch
SDB	Sub-Distribution Board
SB	Switch Board

LIST OF SYMBOLS

Symbol	Name of the Symbol
	Transformer
	Generator
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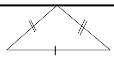
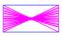
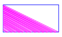
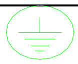
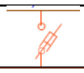
	PFI
	MDB
	SDB
	GROUND PIT
	Drop Out Fuse (DOP)
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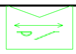
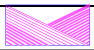
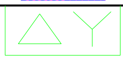
	DOL Starter WithOverload Relay
	POWER BBT
	STAR DELTA CONNECTION

ACKNOWLEDGEMENT

First of all, we want to give thanks to **Almighty Allah**. With his blessing we are able to complete our work with best effort.

We want to pay our most respect to our Supervisor **Dr. Fahmida Hossain Tithi , Associate Professor** of the **Department of EEE, Daffodil International University** for who has given us the chance to work on an impactful idea and taken care of every issue of development of this concept. Then we would like to take this opportunity to express gratitude to our supervisor for being dedicated in supporting, motivating and guiding us throughout this project. This project can't be done without her useful advice and help. Also thank her very much for giving us the opportunity to work with this project.

We also want to convey our thankfulness to Supervisor **Dr. Fahmida Hossain Tithi , Associate Professor** of the **Department of EEE, Daffodil International University** for her support and encouragement. Apart from that, we would like to thank our entire class fellows for sharing knowledge; information and helping us in making this project a success. To beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this Institution.

ABSTRACT

Our journey through the B.Sc. Engineering program at Daffodil International University. Our project title is "Load Calculation & Substation Design," which immersed us deeply into the intricacies of electrical substations and related equipment. Through this project, we transitioned from theoretical understanding to hands-on practical knowledge, significantly enriching our understanding of the subject matter.

Delving into various facets of substation engineering, we meticulously explored substation safeguarding, various protective relay kinds, bus-bar systems, installation techniques, and layout design and essential components like ring main units, AVR, and switchgear. Our comprehensive study extended to power transformers, distribution transformers, and instrument transformers, where we not only grasped theoretical concepts but also engaged in practical testing methodologies.

The project enabled us to differentiate between transformers and instrument transformers, understand the critical role of current transformers (CT) in high-voltage applications, and appreciate the significance of load calculation in substation design. Additionally, we gained proficiency in substation switchgear, including high-tension (HT), low-tension (LT) and power factor improvement (PFI) as well as the utilization of circuit breakers for effective power distribution and protection.

Our journey through this project has been transformative, equipping us with a robust foundation in substation engineering and empowering us with practical skills essential for real-world applications in the field.

CHAPTER 1
INTRODUCTION

1.1 Background/ Motivation/ Introduction

Substations serve as crucial nodes in the electrical grid, where high-voltage power is converted, regulated, and disseminated to cater to the requirements of different customers. The rationale for enhancing substation design stems from the escalating need for power, propelled by population increase, urbanization, and industrial expansion. With the growth of urban areas and advancements in technology, it is necessary for the current electrical infrastructure to adjust in order to meet the needs and overcome the obstacles presented by these changes.

In addition, the requirement for sustainability introduces an additional level of intricacy to the design of substations. In light of the increasing use of renewable energy sources and the emphasis on reducing carbon emissions, it is essential for substations to be equipped with the necessary capabilities to smoothly incorporate clean energy inputs into the power grid, while maintaining stability and dependability. This requires the use of creative methods in designing substations that give priority to efficiency, adaptability, and environmental sustainability.

Introducing modern approaches and technologies in this context has the potential to revolutionize substation design, making it more flexible, efficient, and resistant to future difficulties. Through the utilization of advanced methods in load computation, equipment optimization, and the integration of renewable energy, we can lay the foundation for a future that is both sustainable and reliant on electricity. This document seeks to examine these potentialities, elucidating the difficulties, incentives, and prospects in the realm of substation design.

1.2 Problem Statement and/or Proposed solution(s)

The existing method for substation design and load calculation is facing substantial challenges in accurately predicting electrical demand, optimizing equipment arrangements, and efficiently incorporating renewable energy sources into the power system. These issues arise from the escalating intricacy of contemporary energy systems, marked by unpredictable demand patterns, dynamic regulatory environments.

In order to tackle these difficulties, suggested solutions entail the creation and implementation of sophisticated processes and technology that are specifically designed for substation design and load computation. These solutions involve several methods, such as using advanced algorithms for load forecasting that utilize historical data, machine learning, and predictive analytics to offer more precise predictions. Furthermore, optimization methods will be utilized to determine the most efficient and economical equipment setups, considering expected load patterns, system needs, and considerations such as equipment effectiveness and long-term expenditures.

Moreover, the incorporation of renewable energy sources offers both prospects and difficulties for substation design. Efficient methods and procedures will be created to smoothly integrate renewable energy sources, like solar and wind power, into the power grid. This will be done by addressing the challenges of variability and intermittency through the use of energy storage solutions and smart grid technologies. Under addition, real-time grid management systems will be deployed to facilitate dynamic monitoring and control, optimizing the flow of energy, avoiding inefficiencies, and assuring the stability of the grid under different operating scenarios. These technologies will also enable the incorporation of demand response programs and other demand-side management tools to actively involve consumers in efficiently regulating their energy consumption.

The objective of implementing these recommended solutions is to transform the substation design process, enhancing its efficiency, resilience, and sustainability in response to changing energy demands and environmental problems. Through the utilization of technological developments and the adoption of new strategies, we may establish a more intelligent, environmentally friendly, and dependable electrical grid that effectively caters to the need of both current and future generations.

1.3 Aims/ Objectives

Aims:

- Enhance the efficiency, reliability, and sustainability of substation design and load calculation processes.

Objectives:

- Develop advanced algorithms for accurate load forecasting.
- Optimize equipment configurations to improve performance and efficiency.
- Seamlessly integrate renewable energy sources into substation designs.
- Implement real-time monitoring and control systems for dynamic load management.
- Validate solutions through rigorous testing and real-world demonstrations.

1.4 Brief Methodology/ Technologies/ Procedures

This research aims to enhance substation design and load calculation processes through a method that is both academically rigorous and comprehensive. Our methodology consists of multiple essential elements, each backed by cutting-edge technology and methodologies. Based on the knowledge acquired during the data analysis phase, we will use optimization techniques to determine the most efficient equipment arrangements for substation design. We will use mathematical modeling and simulation to assess different equipment setups based on predetermined performance criteria, including equipment utilization, energy losses, and cost-effectiveness. Through a process of continuously improving our optimization algorithms, we aim to find solutions that achieve the highest level of efficiency while also satisfying the operational needs of the electrical grid.

In addition, we acknowledge the growing significance of incorporating renewable energy sources into substation designs to advance sustainability and mitigate environmental consequences. In order to achieve this objective, we will devise strategies and algorithms to smoothly incorporate renewable energy sources, such as solar and wind power, into the power system. Our goal is to Optimize the utilization of renewable energy sources while maintaining grid's stability and dependability .

Simultaneously, our attention will be directed towards the execution of real-time monitoring and control systems, which will facilitate the adjustment of power distribution inside substations. By implementing state-of-the-art sensor technologies and communication protocols, we will create reliable monitoring systems that can offer up-to-the-minute information on energy usage, grid status, and equipment efficiency. The instantaneous feedback will empower operators to make well-informed choices and maximize energy distribution inside the substation, hence improving the overall efficiency.

