NMI REPORT

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# CHAPTER 1

## Failure Mode and Effects Analysis (FMEA) Report

### Introduction

This Failure Mode and Effects Analysis (FMEA) was carried out to assess the electrical system and appliances used in various rooms and areas of a commercial office building. The goal is to identify potential failure modes, evaluate their impact on safety and system performance, and recommend necessary mitigations. The analysis focuses on appliances such as bulbs, sockets, extensions, heaters, and desktop computers, which are critical to the daily operations of the office. These appliances are located in areas such as the admin building, store rooms, CEO office, production hall, and other vital sections of the building.

### Objective

The primary objective of this FMEA is to:

* Identify potential failure modes related to the electrical appliances and system setup.
* Evaluate the effects of these failures on safety, system functionality, and operational performance.
* Prioritize the identified risks based on severity, occurrence, and the likelihood of detection.
* Propose corrective actions and mitigation strategies to reduce identified risks, improve reliability, and ensure energy efficiency.

### System Overview

The office environment evaluated in this FMEA comprises several rooms, each equipped with electrical appliances. These appliances range from fluorescent energy-saver bulbs to high-power sockets, fridges, and heaters. A detailed assessment of power consumption, current, voltage, and power rating for each appliance was conducted. The appliances operate under varying power ratings, voltages, and current requirements.

Below is an overview of the key data from the FMEA:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Room/Area** | **Appliance** | **Quantity** | **Model** | **Item Type** | **Power(W)** | **Total Power** | **Current** | **Total Current** | **Voltages** | **Total voltages** | **Power Rating** |
| **Entrance of admin building** | **Bulbs** | **2** | **Energy Saver** | **Fluorescent** | **60** | **120** | **0.26** | **0.52** | **100** | **200** | **62.4** |
| **Admin building** | **Bulbs** | **2** | **Energy Saver** | **Fluorescent** | **60** | **120** | **0.26** | **0.52** | **100** | **200** | **62.4** |
| **Sockets** | **3** |  | **Double Socket** | **4600** | **13800** | **40** | **120** | **230** | **690** | **1656000** |
| **Store Room 1** | **Bulbs** | **1** | **Energy Saver** |  | **60** | **60** | **0.26** | **0.26** | **100** | **100** | **15.6** |
| **Sockets** | **1** | **Double Socket** |  | **4600** | **4600** | **40** | **40** | **220** | **220** | **184000** |
| **Store Room 2** | **bulbs** | **1** | **Energy Saver** | **Fluorescent** | **60** | **60** | **0.26** | **0.26** | **100** | **100** | **15.6** |
| **Sockets** | **1** |  | **Double Socket** | **4600** | **4600** | **40** | **40** | **230** | **230** | **184000** |
| **CEO Office** | **Extension** | **1** |  |  | **3120** | **3120** | **13** | **13** | **220** | **220** | **40560** |
| **Bulbs** | **1** | **Energy Saver** | **Fluorescent** | **5** | **5** | **0.66** | **0.66** | **100** | **100** | **3.3** |
| **Desktop** | **1** | **Dell** | **Monitor** | **90** | **90** | **3.33** | **3.33** | **240** | **240** | **299.7** |
| **Ceo toilet** | **Bulbs** | **1** |  | **Energy Saver** | **5** | **5** | **0.66** | **0.66** | **100** | **100** | **3.3** |
| **Admin building** | **Heater** | **1** |  |  | **2000** | **2000** | **10** | **10** | **220** | **220** | **20000** |
| **Kitchen** | **Fridge** | **1** |  |  | **400** | **400** | **2** | **2** | **230** | **230** | **800** |
| **Bulbs** | **1** | **Energy Saver** | **Fluorescent** | **60** | **60** | **0.26** | **0.26** | **100** | **100** | **15.6** |
| **Sockets** | **2** |  | **Single Socket** | **600** | **1200** | **13** | **26** | **230** | **460** | **31200** |
| **Manger Room** | **Bulbs** | **1** | **Energy Saver** | **Fluorescent** | **15** | **15** | **0.66** | **0.66** | **100** | **100** | **9.9** |
| **Sockets** | **1** |  | **Double Socket** | **4600** | **4600** | **40** | **40** | **230** | **230** | **184000** |
| **Welder Room** | **Bulbs** | **1** | **Energy Saver** | **Fluorescent** | **15** | **15** | **0.66** | **0.66** | **100** | **100** | **9.9** |
| **Sockets** | **1** |  | **Double Socket** | **4600** | **4600** | **40** | **40** | **220** | **220** | **184000** |
| **Welder toilet** | **Bulbs** | **1** | **Energy Saver** | **Fluorescent** | **15** | **15** | **0.66** | **0.66** | **100** | **100** | **9.9** |
| **Production hall** | **Bulbs** | **7** | **Energy Saver** | **Fluorescent** | **60** | **420** | **0.26** | **1.82** | **100** | **700** | **764.4** |
| **Extension** | **1** |  |  | **3120** | **3120** | **13** | **13** | **220** | **220** | **40560** |
| **Bluetooth** | **1** |  |  | **5** | **5** | **1** | **1** | **5** | **5** | **5** |
| **Sockets** | **6** |  | **Single Socket** | **600** | **3600** | **13** | **78** | **230** | **1380** | **280800** |
| **Oil Storage Area** | **Bulbs** | **5** | **Energy Saver** | **Fluorescent** | **60** | **300** | **0.26** | **1.3** | **100** | **500** | **390** |
|  |  |  |  |  |  | 46930 |  | 434.57 |  | 6965 | 20394370.1 |

