THE UNITED REPUBLIC OF TANZANIA

NATIONAL AUDIT OFFICE

PERFORMANCE AND SPECIALIZED AUDIT DIVISION

PERFORMANCE AUDIT REPORT ON MAINTENANCE OF POWER GENERATION PLANTS

A REPORT OF THE CONTROLLER AND AUDITOR GENERAL OF THE UNITED REPUBLIC OF TANZANIA

MARCH, 2019

THE UNITED REPUBLIC OF TANZANIA

National Audit Office

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PREFACE

The Public Audit Act No. 11 of 2008, Section 28 authorizes the Controller and Auditor General to carry out Performance Audit (Value for-Money Audit). This is for the purposes of establishing the economy, efficiency and effectiveness of any expenditure or use of resources in the Ministries, Departments and Agencies (MDAs), Local Government Authorities (LGAs) and Public Authorities and other Bodies which involves enquiring, examining, investigating and reporting, as deemed necessary under the circumstances.

I have the honour to submit to His Excellency the President of the United Republic of Tanzania, Dr. John Pombe Joseph Magufuli and through him to the Parliament of the United Republic of Tanzania the Performance Audit Report on the Maintenance of power generation plants. The main audited entity was TANESCO.

The report contains findings of the audit, conclusion and recommendations that have focused mainly on conducting risk based maintenance.

TANESCO has been given the opportunity to scrutinize the factual contents and comment on the draft report. I wish to acknowledge that the discussions have been very useful and constructive.

My office intends to carry out a follow-up audit at an appropriate time regarding actions taken by TANESCO in relation to the recommendations of this report.

In completion of the assignment, the office subjected the report to the critical reviews of Dr. Hassan Rajabu from University of Dar es Salaam and Eng. Boniface S. Njombe independent Consulting Engineer in Mechanical and Energy who came up with useful inputs on improving this report.

This report has been prepared by Eng. Andrew E. Kellei -Team Leader and Mr. Andrew Kazembe - Team Member under the supervision and guidance of Mr. Michael Malabeja - Audit

Supervisor, Eng. James G. Pilly – Assistant Auditor General and Mr. Benjamin Mashauri – Deputy Auditor General.

I would like to thank my staff for their assistance in the preparation of this report. My thanks should also be extended to the audited entities for their fruitful interaction with my office.

Prof. Mussa Juma Assad
Controller and Auditor General
The United Republic of Tanzania
March, 2019

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LIST OF ABBREVIATIONS

CMMS	Computerized Maintenance Management System
EPC	Engineering Procurement and Construction
PMU	Procurement Management Unit
HQ	Headquarters
ISO	International Standards Organization
KPIs	Key Performance Indicators
MoE	Ministry of Energy
MW	Megawatt
PE	Procuring Entity
PPA	Public Procurement Act
PPR	Public Procurement Regulation
PSMP	Power System Master Plan
TAPROS	TANESCO'S Procurement system
TNA	Training Needs Assessment
TZS	Tanzania Shillings

EXECUTIVE SUMMARY

Efficient and effective maintenance of power plants is important to ensure reliable power generation. The obligation to ensure availability of reliable power supply at relatively lower cost has been assigned to Tanzania Electric Supply Company (TANESCO). This will be achieved if TANESCO adequately maintains its power generation plants. The Ministry of Energy has also been given an oversight role to ensure that TANESCO achieve its role.

The main objective of the audit was to determine whether TANESCO conducts risk based maintenance of power generation plants to ensure sustainable power generation. The audit covered maintenance activities during three years period i.e. from 2015/16 to 2017/18.

The audit team used interviews, document reviews and site visit for data collection in undertaking this audit. Interviews and documents were examined at TANESCO headquarters, at power generation plants and at the Ministry of Energy. Also, observations through a number of physical visit to power generation plants.

Main Audit Findings

Inadequate Management of procurement of spare parts and vendors for maintenance of power plants.

TANESCO inadequately implemented annual procurement plans resulted from delays in procurement of required spare parts as well as not implementing the existing TANESCO's Procurement system (TAPROS) at plants level. Also, TANESCO did not carry out adequate market price research for procurement of spare parts.

Inadequate implementation of Annual Procurement Plans

Annual procurement plans were not implemented as expected. This is contributed by cost of items to be procured exceeding the given budget ceiling, lack of prioritization, denial of permission for outage time, late submission of specifications by user department to Procurement Management Unit (PMU) and long procurement process at PMU HQ.