Ultimately, our approaches and technologies will undergo thorough validation through extensive simulation studies and practical demonstrations in real-world settings. Through cooperation with industry partners and stakeholders, we will guarantee that our solutions undergo testing in a wide range of operational situations and are verified against recognized standards. The validation procedure will instill trust in the efficacy and dependability of our proposed methodologies, hence facilitating their adoption.

By employing a rigorous and diverse methodology, our objective is to enhance the current level of expertise in substation design and load computation. This will result in the creation of electrical grids that are more effective, dependable, and environmentally friendly, ultimately benefiting society as a whole.

1.5 Implementation Schedule / Gantt Chart

An implementation schedule is a useful instrument for efficient time management, enabling us to successfully complete our Project within the allotted timeframe. This chart outlines the interconnections between various tasks and offers estimated timeframes for each activity, aiding in the planning and organization of our research activities.

Time(Month) / Task	April	May	June	July	August	September	October	November	December	January	February	March
Topic selection & Planning												
Research and Study												
System design & Calculation												
Data Collection												
Analysis												
Completing thesis book												

Table 1.1: Gantt Chart

1.6 Organization

The report is structured to provide a comprehensive exploration of substation design and load calculation processes, organized into seven distinct chapters. Chapter 1 introduces the project's objectives, significance, and scope, setting the stage for subsequent discussions. Chapter 2 conducts a thorough literature review, summarizing existing research and identifying gaps in knowledge. Chapter 3 details the materials, methodologies, and procedures used in the project, including project/system design and design procedures. Chapter 4 presents the project's results and discussions, analyzing findings and implications in relation to the project objectives and literature review. Chapter 5 focuses on project management, outlining planning, execution, and monitoring activities. Chapter 6 assesses the project's impact on substation design practices and sustainability goals, while Chapter 7 concludes with key findings, recommendations, and insights for future research and applications. Through this structured approach, the report aims to provide a comprehensive understanding of substation design and load calculation processes, fostering innovation and advancement in the field of electrical engineering.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This section conducts a comprehensive analysis of the corpus of recent literature about substation design and load calculation. The literature review is an essential part of this work, offering useful insights into the existing knowledge, approaches, and technology in the topic. A comprehensive comprehension of the fundamental principles, difficulties, and progressions pertaining to substation design and load computation is achieved through the amalgamation and examination of an extensive array of research studies, academic papers, industry reports, and other scholarly sources.

The literature review was undertaken to achieve multiple aims. Firstly, it provides a comprehensive overview of the existing body of knowledge in the topic, which helps to contextualize the research and development efforts. Through the analysis of prior research findings and methodology, this process identifies areas of knowledge that have not been fully explored, highlights gaps in understanding, and pinpoints prospects for additional exploration and potential innovation.

Moreover, the literature review allows for comparing the findings and techniques with existing practices and industry standards. Through a thorough analysis of the current literature, it is possible to confirm the effectiveness of different approaches, determine common ground among experts, and examine differing opinions within the field.

The literature study is an essential element of this book, serving as the fundamental basis and background for the investigation of substation design and load computation. By conducting a methodical examination of current literature, the research community combines their knowledge and experiences to enhance the continuous development of electrical power distribution systems.

2.2 Related Research/ Works

The research on substation design and load calculation is driven by the imperative to improve efficiency, reduce manual work, and enhance automation in the design process to meet the evolving demands of modern electrical grids. As substations play a vital role in distributing electricity from the main grid to various areas, ensuring their optimal performance is essential for the reliability and stability of the entire power system. However, the current manual-intensive design process entails significant engineering activities, including meticulous consideration of customer requirements, geographical conditions, and project scope, which can be time-consuming and prone to human error. Automation and knowledge management emerge as key goals in the pursuit of increased competitiveness in substation design. By leveraging advanced technologies such as artificial intelligence, machine learning, and digital twin simulations, engineers can streamline the design process, automate routine tasks, and enhance decision-making capabilities. Moreover, the integration of knowledge management systems enables the capture, organization, and dissemination of valuable expertise and best practices across the organization, facilitating continuous improvement and innovation in substation design methodologies.. Automation and knowledge management are key goals to increase competitiveness in substation design [1]

Important aspects in substation design encompass a range of factors that are essential for ensuring the functionality, performance, and longevity of the electrical infrastructure. These aspects include low capital cost, reliability, efficiency, simplicity of design, and reserve capacity for future expansion.

Low capital cost is a critical consideration in substation design, as it directly impacts the financial feasibility of the project. By optimizing equipment selection, layout design, and construction methodologies, engineers strive to minimize initial investment while maintaining the required level of functionality and performance.

Reliability is paramount in substation design, as any downtime or failure can lead to disruptions in electrical supply, resulting in economic losses and inconvenience to consumers. Engineers employ redundant systems, robust equipment, and rigorous testing protocols to ensure the reliability of substation operations under normal and contingency conditions.

Efficiency is another key aspect of substation design, as it influences the overall energy losses, operational costs, and environmental impact of the electrical infrastructure. By optimizing equipment configurations, minimizing power losses, and implementing smart grid technologies, engineers aim to maximize the efficiency of substation operations while minimizing environmental footprint.

Simplicity of design is essential for ensuring ease of operation, maintenance, and troubleshooting in substations. Engineers strive to design substation layouts that are intuitive, well-organized, and easy to access, facilitating efficient operation and maintenance activities [2].

The involvement of multiple engineers across various steps of the substation design process can introduce challenges in error tracing and quality consistency, ultimately resulting in increased costs. With multiple individuals working on different aspects of the design, communication breakdowns and misinterpretations may occur, leading to discrepancies and errors that can be difficult to trace and rectify. Additionally, differences in individual approaches and standards may result in inconsistencies in the quality of work produced, further complicating the design process and potentially leading to rework or delays. These challenges highlight the importance of effective collaboration, communication, and quality assurance processes to ensure error-free and consistent substation designs while minimizing costs associated with rework and inefficiencies [3].

To mitigate the challenges associated with multiple engineers and ensure efficient substation development, a novel engineering process based on digital automation (DA), knowledge-based engineering (KBE), and machine learning is proposed. By leveraging digital automation, repetitive and time-consuming tasks can be automated, reducing the likelihood of errors and streamlining the design process. Knowledge-based engineering allows for the capture and utilization of engineering expertise and best practices, facilitating consistent and high-quality designs across various stages of development. Additionally, machine learning techniques enable the system to learn from past experiences and data, improving decision-making and predictive capabilities. Together, these technologies offer a comprehensive solution to enhance substation development efficiency, minimize errors, and optimize costs [3].

Adequate planning is paramount in substation design to preempt unnecessary modifications and guarantee adherence to environmental, safety, and reliability standards. Thorough planning allows engineers to meticulously analyze project requirements, environmental factors, and safety regulations from the outset, facilitating the development of robust design solutions that align with regulatory requirements and industry best practices. By proactively addressing potential challenges and incorporating appropriate measures into the initial design phase, such as environmental impact assessments, safety protocols, and reliability analyses, engineers can mitigate risks, minimize the need for costly modifications, and ensure the overall success of the substation project [4].