The total power consumption for all appliances across the building is 46,930W (46.93 kW), and the total current requirement is 434.57A.

### **Energy Consumption**

The cumulative energy consumption for all appliances used within the building was calculated to be approximately **10,197,185.05 Wh (10.2 MWh)** per operational cycle. This figure considers the total power demand and operating hours for all electrical devices. Such a high energy consumption level emphasizes the need for careful power management to ensure system efficiency and to mitigate the risk of power overloads, particularly during peak operational hours.

## 2.0 **Methodology**

The FMEA methodology involves the following key steps:

1. **Identification of Failure Modes**: The potential failure modes for each appliance, such as overheating, overloading, and power surges, were identified based on their power, voltage, and current ratings.
2. **Effect Analysis**: The potential effects of each failure mode were analyzed in terms of system performance, safety risks, and operational impact.
3. **Risk Assessment**: Risk was evaluated by considering the severity, likelihood of occurrence, and the ability to detect the failure modes.
4. **Prioritization**: Risks were ranked based on their potential to disrupt operations and safety. The analysis focuses on high-consumption areas, particularly sockets and high-power appliances.
5. **Recommendations**: Mitigation strategies were suggested to minimize the risk of electrical failures, improve safety, and optimize energy efficiency.

### **Key Findings**

The following key issues were identified during the FMEA:

#### ****Overloading Risks****:

* + The admin building's sockets and heaters are among the highest energy consumers, drawing significant amounts of power and current. The sockets in particular (4600W each) present a potential risk for electrical overloads if multiple devices are connected simultaneously, especially during periods of peak energy consumption.
  + The admin building heater, which consumes 20,000W and requires a current of 9.1A, poses a major risk for circuit failure or overheating if not properly regulated.

#### ****Frequent Burnouts in Bulbs****:

* + Fluorescent energy-saver bulbs used in multiple locations (entrance, store rooms, production hall) consume relatively low power (60W each), but due to the total quantity in use, there is a cumulative risk of frequent burnouts or power surges. This could lead to higher maintenance costs and increased downtime in case of failures.

#### ****Extension Overload****:

* + Extensions in areas such as the CEO office and welder toilet also present risks of overload, particularly if high-power devices are connected. The extension in the CEO office is rated for 3120W, which is manageable under normal conditions, but overloading could occur if additional devices are connected without monitoring.