In financial year 2017/18, twenty seven (27) tenders out of 59 from generation department business unit equivalent to 46% of all tenders were not initiated one of the reasons being lack of specifications from users.

TANESCO's Procurement system (TAPROS) is not implemented at some plants

TANESCO does not apply TAPROS at power plants level. The system is only applied at Headquarters, Zonal Offices as well as regional offices. This reduced real-time visibility of procurement activities in maintenance of power generation plants due to usage of manual system. This resulted in poor monitoring and tedious tracing of stages at which initiated procurement process has reached.

Consequently risks and mitigation measures pertaining to procurement of works, spares, working tools and vendors cannot be visible from Headquarters and Zonal offices.

Inadequate market price research for the Procurement of spare parts

There were some items which were over budgeted by up to 99% and under budgeting of up to 116% which gives an indication of not conducting adequate market price research.

TANESCO lacks specialized skills in thermal plants

TANESCO did not adequately execute training plans for specialized skills in maintenance of thermal power generation plants; partially conducted Training Needs Assessment (TNA); and lacks preparedness to cope with changes in technology.

Inadequate training on specialized skills in maintenance of power generation plants

Technical staff were rarely trained on the basis of their gaps and needs despite the fact that, the technology is changing and there is a need to be up to date with the change of technology.

TANESCO failed to attach its staff to manufacturers so as to acquire specialized skills. For the last three years, 15 (fifteen) staff from Kinyerezi I were trained abroad on issues of package familiarization, control and maintenance which does not reflect the Training Needs Assessment. TANESCO focused on the numbers of personnel to be trained instead of quality and items for training.

Training needs assessment was partially conducted

Training Needs Assessment was conducted by distributing 2,358 questionnaires to Power Plants, Regions and Head Office Departments. The distributed questionnaires were only 36% of the Company's workforce. It was not clear to what extent the questionnaires were reflective of training requirements by the Strategic Plan and how they were analysed.

Lack of preparedness to cope with changes in technology

TANESCO was lacking proactive plans that prepare its staff to keep pace with power generation technologies. The practice requires TANESCO to put a clause that ensures each contractor has an item of technology transfer and capacity building.

TANESCO inadequately conducts risk based maintenance of power generation plants

Although TANESCO has been conducting preventive maintenance, the breakdowns have been occurring resulting to power disruption, and other associated risks. This was a result of inadequate identification of maintenance risk and non-prioritization of identified risk.

Inadequate identification of maintenance risk

TANESCO lacks maintenance risk framework. All visited TANESCO power plants were lacking performance trends and failure analysis and history for power generation machines and spare parts. Also, TANESCO only keeps records of preventive maintenance activities, but does not keep failure analysis, failure frequency and impacts.

Non-prioritization of risks for conducting maintenance of power generation plants

TANESCO conducted limited scheduled maintenance activities. Some worn parts were neither repaired nor replaced when there was a scheduled preventive maintenance.

Inadequate Execution of Risk based Maintenance

TANESCO did not conduct Risk based Maintenance but it rather conducted Preventive maintenance. Optimal asset management of power system components based on analysis of technical condition, residual life, risk, profitability and optimal timing of maintenance and reinvestments was not done.

Ineffective prioritization of the budgeted fund to the plants with critical conditions

There were inconsistences in the use of funds allocated for maintenance activities. The inconsistences were in spending more than the amount budgeted and in one financial year only twenty percent of the budgeted amount was utilized. While utilizing only 21% (2016/17) and 48% (2017/18) of the budgeted amount for maintenance, there were plants such as Pangani, Nyakato and Sumbawanga which needed major overhaul but they were not maintained due to lack of funds.

Inadequate maintenance reporting mechanism for power generation plants by TANESCO and the Ministry of Energy

TANESCO and the Ministry of Energy have inadequate reporting mechanism for maintenance activities of power generation activities enabling management to make informed decisions regarding maintenance of power generation plants.

Not all reports submitted to the Ministry of Energy have information on maintenance of power generation. Consequently, TANESCO and Ministry of Energy lack substantial information for maintenance of power generation plants. Non-existence of reporting structure resulted to lack of emphasis on effective maintenance of plants.