Recent technological advancements have exerted a profound influence on all facets of substation design and operation. Innovations such as digital automation, smart grid technologies, and advanced sensors have revolutionized the way substations are conceived, constructed, and managed. Digital automation has streamlined design processes, enabling engineers to automate routine tasks, optimize equipment configurations, and enhance decision-making capabilities. Smart grid technologies have facilitated real-time monitoring and control, empowering operators to manage energy flows, detect faults, and optimize grid performance with unprecedented precision and efficiency. Furthermore, advanced sensors and data analytics tools have provided invaluable insights into substation operations, enabling predictive maintenance, fault detection, and performance optimization. These technological advancements have not only improved the reliability, efficiency, and safety of substations but have also paved the way for a more sustainable and resilient electrical grid capable of meeting the challenges of the 21st century [5].

This research offers invaluable insights into enhancing substation design processes through the integration of automation and advanced engineering techniques. By leveraging digital automation, repetitive tasks can be streamlined, allowing engineers to focus on more complex design aspects and decision-making processes. Additionally, the adoption of advanced engineering techniques, such as knowledge-based engineering and machine learning, enables the capture and utilization of expert knowledge and data-driven insights to optimize design outcomes. Through the implementation of these innovative approaches, substation design processes can be made more efficient, reliable, and cost-effective, ultimately contributing to the advancement of electrical infrastructure and the sustainability of energy systems.

2.3 Compare and Contrast

The existing systems and methodologies in substation design and operation present both challenges and opportunities for improvement. Firstly, the current manual-intensive design process, as outlined in the literature, involves significant engineering activities and meticulous consideration of various factors such as customer requirements, geographical conditions, and project scope. This manual approach can be time-consuming and prone to human error, leading to inefficiencies and potential inaccuracies in the design process. Additionally, the involvement of multiple engineers across different stages of design can introduce challenges in error tracing and quality consistency, resulting in increased costs and potential delays in project delivery.

In contrast, recent technological advancements such as digital automation, smart grid technologies, and advanced sensors offer promising solutions to enhance substation design processes and address existing challenges. Digital automation streamlines design processes by automating routine tasks and optimizing equipment configurations, reducing the likelihood of errors and improving overall efficiency. Smart grid technologies enable real-time monitoring and control, empowering operators to manage energy flows and optimize grid performance with unprecedented precision. Advanced sensors and data analytics tools provide valuable insights into substation operations, enabling predictive maintenance and fault detection.

Despite these advancements, there are still research gaps and opportunities for further improvement in substation design processes. For instance, there is a need to develop more integrated and interoperable systems that can seamlessly incorporate automation, knowledge management, and machine learning techniques. Additionally, there is a need for standardized approaches and best practices in substation design to ensure consistency and quality across different projects and organizations. Furthermore, adequate planning remains crucial to preempt unnecessary modifications and ensure adherence to environmental, safety, and reliability standards.

In conclusion, while existing systems and methodologies in substation design provide a solid foundation, there is significant room for improvement through the adoption of advanced technologies and standardized approaches. By leveraging digital automation, smart grid technologies, and advanced engineering techniques, engineers can enhance the efficiency, reliability, and sustainability of substation design processes, ultimately contributing to the resilience and effectiveness of electrical infrastructure. Recommendations for future research include further exploration of integrated systems, development of standardized approaches, and continued emphasis on adequate planning and risk mitigation strategies.

2.4 Summary

This chapter examined many facets of substation design and operation, along with the difficulties and possibilities linked to existing approaches and technology. The conversation commenced by emphasizing the necessity of enhancing efficiency, minimizing human labor, and optimizing automation in substation design procedures to address the changing requirements of contemporary electrical networks. Key factors in substation design, such as cost-effectiveness, dependability, effectiveness, simplicity of design, and the flexibility to accommodate future growth, were highlighted as crucial considerations for assuring the best possible performance and functioning. Nevertheless, the participation of numerous engineers in the design process might result in difficulties in identifying errors and maintaining consistent quality, ultimately resulting in higher costs and possible delays.

In order to tackle these difficulties, a new engineering method was suggested, which relies on digital automation, knowledge-based engineering, and machine learning. This approach shows potential in improving the efficiency of substation development and reducing errors. Furthermore, it was stressed that thorough planning is essential to prevent unwanted alterations and guarantee compliance with environmental, safety, and dependability regulations. Moreover, the discussion emphasized that current technical progress, including digital automation, smart grid technologies, and improved sensors, can significantly transform substation design and operation. These developments have the potential to enhance efficiency, dependability, and sustainability.

CHAPTER 3
MATERIALS AND METHODS

3.1 Introduction

The materials and methods used in the design process or project/system design. A comprehensive reference to the methodical examination of the approaches utilized in load calculation and substation design is given in this part.. The chapter commences by presenting the fundamental elements and factors entailed in the design process. It subsequently describes the processes, tools, and procedures employed to get the desired results. Moreover, it examines the reasoning behind the selected strategy and emphasizes any inventive or original components of the design process. In essence, this chapter provides a clear and detailed guide for comprehending the complexities of the project/system design or design technique, following the document.

3.2 Methods and Materials or System Design and Components

This section provides an in-depth examination of the methodologies employed and the materials utilized in the project/system design or design procedure. It entails a thorough analysis of the principles and methods associated with substation design and load calculation. The section also presents a comprehensive overview of the major components and elements involved in the system design, including their selection, integration, and functionality. By delineating the methodologies and materials used, this section offers valuable insights into the systematic approach adopted to achieve the project/system objectives. Additionally, it highlights the critical components and considerations that underpin the design process, laying the groundwork for the subsequent sections of the document.

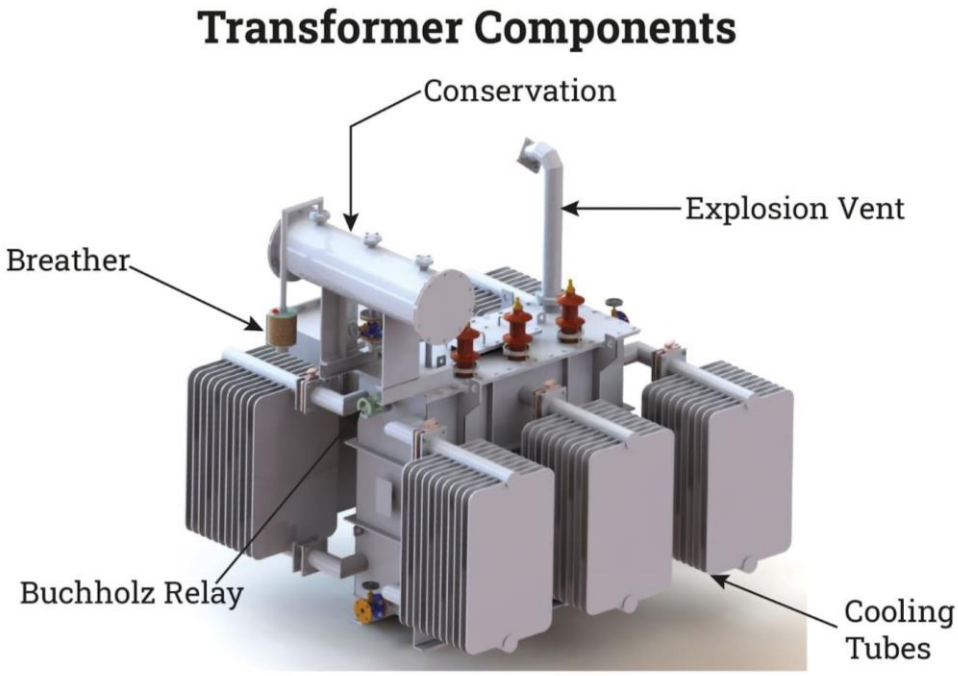


Fig 3.1: Transformer

Substation parts are essential to the effective and dependable operation of electrical power distribution systems. Some of the key components commonly found in substations include:

Transformers: Transformers are essential for voltage transformation and regulation, converting high voltage electricity from the transmission lines to lower voltages suitable for distribution.