#### ****Energy Inefficiencies****:

* + Despite the presence of energy-saving devices, such as fluorescent bulbs, the overall energy consumption of **10.2 MWh** indicates a potential for further optimization. The building's high total voltage (6965V) and current levels suggest inefficiencies in power distribution and usage, particularly in areas with higher consumption.

#### ****Current Fluctuations****:

* + Some areas, such as the CEO office and kitchen, experience higher-than-normal current flow due to appliances like heaters, desktop computers, and fridges. Fluctuations in current could lead to device failures or reduced equipment lifespan if not carefully managed.

#### ****Socket Reliability****:

* + Sockets across various rooms (especially double sockets) show consistent power ratings of 4600W per unit. While these sockets are designed to handle heavy loads, the cumulative impact of high-energy devices could weaken circuit reliability over time.

#### ****Power Distribution and Total Energy Impact****

The cumulative power consumption and energy impact reveal significant demand on the office’s electrical infrastructure. The total energy usage for all appliances is **10.2 MWh**, a substantial load for the building. High-consumption devices like heaters, fridges, and desktop computers contribute to a large portion of this energy usage, particularly during extended operation. The voltage stability across the building appears sufficient, but consistent monitoring and power balancing are essential to avoid overloads and failures.

## **Conclusion**

The analysis highlights several areas where improvements can be made to reduce risks and improve the energy efficiency of the building. By implementing the recommended mitigation strategies, such as reducing the load on individual sockets, upgrading high-energy-consuming devices, and enhancing maintenance protocols for lighting systems, the overall safety and operational reliability of the electrical infrastructure can be significantly enhanced.

The total energy consumption of **10.2 MWh** serves as a baseline for assessing further energy-saving initiatives and optimizing power usage across the building

# Chapter 2

## Induction Training

### **Introduction**

On the 20th, a field induction was conducted for workers involved in the construction of an oil facility in the company. The primary objective of this activity was to provide essential training on personal protective equipment (PPE) and safety measures necessary for ensuring worker safety in a construction environment.

### **Objectives**

The key objectives of the induction were:

1. To educate workers on the importance and proper use of PPE.
2. To highlight safety protocols relevant to the construction of oil facilities.
3. To demonstrate the maintenance of safety equipment to ensure its effectiveness.

### Induction Overview

The induction program comprised several key components, including presentations and practical demonstrations.

### 1. **Toolbox Talks**

Toolbox talks were conducted to initiate discussions about workplace hazards and safety practices. Workers were encouraged to share their experiences and concerns regarding potential risks they might face on-site.

### 2. **Personal Protective Equipment (PPE)**

The following types of PPE were emphasized during the induction:

* **Safety Helmets**: Importance of wearing helmets to protect against head injuries from falling objects and the necessity of ensuring proper fit.
* **Safety Boots**: Discussion on the various types of safety boots, emphasizing the need for steel-toe protection and slip resistance.
* **Flashes**: Instruction on the use of flashers for visibility in low-light conditions, to prevent accidents.
* **Safety Goggles**: The necessity of goggles to protect the eyes from debris and harmful substances during construction activities.
* **Safety Gloves**: Overview of different glove types suited for specific tasks, focusing on hand protection.

### 3. **Maintenance of Equipment**

Workers were educated on the proper maintenance of PPE, which included:

* Regular inspection for damage or wear.
* Proper cleaning procedures to maintain hygiene and functionality.
* Guidelines for the safe storage of equipment when not in use.

### Conclusion

The field induction conducted in Makeni successfully provided workers with essential knowledge regarding the use and maintenance of PPE, alongside crucial safety measures for construction activities. Ensuring adherence to these protocols is vital for minimizing workplace accidents and injuries.

### Recommendations

To further enhance safety awareness and training:

* Implement regular follow-up sessions to reinforce safety practices.
* Provide hands-on training opportunities to familiarize workers with the equipment.
* Establish a feedback mechanism to gather workers' insights on safety concerns and suggestions.