Insufficient monitoring of power generation plants maintenance by TANESCO

TANESCO insufficiently monitors power generation activities. TANESCO could not meaningfully turn its Corporate Business Plan into actionable plans. The Internal Audit Department of TANESCO conducted technical audits. Although the audit was substantial for technically monitoring maintenance activities, coverage and frequency of the exercise did not give assurance of performance improvement.

Inadequate monitoring tool for maintenance activities

There is inadequate monitoring of maintenance activities by TANESCO and the Ministry of Energy. This tool could have helped power generation plants to easily execute maintenance activities. Ultimately the system could have helped the power plants to minimize unnecessary breakdowns, downtime, and running costs. This inhibited TANESCO to have maintenance information to enable prompt reporting and responding to maintenance issues.

Inadequate monitoring of power generation plants by the Ministry of Energy

The Ministry of Energy did not adequately monitor power generation plants. The role of the Ministry was to ensure availability of adequate power at relatively reduced cost. The Ministry did not analyse submitted reports to establish trend in information regarding maintenance of power generation plant. Consequently, the Ministry could not adequately monitor the effect of maintenance on ensuring availability of power generations at relatively reduced cost.

Overall Audit Conclusion

TANESCO inadequately conducted risk based maintenance of its power generation plants to ensure quality electricity supply and generation capacity was enough to meet peak demands throughout the year and in all regions of the country. TANESCO did not adequately manage procurement of spare parts and vendors for maintenance of power generation plants with due regard to

timelines, cost effectiveness and quality. Also TANESCO did not set and disburse adequate funds for maintenance of the plants and did not have adequate plans to have in-house specialized skills needed to conduct maintenance of power generation plants. Both TANESCO and Ministry of Energy did not adequately monitor activities for maintenance of power generation plants.

Audit Recommendations:

Ministry of Energy should:

1. Ensure that it is informed by TANESCO on the maintenance and condition of plants and document action to be taken on a regular basis;
2. Put in place guidelines with measurable deliverables to ensure maintenance of power generation plants, including Risk Based Maintenance is adequately conducted to ensure available electricity in the country, generated at lower cost; and
3. Form a team of long experienced experts to periodically do advisory services to MoE management on TANESCO key and critical issues.

TANESCO should:

1. Ensure procurement processes are conducted under strict adherence to existing laws and regulations and in a timely manner and APPs are initiated immediately after budgets are approved;
2. Ensure EPC contracts are exhaustive and to include specialised skills and certified training of critical systems. Also training courses need to be closely supervised evaluated and monitored;
3. Capacitate the maintenance staff in all its plants and equip its workshops with required working tools to enable in-house repairs and modifications;

4. Implement a computerized procurement system to all plants whereby its procurement status can be monitored and accessed at all levels;
5. Put in place a mechanism that will allow innovations and creativity for maintenance activities especially those requiring specialized skills (rewards should be provided for creativity and innovations);
6. Adequately conduct market research for all procurements and high risk machine parts should be prioritized and establish supplier and vendor data base as well as price data base for each plant;
7. Formulate a risk maintenance framework which shows performance trends, failure analysis and history and analysing failure duration and impact;
8. Ensure sustainable and regular maintenance audits covering all power generation plants;
9. Standardize the format of reporting from power plants to the Ministry such that all issues that need to be monitored by the Ministry are covered and presented in the same manner in all plants;
10. Procure major equipment from original manufacturers and not supplying companies. This shall commit the manufacturers to provide proper specialized training and enhance traceability of spare parts in the future; and
11. Create a power generation forum whereby all generation plants (including private owned plants) will participate and share experience, challenges and successes.

CHAPTER ONE

INTRODUCTION

1.1 Background

The demand of power in many developing countries has been a major challenge as there is shortage of power generation due to various reasons ranging from economic, environmental, lack of proper strategies. Most of these countries experience frequent power interruptions, intermittent supply and large-scale blackouts. Over the years, power outages have contributed to slow economic development in these countries. Serious impacts have been noted by looking through the life of local communities, customers, utilities, all complaining on their economic losses.

The government of Tanzania had set an ambitious target to minimize power interruption. The plan is to ensure that it increases power generation and improve the maintenance of available power generation plants, and its transmission and distribution systems. The government targets to increase electricity generation to 4,915 MW by 2020 and increase electricity connections to 60 percent of the population, up from 36 percent in 2015[1]. Some of challenges characterizing the electricity sub-sector include inefficiencies of electricity supply due to old and poor infrastructures and costly electricity generation. All these have constrained the sub-sector's ability to enhance the envisaged target of accelerating industrialization and economic transformation.