- **Power Transformers:** These are used for voltage transformation between low-voltage distribution networks and high-voltage transmission lines.
- **Distribution Transformers:** These are installed at various points in the distribution network to further step down voltages for consumer use.

Circuit Breakers: Circuit breakers are protective devices that interrupt the flow of electricity in the event of a fault or overload, preventing damage to equipment and ensuring the safety of the electrical system.

- **Air Circuit Breakers (ACB):** These use compressed air as the interrupting medium to extinguish the arc when a fault occurs.

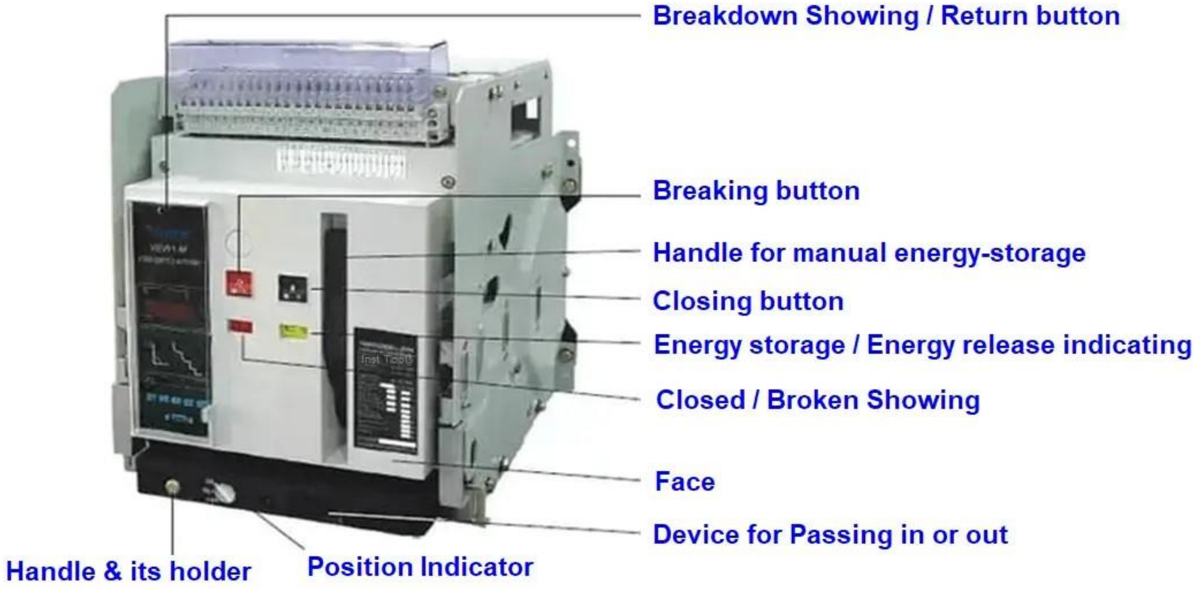


Fig 3.2: Air Circuit Breakers

- **Oil Circuit Breakers (OCB):** These use oil as the arc extinguishing medium and are commonly found in older substations.

Fig 3.3: Oil Circuit Breakers

- **Vacuum Circuit Breakers (VCB):** These use vacuum interrupters to extinguish the arc and are widely used in modern substations.

Fig 3.4: Vacuum Circuit Breakers

- **SF6 Circuit Breakers:** Gas sulfur hexafluoride is used in these as the arc extinguishing agent, offering high dielectric strength and excellent insulating properties.

Fig 3.5: SF6 Circuit Breakers

Switchgear: Switchgear is a collection of circuit breakers, fuses, and switches that are used in substations to isolate, control, and safeguard electrical equipment..

- **Metal-Enclosed Switchgear:** This type of switchgear is enclosed in metal housings for protection against environmental factors and unauthorized access.

- **Gas-Insulated Switchgear (GIS):** GIS uses sulfur hexafluoride gas as an insulating and arc-quenching medium, allowing for compact and space-saving designs.
- **Air-Insulated Switchgear (AIS):** AIS relies on air as the insulating medium and is commonly used in outdoor substations.

Busbars: Busbars are conductive bars or strips that serve as a common connection point for multiple circuits within the substation, facilitating the transfer of electrical power between different components.

- **Single Busbar Configuration:** This is the simplest arrangement, with one set of busbars used to connect all the incoming and outgoing feeders.
- **Double Busbar Configuration:** In this configuration, two sets of busbars are used to provide redundancy and flexibility in operation and maintenance.
- **Ring Bus Configuration:** This configuration forms a ring topology, providing multiple paths for power flow and enhancing system reliability.

Disconnect Switches: Disconnect switches provide a means for isolating electrical equipment from the power source for maintenance or repair purposes, ensuring the safety of personnel working in the substation.

- **Load Break Switches:** These are used for isolating and disconnecting electrical loads from the power source.
- **Isolating Switches:** These are used for isolating and disconnecting sections of the electrical network for maintenance or repair purposes.

Protective Relays: Protective relays monitor electrical parameters such as voltage, current, and frequency, and initiate protective actions, such as tripping circuit breakers, in response to abnormal conditions to prevent damage to equipment and maintain system stability.

- **Over current Relays:** These operate when the current flowing through a circuit exceeds a predefined threshold, indicating a fault condition.
- **Differential Relays:** These compare the currents entering and leaving a section of the electrical network to detect internal faults, such as short circuits.
- **Distance Relays:** These measure the impedance between the relay location and the fault point to determine the distance to the fault and initiate tripping if necessary.

Capacitors and Reactors: Capacitors and reactors are used to improve power factor, voltage regulation, and transient stability in the electrical system, enhancing the efficiency and performance of the substation.

- **Shunt Capacitors:** These are connected in parallel with the electrical network to improve power factor and voltage regulation.
- **Shunt Reactors:** These are connected in parallel with the network to compensate for capacitive loads and mitigate voltage fluctuations.

Control and Monitoring Systems: Control and monitoring systems enable operators to remotely monitor and control substation operations, including voltage regulation, load balancing, and fault detection, to optimize system performance and reliability.

- **SCADA (Supervisory Control and Data Acquisition) Systems:** These provide real-time monitoring and control of substation equipment and processes from a central location.
- **PLC (Programmable Logic Controller) Systems:** PLCs automate control functions within the substation, executing predefined logic based on input signals.
- **Remote Terminal Units (RTUs):** RTUs collect data from sensors and relays in the substation and transmit it to the central control system for analysis and decision-making.

Grounding Systems: Grounding systems provide a low-resistance path to earth for fault currents, ensuring the safety of personnel and equipment by minimizing the risk of electric shock and damage from lightning strikes.

- **Rod Grounding:** This involves driving metal rods into the ground and connecting them to the substation equipment to provide a low-resistance path to earth.
- **Grid Grounding:** Grid grounding systems consist of interconnected conductors buried underground to ensure uniform grounding throughout the substation area.

Auxiliary Equipment: Auxiliary equipment such as lighting, heating, ventilation, and security systems are essential for maintaining a safe and comfortable working environment within the substation and protecting critical infrastructure from environmental factors and unauthorized access.

- **Lighting Systems:** These provide illumination for safe operation and maintenance activities within the substation.
- **Heating and Ventilation Systems:** These maintain suitable temperature and air quality levels within the substation to ensure equipment reliability and personnel comfort.