# Chapter 3

## Step Up Transformer

### Introduction

A step-up transformer is an essential electrical device used to increase the voltage level from the input (primary side) to the output (secondary side). It plays a vital role in power transmission and various industrial applications, operating on the principle of electromagnetic induction. This report explains the working mechanism, key uses, and advantages of step-up transformers.

### Working Principle

The step-up transformer functions based on **Faraday’s Law of Electromagnetic Induction**, which states that a change in magnetic flux induces an electromotive force (EMF) across the windings. The transformer consists of two coils: the **primary coil** (connected to the input) and the **secondary coil** (where the output is drawn). In a step-up transformer, the number of turns in the secondary coil is greater than the primary coil, leading to an increase in voltage on the secondary side.

The voltage ratio between the primary and secondary sides is determined by the following formula:

Vs/Vp =Ns/Np

Where:

* V s is the secondary voltage,
* Vp is the primary voltage,
* Ns is the number of turns in the secondary coil, and
* Np is the number of turns in the primary coil.

This shows that the output voltage increases in proportion to the ratio of the turns in the windings. Conversely, as the voltage increases, the current on the secondary side decreases to conserve power (ignoring losses).

### Uses of Step-Up Transformers

Step-up transformers are widely used in various fields due to their ability to efficiently increase voltage levels. The key applications include:

1. Power Transmission  
   One of the primary uses of step-up transformers is in electrical power transmission. After electricity is generated at power plants, its voltage is stepped up for efficient long-distance transmission. This reduces power losses that occur due to resistance in the transmission lines. For example, transformers step up voltage from 11 kV to much higher levels like 132 kV or more.
2. Industrial and Domestic Equipment  
   Many electrical devices require higher operating voltages than those supplied by standard power outlets. Step-up transformers are commonly used in equipment like microwave ovens, X-ray machines, and other industrial devices that operate at high voltages.
3. Renewable Energy Systems  
   Step-up transformers are crucial in renewable energy setups such as solar and wind power. Solar panels and wind turbines often generate low-voltage power, which needs to be stepped up to a higher voltage suitable for feeding into the electrical grid.
4. Testing and High-Voltage Applications  
   In industrial and research settings, step-up transformers are used for high-voltage testing. This includes testing electrical components, insulation materials, and other equipment that requires elevated voltage levels for performance evaluation.
5. High-Voltage AC Systems  
   Step-up transformers are integral to HVAC (High Voltage Alternating Current) systems used for distributing electricity over long distances. By increasing the voltage, these transformers ensure efficient power distribution, minimizing energy losses.

## Advantages

* **Reduction in Power Losses**: Stepping up the voltage for power transmission minimizes energy loss due to resistance in transmission lines. Higher voltage levels lead to lower current, which reduces heat generation and power dissipation.
* **Cost-Effective Power Distribution**: Step-up transformers make long-distance power transmission feasible and economical, reducing the need for additional generation stations.
* **High Efficiency**: These transformers are typically very efficient, with efficiency rates between 95% and 99%.
* **Reliability**: With no moving parts, step-up transformers are highly reliable and require minimal maintenance.

## Disadvantages

Despite their numerous benefits, step-up transformers have a few limitations:

* **Initial Cost**: The installation of large transformers, especially for grid-scale applications, can involve significant initial investment.
* **Size and Weight**: High-capacity transformers used in power transmission are often large and heavy, making them difficult to install and transport.
* **Harmonic Distortion**: In some cases, step-up transformers can cause harmonic distortion, which can interfere with the operation of sensitive electrical devices.

## Conclusion

In conclusion, step-up transformers are critical components in modern electrical systems. Their ability to increase voltage efficiently has made them indispensable in power transmission, industrial applications, and renewable energy systems. Despite some limitations, their high efficiency and reliability make them an essential part of today’s energy infrastructure.