Although effective maintenance of power generation plants is the most crucial process in ensuring the prolonged operational lifetime of power plants, this activity has not been well addressed and managed. Ideally, power plants maintenance as an important activity needed a significant proportion of the budget on power generation. However, in some cases management considers minimizing the maintenance costs by encouraging ad hoc repairs.

1.2 Motivation for the audit

The audit was motivated by the following observations: TANESCO's inadequate capacity for maintenance of hydropower plants; Frequent

[1]Ministry of Finance and Planning (2016), National Five Year Development Plan 2016/17 -2020/21

power blackout to Regions connected to the national power grid; Outdated tools, old machines and infrastructure for hydropower; and low priority given in maintenance of plants and infrastructure.

a) *TANESCO's inadequate capacity for maintenance of hydropower plants.*

TANESCO lacks capacity in terms of funds and specialized skills to conduct major rehabilitation of hydro power plants. This called upon the Norwegian Government to enter into contract with TANESCO to assist TANESCO with funds and capacity to conduct hydropower plants repair and prepare a scheme of planned maintenance in November 2011[2]. They prepared a program activity which was expected to complete in year 2017.

The Program Document and Institutional Cooperation Agreement between TANESCO and Norwegian Government, highlighted areas of cooperation that included: Assisting TANESCO for emergency upgrading and immediate training of the personnel; and increasing professional level and knowledge of the staff at TANESCO, and sufficient capacity to reach the goals set in the Power Sector Reform Strategy. Taking into consideration of the highlighted areas of cooperation, it is obvious that, those are areas that TANESCO needed to strengthen.

b) *Frequent power blackout to the Regions connected to the national power grid*

In November 2017, all regions connected to the national grid lost electricity supply due to a technical glitch in the national power grid. Reuters[3] reported that, partial blackouts occur regularly in Tanzania which relies on hydro, natural gas and heavy fuel oil to generate electricity. The effects of these outages have been affecting industrial investments and business.

[2]"Capacity Building and Emergency Repair of Existing Hydro Power Plants in Tanzania" Norwegian Water resources and Energy Directorate

[3]https://www.reuters.com/article/tanzania-power/update-1-tanzania-suffers-national-power-outage-after-technical-fault-supply-company-idUSL8N1O01H7

c) *Outdated tools, old machines and infrastructure for hydropower*

Hydro power generation plants have an outdated technology since 70% were installed a decade ago. Outdated tools and machines require reinstallation and frequent maintenance otherwise the operation cost becomes higher than operating new machines/plants. If proper maintenance will not be conducted, there is a risk of losing more than 52% of total power generation capacity in the national grid as improper and ineffective plant maintenance may adversely affect a wide range of plants.

d) *Low priority is given in maintenance of plants and infrastructure*

Songas Power Generation Plant is considered to be one of the efficient power generation plants. One of the reasons for their efficient production is the high priority they put on maintenance. According to the Citizen Newspaper[4] , on June 2, 2017 General Engineering Power Services business and Songas signed a multiyear service agreement to upgrade, maintain and repair the gas turbines. This was expected to increase the efficiency of the plant to around 41 percent which is an increase of 10 MW.

Due to the above indications of problems, the National Audit Office of Tanzania decided to conduct a performance audit on Maintenance of power generation plants to assess whether TANESCO conducts risk based maintenance according to good practices and experience obtained after running the plants over the years.

1.3 Design of the Audit

1.3.1 Audit objective

To determine whether TANESCO conducts risk based maintenance of its power generation plants to ensure undisruptive power generation and increase availability of plants.

[4]http://www.thecitizen.co.tz/News/Business/Songas-plants-to-produce-more-power-after-GE-deal/1840414-3952552-hqm6y1/index.html

Specific objectives:

To determine whether:

1. TANESCO adequately manages procurement of spare parts and vendors for maintenance of power generation plants with due regard to timeliness, cost effectiveness and quality;
2. TANESCO has capacity to conduct maintenance of power generation plants;
3. TANESCO has a mechanism and tools to identify and prioritize maintenance according to the conditions in the power generation plants, and
4. TANESCO monitors maintenance of the power generation plants; and
5. Ministry of Energy monitors maintenance of the power generation plants.