- **Security Systems:** These include surveillance cameras, access control systems, and intrusion detection sensors to protect against unauthorized access and vandalism.
- **Fire Suppression Systems:** These systems detect and suppress fires using methods such as water sprinklers, foam, or gas-based extinguishing agents to protect critical infrastructure and personnel safety.

Each type of component serves a specific function in the substation, contributing to the overall reliability, safety, and efficiency of the electrical system.

In addition, this part covers the process of choosing and incorporating essential elements into the substation design, including transformers, circuit breakers, switchgear, and protective relays. When selecting a substation, factors including as capacity, efficiency, dependability, and compatibility are carefully considered to maximize its performance. Additionally, this part emphasizes any groundbreaking or original elements of the design process, such as the utilization of digital automation, sophisticated modeling techniques, or incorporation of renewable energy sources. These developments are intended to improve the efficiency, sustainability, and resilience of substation design and operation.

In summary, this section offers a comprehensive explanation of the approach and materials employed in the project/system design or design procedure, establishing the foundation for the ensuing examination and discussion of outcomes.

3.3 Design Specifications. Standards and Constraints

Design specifications, standards, and constraints are essential considerations in the development of substation projects to ensure compliance with regulatory requirements, industry best practices, and project objectives. Here's an overview of each:

1. **Design Specifications:**
    - Design specifications outline the technical requirements and performance criteria that the substation must meet. These specifications typically include parameters such as voltage levels, power capacity, fault tolerance, and environmental conditions.
    - They may also specify the type and rating of equipment to be used, such as transformers, circuit breakers, and switchgear, as well as the layout and configuration of the substation.

- Design specifications are often based on specific needs and requirements of the project, including factors such as load demand, geographic location, and available resources.

2. **Standards:**
   - Standards refer to established guidelines, codes, and regulations set forth by industry organizations, government agencies, and international bodies to ensure the safety, reliability, and interoperability of electrical systems.
   - Common standards applicable to substation design include those developed by organizations such as the International Electrotechnical Commission (IEC), the Institute of Electrical and Electronics Engineers (IEEE), and national regulatory bodies such as the National Electrical Safety Code (NESC) in the United States.
   - These standards cover various aspects of substation design, including equipment specifications, safety requirements, environmental considerations, and testing procedures, providing a framework for engineers to follow during the design process.
3. **Constraints:**
   - Limitations or limits that could affect the substation project's design and execution are referred to as constraints. These limitations may be of a technical, economical, governmental, or environmental character.
   - Technical constraints may include factors such as space limitations, soil conditions, and existing infrastructure that must be considered when designing the substation layout.
   - Financial constraints may dictate budget limitations and cost considerations that influence equipment selection, construction methods, and project timelines.
   - Regulatory constraints encompass legal requirements and permitting processes that must be adhered to ensure compliance with local, state, and national regulations governing electrical infrastructure.
   - Environmental constraints may include factors such as noise levels, electromagnetic interference, and habitat conservation requirements that must be addressed to minimize the impact of the substation on the surrounding environment.

In summary, design specifications, standards, and constraints play integral roles in guiding the design and development of substation projects, ensuring that they meet performance requirements, comply with regulatory mandates, and address project constraints effectively. By adhering to established standards and specifications while considering project-specific constraints, engineers can design substation projects that are safe, reliable, and environmentally sustainable.

3.4 System Analysis or Design Analysis

Framework analysis or design analysis involves the systematic examination of the substation project to ensure that the desired output or result is achieved while addressing both technical aspects and business needs. This process aims to optimize the project design to meet specific standards or requirements, considering factors such as efficiency, performance, reliability, and cost-effectiveness.

The optimization process involves identifying the key objectives and constraints of the project and then finding the best solution that maximizes desired factors while minimizing undesired ones. This may involve selecting the most suitable components, technologi es, and design configurations to achieve the desired performance outcomes within the specified constraints.

For example, in the design of a substation, system analysis may involve optimizing the layout and configuration of equipment to maximize energy efficiency, minimize power losses, and ensure reliable operation under various operating conditions. This may require conducting detailed analyses, such as load flow studies, fault studies, and transient stability analyses, to evaluate different design options and identify the most optimal solution.

Additionally, system analysis may involve considering business needs and objectives, such as meeting regulatory requirements, minimizing capital and operating costs, and maximizing return on investment. This may entail evaluating different design alternatives based on their lifecycle costs, including initial investment, maintenance costs, and energy consumption, to determine the most cost-effective solution.

System analysis or design analysis is an essential step in the substation design process. It ensures that the project is optimized to fulfill technical needs and business objectives, while also conforming to financial and regulatory limitations. Through the utilization of meticulous analysis approaches and optimization procedures, engineers have the ability to create substation designs that are highly efficient, dependable, and economically feasible. This ultimately results in providing value to stakeholders and end-users.

3.5 Simulation

We are provide a complete description on the implementation of the project design and how the results have been obtained. It could be via a laboratory setting or in-premises setup. Describe and explain the experiment design and analysis that were employed in this instance. Take notes on the experimental setup in the working space. Enhance with illustrations, images, etc. The same is applicable for any sort of simulation design.