1.3.2 Scope of the Audit

The audited entity was Tanzania Electric Supply Company Limited (TANESCO) which has the role on the implementation of the underlying policy and regulations regarding maintenance of power generation plants. The audit looked on how TANESCO planned, executed, reported, evaluated and monitored activities related to preventive maintenance of power generation plants following the existing policies, laws, regulations and other guidelines on power generation plants in Tanzania.

The audit examined the extent to which TANESCO conducts risk based maintenance of power plants to ensure sustainable power generation in the country. The Audit was conducted at TANESCO HQ-Dar es Salaam and Dodoma, and at Power generation plants using natural gas including Kinyerezi I, Ubungo II and Mtwara; Nyakato (HFO), Sumbawanga (diesel) and hydropower plants including Kidatu, Hale, New Pangani, and Mtera.

The audit took a period of four months from December, 2018 to March, 2019. Information collected covered three years from 2015/2016 to 2017/2018, to allow auditors to conduct in-depth review and analysis for the purpose of establishing the trend of the problems associated with maintenance of power plants in the country. The audit was conducted after the National Energy policy (2015) was introduced and the Power System Master Plan (2016) was updated.

The audit focused on assessing guiding documents for maintenance, capacity of TANESCO to conduct maintenance, system for supervision and monitoring of maintenance of power generation plants. Also, the audit evaluated challenges affecting risk based maintenance of power generation plants.

1.3.3 Methods for Data Collection and Analysis

In undertaking the audit, purposive random sampling was applied to sample areas to visit. Sampled hydro and thermal power generation plants were visited. Interviews, documents review and field visits were used for data collection.

The following documents were reviewed: Electricity Act (2008), TANESCO Strategic Plan 2017/18 - 2020/21, TANESCO Corporate Business Plan (2016/17), Public Procurement Act (2011), Public Procurement Regulations (2013), Public Procurement Act Amendment (2016), ISO 9001:2008, Performance Maintenance Plans, Procurement Plans, Work plans and Maintenance Budgets, Action Plan 2015/16 – 2017/2018. Other documents reviewed include; Power Plants Generation Performance reports, Maintenance reports, Maintenance Risk Registers, Training Needs Analysis and Maintenance Service Contracts.

Interviews were conducted to management staff involved in decision making, execution and support of maintenance of power generation plants. Interviews were also conducted with Officials from the Ministry of Energy (MoE) responsible for TANESCO and maintenance issues for Monitoring purposes. Furthermore, during the visits to the power plants plant Managers, Engineers, Human resource, Supplies and budget officers (accountants) were interviewed in all visited plants.

1.3.4 Assessment Criteria

The criteria used to assess performance of TANESCO in managing maintenance activities include: Procurement of spare parts and services for maintenance of power generation plants; Capacity to conduct maintenance of power generation plants; Risk identification, prioritization and their application in power generation plants maintenance; and Monitoring activities for maintenance of power generation plants in collaboration with the Ministry of Energy.

(i) Procurement of spare parts and services for maintenance of power generation plants

TANESCO strategic Plan (2017/18-2020/21) (1.3.1.1(a)) required management to ensure maintenance of all power generation plants is conducted in a manner that ensures maximum plant availability and efficient utilization.

This is complimented by Regulation 5(2) (b) of Public Procurement Regulations (PPR) (2013) requiring procured goods, works, or services to be appropriate to the requirements. Section 63 (2) of PPA (2011) requires all procurement to be conducted in a manner that maximizes competition and achieve economy, efficiency, transparency and value for money. Procurement is categorically required by Regulation 5(2) (c) of this regulation that it should be completed timely, cost effectively and by ensuring quality.

Section 49(1) (d) which requires PEs to integrate its procurement budget with its expenditure programme, Regulations 69(3) to (7) which requires PEs to forecast, estimate optimum time, ensure adequate funding, preparation of estimates basing on market prices, prepare a reflective procurement plan.

Further PPA (2011) Section 50 and PPR (2013) No. 131, 136 and 137 require TANESCO to procure common/frequently used goods using framework contracts.

(ii) Capacity to conduct maintenance of power generation plants;

Section 6.2.2 of International Standards Organization (ISO 9001:2008) (best practice) requires TANESCO to ensure necessary competence is acquired by personnel performing technical work. This is also required by section (3) and (4) of TANESCO Corporate Business Plan 2016/2017 requiring TANESCO to attain competency requirements for its personnel by managing training plans and coordinating all corporate trainings as required by needs.

A contract engagement best practice requires a procuring entity to ensure knowledge transfer for enhancement of staff capacity is part of the negotiation with contractors before contract signing.

Furthermore, TANESCO Corporate Plan (2016/17) requires the company to ensure availability of adequate tools, equipment and technology for maintenance of power generation plants.

(iii) Risk identification, prioritization and their application in power generation plants maintenance

According to Section 9 of Corporate Business Plan 2016/17, TANESCO is required to avoid equipment performance degradation or failure through operational risk management. TANESCO is also required by Section 9 of the same plan to strategize and conduct operational risk evaluation and mitigation to ensure timely delivery of services.

Specifically, section 63 (1) (c) of Public Procurement Regulations (2013) requires TANESCO to identify, specify and prioritize the immediate procurement activities which may be used in the period of the emergency.

(iv) Monitoring activities for maintenance of power generation plants in collaboration with the Ministry of Energy

Regulation 114 (b) of PPR (2013) requires TANESCO to monitor the progress and timely completion of maintenance works in accordance with the terms of each contract. TANESCO is also required by section 6.5 of Corporate Business Plan (2016/17) to ensure targets are met and promotes a better follow up of KPIs within the company.

Furthermore regulation 114 (c) of PPR (2013) requires TANESCO to take or initiate steps to correct deviations from observance of contract condition. The Ministry of Energy, being the parent ministry is also required to monitor activities of TANESCO including maintenance of power generation plants.

1.4 Standard used for the Audit

This audit was undertaken through International Standards of Supreme Audit Institutions (INTOSAI). It was also implemented by following a guideline of conducting performance auditing of the National Audit Office of Tanzania.

1.5 Data Validation Process

TANESCO have been given opportunity to correct factual errors in the draft report. We wish to put on record that the meetings with TANESCO have been constructive.

1.6 Structure of the Report

This report contains five chapters. Chapter 1 introduces the audit by giving background information, motivation of the audit, audit objective, scope, methods for data collection and analysis as well as assessment criteria. Chapter 2 provides governing legislation, description of the audit area and processes involved in risk based maintenance for power generation plants.

Chapter 3 provides findings of the audit. Chapter 4 provides the conclusion of the audit and Chapter 5 presents the audit recommendations for future improvements.

CHAPTER TWO

THE GOVERNING LEGISLATIONS AND SYSTEM DESCRIPTION

2.1 Introduction

This chapter describes Maintenance practices, governing policies and legislations as well as process involved in maintenance of power plants. It gives insight on power plant maintenance planning, execution and reporting.

2.2 Governing Policies and Legislations on Maintenance Issues

Maintenance of power generation plants is governed by various instruments at policy and legislation level.

2.2.1 Policies

At policy level, maintenance of power plants is governed by National Energy Policy (2015). Section 3.1.1 of the Policy indicates that, the government intends to meet the growing demand for electricity generation. The government intends to ensure cost reflective tariff for electricity services to attract both public and private sector investments; and ensure use of modern and efficient technologies in electricity generation. The five year development plan (2016/17-2020/21) targets increased power generation from a mix of energy sources.

2.2.2 Governing Legislations

Governing legislations for maintenance of power generation are Electricity Act (2008), Public Procurement Act (2011); Regulations for Public Procurement (2013); Electricity (System Operation Services) Rules (2016) and Energy and Water Utilities Authority Acts, (2001) and (2006).

EWURA Act sets conditions to Licensee on maintenance of plants to ensure a sustainable power supply and realistic cost of power production.

Electricity Act, 2008

The Electricity Act 2008 outlines rules for the generation of electricity of which maintenance is involved. It specifies legal procedures for facilitation and regulation of generation.

Public Procurement Act (2011); Public Procurement Regulations (2013)

The Public procurement Act 2011 guides all procurement in a manner that maximizes competition and achieves economy, efficiency, transparency and value for money. It requires a procuring entity to prepare its estimates based on prevailing market prices as updated from time to time.

The Public Procurement Regulations guides a PE when undertaking or approving procurement by tender, in choosing appropriate procedures and cause the procurement to be carried out diligently and efficiently, so that the prices paid by the PE represent the best value that can reasonably be obtained for the funds applied for.

Furthermore, the PPR (2013) guides a PE in procuring goods, works or services to ensure quality, appropriateness to the requirements and the goods are delivered, the services are provided, works are completed in a timely manner.