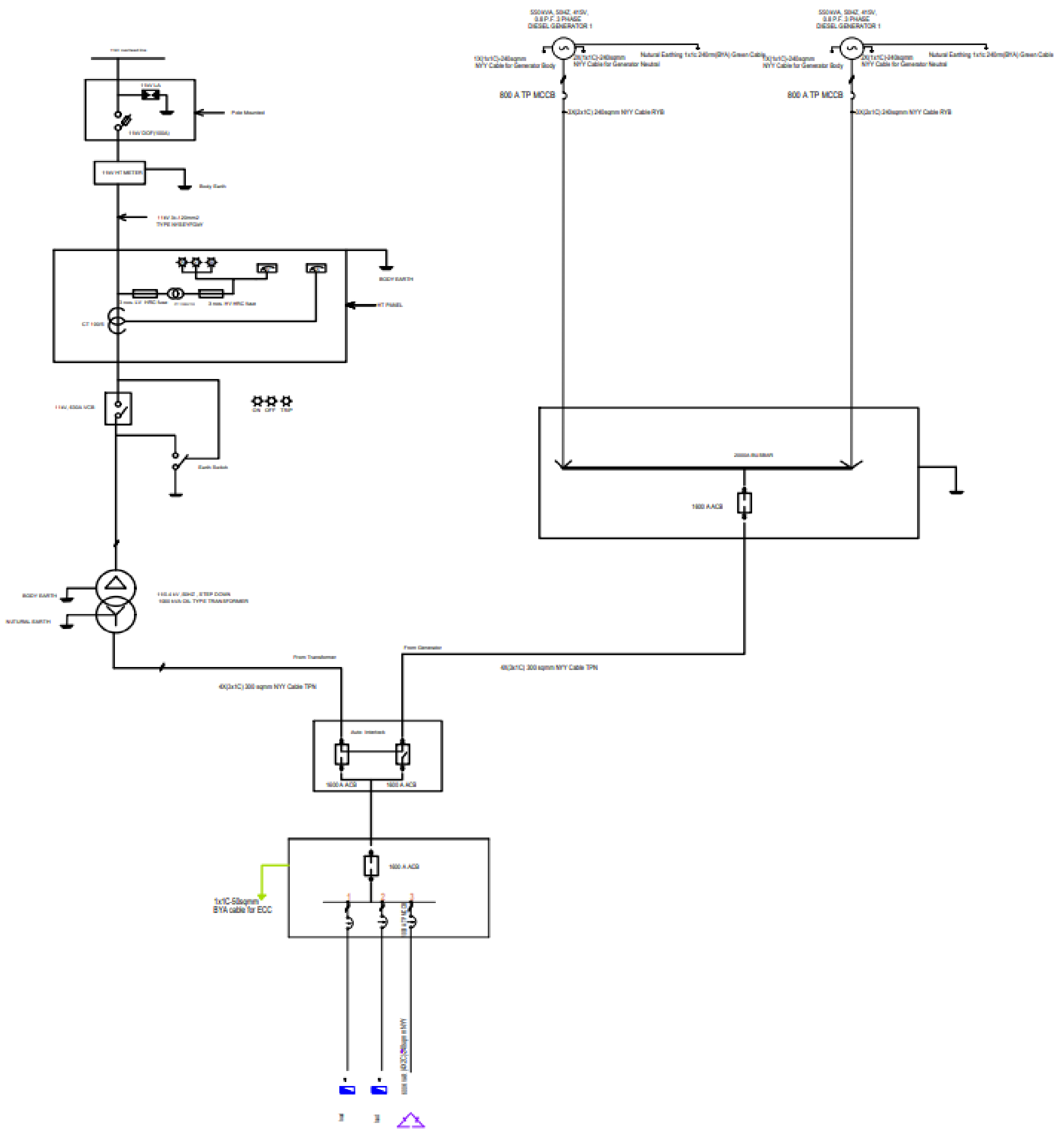


Fig 3.6: Single Line Diagram

3.6 Summary

This chapter examined the several types of substations that are typically included in electrical power systems. Substations play a vital role in the electricity grid, performing several services including voltage conversion, transmission, distribution, and switching. The discussion covered many types of substations categorized by their specific functions, such as step-up substations, step-down substations, transmission substations, distribution substations, switching substations, mobile substations, compact substations, and industrial substations. Each type of power grid equipment serves distinct objectives and is specifically engineered to satisfy the requirements of different sections of the power grid and diverse applications.

The highlighted aspects of each type of substation included key characteristics and features, such as voltage levels, equipment configurations, and operating considerations. Comprehending the many categories of substations is crucial for effectively and dependably planning, designing, and operating electrical power systems.

CHAPTER 4

RESULTS AND DISCUSSIONS

We are assuming a load 600 KW. In this project we are calculate substation design and load calculation is facing substantial challenges in accurately predicting electrical demand, optimizing equipment arrangements, and efficiently incorporating renewable energy sources into the power system. Calculation and result given below:

4.1 Results/ Observations:

Our main substation load =600KW

- Transformer selection: $\dfrac{KW}{P.F}$

$$= \frac{600}{0.8}$$

= 750kVA

=750*1.2(Risk Factor)

=900kVA

Selected Transformer: 1000kVA

- Primary side cable selection:

Primary side current:

$P = \sqrt{3} \times V \times I_p \times \cos(\phi)$

$$I_p = P \times \frac{1}{1.732 \times 11000}$$

$= 1000 \times 0.05249$

$= 52.49A$

Short Circuit Current:

$I_{sh} = \mathbf{I_p}$ / Percentage of Impedance

$= 52.49/0.06$

$=874.83A$

$=0.87$ KA × 10 (Short Circuit Current 10 times)

= 8.74 KA

$$S = \frac{\mathbf{I_{sh}} \times \sqrt{t}}{K}$$

$$= \frac{8.74 \times 1.732}{0.049}$$

=105 RM

Primary side Selected Cable =120 RM

- Drop-out fuse:

Drop-out fuse = $\mathbf{I_p} \times$ Risk Factor

= 52.49× 1.2

= 62A

=100A

Selected Drop-out Fuse =100A

- CT Ratio :

CT Ratio== $\mathbf{I_p} \times$ Risk Factor

= 52.49× 1.25

= 65.61

=100/5A

Selected CT Ratio = 100/5A

- VCB Selection :

$$I_p = P \times \frac{1}{1.732 \times 11000}$$

= 1000 × 0.05249

= 52.49A × 200%

=318A

Selected VCB =630A

- Secondary Cable Selection :

$$I_p = \frac{1}{1.732 \times 415}$$

$= P \times (1000 \times 0.0139)$

$= 1000 \times 1.39$

$= 1390A$

PHYSICAL DATA								ELECTRICAL DATA					
Cross Sectional Area	No. & approx. dia. of wire Cu/Al	Shape of Conductor	Nominal thickness of insulation	Nominal thickness of sheath	Overall diameter (approx)	Approx. weight of cable		Max. DC resistance of conductor at 20 °C		Current rating at 30 °C in ground		Current rating at 35 °C in air	
						Cu	Al	Cu	Al	Cu	Al	Cu	Al
core x mm²	nos./mm	-	mm	mm	mm	kg/km	kg/km	ohm/km	ohm/km	amps	amps	amps	amps
1x1.5	1/1.38	re	0.8	1.8	6.6	55	-	12.1	18.1	27	-	22	-
1x1.5	7/0.52	rm	0.8	1.8	6.8	58	-	12.1	18.1	27	-	22	-
1x2.5	1/1.78	re	0.8	1.8	7.2	70	-	7.41	12.1	36	-	30	-
1x2.5	7/0.68	rm	0.8	1.8	7.4	75	-	7.41	12.1	36	-	30	-
1x4	7/0.85	rm	1.0	1.8	8.2	106	80	4.61	7.41	47	37	39	31
1x6	7/1.04	rm	1.0	1.8	8.7	132	92	3.08	4.61	59	48	50	41
1x10	7/1.35	rm	1.0	1.8	9.7	182	118	1.83	3.08	78	60	69	53
1x16	7/1.70	rm	1.0	1.8	10.7	252	150	1.15	1.91	100	78	94	73
1x25	7/2.14	rm	1.2	1.8	12.4	363	202	0.727	1.2	130	101	125	97
1x35	min.6	rm	1.2	1.8	13.7	470	248	0.524	0.868	155	120	160	124
1x50	min.6	rm	1.4	1.8	15.6	645	332	0.387	0.641	185	144	195	151
1x70	min.12	rm	1.4	1.8	17.3	858	420	0.268	0.443	225	175	245	190
1x95	min.15	rm	1.6	1.8	19.4	1129	530	0.193	0.32	270	210	300	232
1X120	min.18/15	rm	1.6	1.8	21	1384	628	0.153	0.253	310	240	350	272
1x150	min.18/15	rm	1.8	1.8	23.1	1709	780	0.124	0.206	350	270	405	314
1x185	min.30	rm	2.0	2.0	25.6	2097	932	0.0991	0.164	390	302	460	357
1x240	min.34/30	rm	2.2	2.0	28.6	2708	1190	0.0754	0.125	450	349	555	430
1x300	min.34/30	rm	2.4	2.0	31.3	3405	1248	0.0601	0.1	515	386	640	448
1x400	min.53	rm	2.6	2.2	35.3	4408	1952	0.047	0.0778	585	439	770	540
1x500	min.53	rm	2.8	2.2	38.0	5436	2340	0.0366	0.0605	680	510	900	630
1x630	min.53	rm	2.8	2.2	42.0	6780	2780	0.0283	0.0469	800	600	1030	721
1x800	min.53	rm	2.8	2.4	46.2	8510	3195	0.0221	0.0367	945	708	1160	812
1X1000	min.53	rm	3.0	2.6	51.1	10530	3350	0.0176	0.0291	1095	821	1310	917

Table 4.1: LT Cable Selection

Selected Cable Rating: 4 x (3x1C) 300 sq mm NYY Cable TPN

- ACB selection : 1600A

- PFI Calculation :

Initial power factor ($PF_{initial}$) = 0.8 (cosine of the phase angle)
Desired power factor ($PF_{desired}$) = 0.95 (closer to unity)
First, calculate the apparent power (S) using the initial power factor: S=kVA=1000kVA

Then, calculate the real power (P) using the formula:
$P=S\times PF_{initial}$
$P=1000kVA\times0.8=800kW$
Now, calculate the reactive power (Q) using the formula:
$Q=\sqrt{S^2-P^2}$
$Q=\sqrt{(1000kVA)^2-(800kW)^2}$
$Q=\sqrt{1,000,000-640,000}$
$Q\approx\sqrt{360,000}$ $Q\approx600kVAR$

Selected Capacitor Bank =600KVAR

- Generator Side Calculation:

Selected Generator = (2 × 550) kVA

For Generator 1,

$$I_p = \frac{1}{1.732\times 415}$$

= P×(1000 × 0.0139)

= 550 ×1.39

= 764A

Selected Cable =4× (2x1C) 240sqmm NYY Cable RYBG

Busbar Selection Generator Side,

110mm (Thickness)× 12mm(width)= 2046A

4.2 Discussions

Our project focus enhance the efficiency, reliability, and sustainability of substation design and load calculation processes. Our main load 600KW . That's way we are using 1000kVA transformer and other necessary equipment for build sustainability of substation and we are also using **Autocad** for completed this 1000kVA substation design. We are using step-down transformer for step-down the voltage 11kV to 440V . we are using power factor improvement (PFI) is essential for substations to enhance efficiency and stability in power distribution. By correcting lagging power factors, PFI reduces reactive power flow, minimizing line losses, improving voltage stability, and increasing system capacity. This ensures optimal utilization of infrastructure and reliable supply to consumers, ultimately optimizing the performance of electrical substations. We are also generator 2 generator for backup purpose. If one generator is unable to work then we can easily work on second Generator .

CHAPTER 5
PROJECT MANAGEMENT

5.1 Task, Schedule and Milestones

- **Tasks :**

Initial Planning: This project begins with initial planning, which involves defining project objectives, scope, and deliverables. This task also includes assembling the project team and allocating resources accordingly.

Requirement Analysis: We are understanding the requirements of the substation design project is essential. This task involves gathering information about load requirements, site conditions, regulatory standards, and client preferences.

Equipment Selection: Selecting appropriate equipment is a key task in substation design. This involves researching available options, evaluating their suitability based on project requirements, and procuring necessary equipment.

Load Calculation: Accurately calculating the load requirements of the substation is critical. This task entails analyzing historical data, predicting future load growth, and determining the capacity needed to meet demand.

Site Survey: Conducting a thorough site survey is necessary to assess factors such as terrain, accessibility, environmental impact, and proximity to load centers. This task provides essential information for site selection.

Design Development: Developing the substation design involves creating layout plans, schematics, and specifications. This task requires collaboration between engineers, designers, and stakeholders to ensure alignment with project goals.

- **Schedule**

The project schedule outlines the timeline for completing each task and achieving project milestones. It is essential to create a realistic schedule that accounts for potential delays and resource constraints. The schedule should be regularly monitored and adjusted as needed to ensure timely project completion.

- **Milestones**

Completion of Requirement Analysis: The completion of requirement analysis signifies that project objectives and scope have been clearly defined. It provides a solid foundation for the subsequent stages of the project.

Equipment Procurement: Procuring necessary equipment is a significant milestone in the project timeline. It ensures that the project has access to essential resources for substation design and construction.

Completion of Design Development: The completion of design development indicates that the substation design plans and specifications have been finalized. It paves the way for the implementation phase of the project.

Site Preparation: Site preparation involves clearing and preparing the selected site for construction. It is a crucial milestone that marks the transition from planning to implementation.

Commencement of Construction: The commencement of construction signifies the beginning of physical work on the substation site. It marks a significant step towards completing the project objectives.

5.2 Resources and Cost Management

Serial NO.	Name of Equipment	Quantity	Unit	Price (TK)
1	11 kV Lightning Arrestor	1	Pcs	180000
2	11 kV Drop Out Fuse(100A)	1	Pcs	17000
3	11kV,630A ,Vacuum Circuit Breaker	1	Pcs	550,000
4	11/0.4 kV,50hz Step Down 1000 kVA Oil Type Transformer	1	Pcs	3,500,000
5	1600A ACB Breaker	4	Pcs	290,000
6	2000A Busbar	1	Pcs	215,000
7	550 kVA, 50HZ, 415V, 0.8 P.F. 3 Phase Diesel Generator	2	Pcs	4,500,000
8	800A TP MCCB	2	Pcs	150,000
9	1000A TP MCCB	1	Pcs	152,000
10	600KVAR PFI Panel	1	Pcs	5,00,000
11	NYSEYFGbY 3x120 rm	1	Coil	999042
12	NYY 3x300 sm	1	Coil	1,801,378
13	NYY 3x240 sm	1	Coil	1,437,478
Total Amount				**14,291,898**

Table5.1: Resources and Cost Management

5.3 Lesson Learned

This project's main goal is improve the sustainability, dependability, and efficiency and our project name is load calculation and substation design .We are assume a load 600KW. We are learned how to calculated drop out fuse , cable , transformer selection and other necessary things . This project help to get real life expiration calculation on substation . In order to construct a sustainable substation, we are doing so by utilizing a 1000kVA transformer and other essential equipment. We are learn Autocad and after using Autocad finish the design of this 1000kVA substation. The voltage is being stepped down from 11 kV to 440 V using a step-down transformer. Power factor improvement, or PFI, is what we use in substations to improve power distribution reliability and efficiency.

CHAPTER 6

IMPACT ASSESSMENT OF THE PROJECT

6.1 Economical, Societal and Global Impact

Substations are essential to the electrical infrastructure and have a big impact on society, the economy, and the world at large. Substations provide a cost-effective means of distributing power, reducing transmission losses, and guaranteeing a steady supply of electricity to homes, companies, and industries. Substations improve overall economic output by reducing costs for utilities and customers by streamlining energy transmission and distribution.

Substations serve a variety of industries, including healthcare, education, transportation, and communication, and are crucial to modern society. Substations provide a steady supply of energy that allows schools to run efficiently, hospitals to run life-saving machinery, and transportation networks to continue running. All of these things contribute to the growth and welfare of society.

6.2 Environmental and Ethical Issues

Substations are necessary for the distribution of energy, there are ethical and environmental issues that must be taken into account.

Substations can have a variety of effects on the environment. First of all, their installation and maintenance might necessitate destroying land or upsetting natural habitats, which would reduce biodiversity and fragment ecosystems. Furthermore, electromagnetic fields (EMFs) released by substations might cause health issues, particularly in residential areas, even though they are generally regarded as harmless within regulation limits. Additionally, sulfur hexafluoride (SF6), an insulating gas that has a significant potential for global warming and can contribute to climate change if released into the atmosphere during maintenance or accidents, is used in substations.

Substation location might ethically bring up questions of environmental justice and community involvement. Substations are frequently found in or close to marginalized

6.3 Utilization of Existing Standards or Codes

Adherence to relevant standards, safety concerns, codes, laws, and regulations is crucial during the development of the "Load Calculation & Substation Design" project in order to guarantee the dependability, safety, and compliance of the substation design. For this project, a number of important standards and norms are pertinent:

- **Bangladesh National Building Code (BNBC) :** we are maintain according to the BNBC rules and regulation . All data and calculation are maintain BNBC Bangladesh-National-Building-Code-2020.pdf. Compliance with BNBC requirements ensures electrical safety, fire protection, and proper equipment installation.

- **Regulations by the Occupational Safety and Health Administration (OSHA):** OSHA rules in the US include worker health and safety, and they include electrical safety requirements for substation construction and maintenance.

- **Environmental Protection Regulations:** These regulations control how substations affect the quality of the air, water, and soil. Adherence to environmental regulations guarantees appropriate handling of dangerous substances, elimination of waste, and reduction of ecological consequences.

6.4 OTHER CONCERNS

a crucial element that merits substantial consideration is the possibility of technical breakthroughs and changing industrial norms. future versions of substation design may incorporate new techniques and technologies that have a substantial impact on sustainability, efficiency, and performance as technology advances. in order to guarantee the project's sustained efficacy and relevance, constant observation and adjustment to new developments and trends are essential. to properly address this issue, proactive involvement with industry stakeholders, ongoing professional development, and funding for research and development are crucial.

CHAPTER 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Our Project name is "load calculation and substation design". We have great theoretical understanding because of this bond. We practically learned substation's equipment is protected. Additionally, we study bus bar configuration. A substation receives energy from a grid or a power generating firm, steps down the power, and supplies the power based on customer demand. There are numerous procedures to complete each and every procedure between the taking and distribution of power. We have made every effort to learn as much as we can about the sub-station's system protection planning and transmission system in the limited time we have had. Additionally, we now understand the operation of the substation and we received assistance from supervisors in every sector. We anticipate that the real-world experience and information we have learned will be useful in my future career.

7.2 New Skills and Experiences Learned

The practical experience which we have gained knowledge to helpful for my future job sector. We gained a wealth of new knowledge and expertise during the project, which has improved our comprehension and competence in electrical engineering. First and foremost, we improved our technical proficiency in substation design, including methods for load calculations and layout planning, which allowed us to efficiently optimize power distribution networks. We learned the ins and outs of testing transformers firsthand and became knowledgeable about the subtleties of different substation components like bus-bar systems, circuit breakers, and safety relays.

In addition, we gained a deeper understanding of the safety guidelines and standards that control substation installations, guaranteeing adherence to industry rules and reducing possible risks. We also developed project management abilities by working with team members to assign tasks, establish deadlines, and successfully follow project schedules. This experience heightened our awareness of the importance of mitigating environmental risks and promoting social justice in infrastructure projects.

7.3 Future Recommendations

The practical experience which we have gained knowledge to helpful for my future job sector Several suggestions might be made for the project's future iterations to increase its efficacy and relevance:

Integration of Renewable Energy: Take into consideration adding components to substations that are associated with the integration of renewable energy. This can entail researching how to integrate solar or wind power with the current substation infrastructure while taking grid stability, voltage management, and power quality into account.

Advanced technology: Investigate the use of cutting-edge technology including digital substations, smart grids, and Internet of Things (IoT) gadgets. These technologies can improve substation performance and downtime by increasing their efficiency, dependability, and monitoring capabilities.

Cybersecurity Measures: With substations becoming more digitally connected, cybersecurity issues must be addressed. Subsequent research endeavors may concentrate on formulating cybersecurity policies and procedures to protect substations.

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APPENDIX A

TURNITIN REPORT

FINAL BOOK 1000KVA SUBSTATION DESIGN AND LOAD CALCULATION

ORIGINALITY REPORT

15%	14%	3%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	dspace.daffodilvarsity.edu.bd:8080 Internet Source	9%
2	Submitted to Daffodil International University Student Paper	2%
3	fastercapital.com Internet Source	1%
4	www.techsciresearch.com Internet Source	<1%
5	www.open2hire.com Internet Source	<1%
6	centaur.reading.ac.uk Internet Source	<1%
7	Submitted to Arab American University - Jenin Student Paper	<1%
8	Submitted to Milton Keynes College Student Paper	<1%
9	umpir.ump.edu.my Internet Source	<1%

APPENDIX B

COMPLEX ENGINEERING PROBLEM SOLVING AND ENGINEERING ACTIVITIES

Complex Engineering Problems (P) Solving		
	Attributes	Statement from students
P1	Depth of knowledge required	"1000kVA Substation Design and Load Calculation" project requests a significant comprehension of electrical designing standards, substation plan strategies, and administrative principles. Engineers should have ability in load estimation methods, hardware choice standards, and consistence with security codes.
P2	Range of conflicting requirements	This project includes exploring a huge number of clashing prerequisites, including load limit, spatial imperatives, cost contemplations, and administrative consistence.
P3	Depth of analysis required	Ensures to optimal performance and adherence to industry standards, the project requires a depth of research that includes a complete evaluation of substation design concepts, safety practices, and regulatory compliance.
P4	Familiarity of issues	A strong familiarity with the issues to be solved and project results to be maximized, one must have a solid understanding of substation design, safety, and regulatory compliance. Because of this experience, engineers are better able to foresee any roadblocks, put suitable solutions in place, and guarantee the effective development and operation of substations.
P5	Extent of applicable codes	————
P6	Extent of stakeholder involvement and conflicting requirements	Resolve competing requirements and guarantee project success, the level of stakeholder involvement in substation projects needs to be carefully handled. To get agreement and be in line with project goals, it is necessary to effectively communicate, negotiate, and compromise with a variety of stakeholders, including regulatory

		agencies, local communities, and utility companies.
P7	Interdependence	Interdependence is clear because the overall design framework provides the mechanical support and structural integrity that electrical components need to function well. The smooth transition between structural and electrical components emphasizes how important it is to have a coordinated strategy in place to guarantee the substation's functionality and dependability.

Complex Engineering Problems (P) Solving		
	Attributes	Statement from students
A1	Range of resources	Project needed expertise, tools, materials, and finances, for successful substation design and implementation.
A2	Level of interaction	Effective collaboration and communication among team members, stakeholders, and relevant parties are crucial for the successful execution .
A3	Innovation	project promotes innovation in substation design techniques, tools, and procedures to maximize power distribution systems' sustainability, dependability, and efficiency.
A4	Consequences of society and environment	The project's results have an impact on community well-being, environmental sustainability, and energy accessibility.
A5	Familiarity	To properly solve difficult technical challenges, the project demands a strong understanding with substation design processes, electrical engineering concepts, and regulatory standards.

APPENDIX D

DATASHEET OF COMPONENTS

Serial NO.	Name of Equipment	Quantity	Unit
1	11 kV Lightning Arrestor	1	Pcs
2	11 kV Drop Out Fuse(100A)	1	Pcs
3	11kV,630A ,Vacuum Circuit Breaker	1	Pcs
4	11/0.4 kV,50hz Step Down 1000 kVA Oil Type Transformer	1	Pcs
5	1600A ACB Breaker	4	Pcs
6	2000A Busbar	1	Pcs
7	550 kVA, 50HZ, 415V, 0.8 P.F. 3 Phase Diesel Generator	2	Pcs
8	800A TP MCCB	2	Pcs
9	1000A TP MCCB	1	Pcs
10	600KVAR PFI Panel	1	Pcs
11	NYSEYFGbY 3x120 rm	1	Coil
12	NYY 3x300 sm	1	Coil
13	NYY 3x240 sm	1	Coil