Electricity (System Operation Services) Rules, 2016 of Electricity Act (Cap 131)

Section 40 (1) *of Electricity Act (Cap 131)* requires a licensee to carry out preventive maintenance, replacement, restoration or any other construction that may lead to an interruption, to issue a public notice thereof, not less than two days prior to undertaking such activity.

Section 2 (c) requires a licensee to carry out all works related to the conduct of system operations activity, including engineering, construction, rehabilitation, operation and maintenance of a licensed facility in accordance with relevant laws and Prudent Utility Practices. Electricity (System Operation Services) rules refers Prudent Utility Practices as good practices, methods, and procedures attained by exercising a degree of skill, diligence, prudence, and foresight.

2.2.3 Strategic Objectives and Targets

The National five year development plan 2016/17 – 2020/21 targets by 2020/21 an electricity generation of 4,915 MW which is an increased power generation from a mix of energy sources – gas, hydro and geothermal.

The objectives stated in TANESCO Corporate Business Plan – 2016/17 are sustainable Development of Energy Resources enhanced; and Corporate Image, Quality and Efficiency of Services improved.

The targets are to increase power generation capacity, from 1,058.24 MW (2015) to 4,487 MW by June 2021. This is expected to be achieved by construction and extension of gas fired power plants, hydro, solar and wind; and maintaining availability of existing plants above 90% of installed capacity throughout.

2.3 Actors in Maintenance of Power generation plants

In the context of this audit, actors for maintenance of power generation plants are Ministry of Energy and TANESCO.

2.3.1 Ministry of Energy (MoE)

The Ministry of Energy (MoE) was established in 2017 with the mandate of developing and managing energy resources in Tanzania. MoE is responsible for energy sector policy formulation and implementation of programs including enhancing security of power generation and supply.

For the purpose of maintenance of power generation plants, the Ministry has specific functions to perform such as monitoring power generation; Develop and facilitate the implementation of strategies, including Master Plans and Budget; and facilitate capacity building and enhancing cooperation with stakeholders and development partners.

2.3.2 Tanzania Electric Supply Company Limited (TANESCO)

This is the public company licensed by Energy and Water Utilities Regulatory Authority (EWURA) to generate, transmit and distribute electricity. The company is 100% owned by the Government under the Ministry of Energy (MoE) and specifically supervising TANESCO through the Board of Directors.

TANESCO was granted twenty years terms electricity generation License (No. EGL-2013-001), commencing from 1st March 2013. The company is responsible for conducting maintenance of power generation plants.

2.4 System description for risk based Maintenance

Risk-based maintenance is a method/process that minimises costs, where analysis of technical condition, residual life, risk and profitability and optimal timing of maintenance and reinvestments and hence prioritizing maintenance resources is done. This is intended to avoid failures that may result in major economic, safety and environmental impacts and eventually represent an unacceptable risk for plant owners and society at large. The process helps to identify assets that carry the most risk if they were to fail. It is a methodology for determining the most economical use of maintenance resources. This is done so that the maintenance effort across a facility is optimized to minimize any risk of a failure. It is for this reason that it is more superior over other types of maintenance practices.

Risk based maintenance is a management approach to calculate/estimate amount of risk and propose a hierarchy of maintenance priority based on various equipment risks. The system for risk based maintenance is described by the International Standards Organization (ISO) in ISO 9001:2015. Based on quality management standards, as a potential event that if not properly addressed could harm exposed objects, process or the entire system. The event can be expressed in terms of consequence, impact, or severity of the impact and its related likelihood of occurrence.

The system for risk based Maintenance is comprised of an approach applied in planning execution as well as monitoring maintenance activities. Planning actions in power plants maintenance is expected

to consider time, cost and quality of maintenance activity. The risk based maintenance process involves sequential activities as shown below:

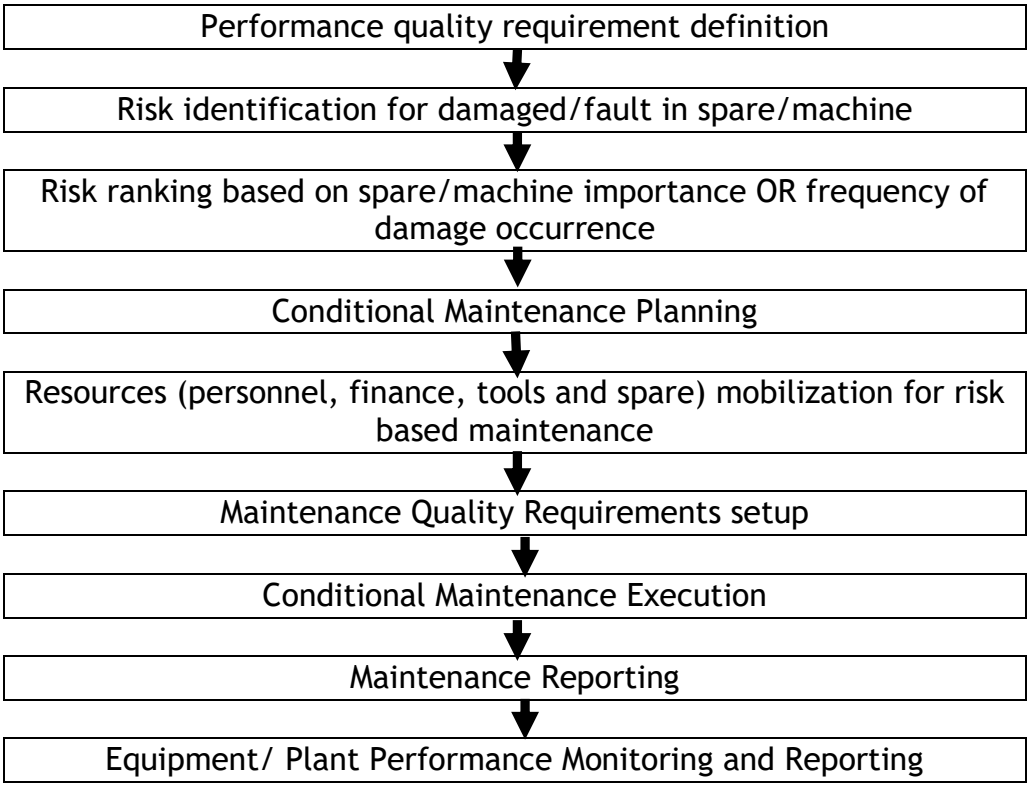

Figure 2.0: Sequential activity Risk based maintenance process
Source: Auditors analysis

2.4.1 Maintenance best practices

Maintenance practices in power generation in TANESCO are expected to adhere to best practices. It is expected TANESCO to develop documented maintenance procedures. These need to be applied in maintenance deployment especially for critical equipment, specifically in sensitive and old plants.

If acquisition of spare parts or service is anticipated in planned or emergency maintenance, then procurement process is initiated and executed. The best practice requires efficient procurement management as well as timely initiation of procurement processes. In this response, TANESCO applies Procurement Management System

(TAPROS), which is a software applied to manage effective and efficient procurement process. This includes the procurement of goods and services for maintenance activities.

2.4.2 Documenting maintenance operations

Maintenance and related activities are to be documented in a Comprehensive database of performance trends and failure analysis and history for critical assets. They should be available and recorded in a computerized system and or recorded in hard copy maintenance registers and should be used for failure history analysis or for monitoring mean time between failures. Failure modes and effect analysis should be an institutional practice.

2.4.3 Maintenance Planning

There should be a dedicated maintenance planning department/section/unit which should effectively be contributing to systematic maintenance planning. Maintenance planning should start from maintenance planning unit. Long term planning such as overhaul tasks expected to be done 2-3 years in advance to avoid inadequate planning and preparation which will lead to extension of shutdown-schedule. Spare parts planning should be carried out on the basis of a systematic analysis of spares requirement to avoid delays during maintenance. Spares for planned-maintenance should be planned in advance by individual maintenance groups so as to be included in annual procurement plans.

2.4.4 Prioritization of maintenance areas

There should be commercial linkages of plant level availability and the reliability of individual equipment. The commercial implications of productivity loss should objectively be assessed in the maintenance decision-making process. Prioritization of maintenance areas should be based on a '*Pareto*' analysis of failures (meaning that, in prioritization of maintenance, those which produce significant effect should be prioritized). You do a 20% of the work and you generate 80% of the benefit of doing the entire job.

2.4.5 Condition Monitoring

Since most of the available power plants (especially hydro plants) are relatively old, there is a need for the use of modern condition monitoring equipment on critical components of the plant and protective control system for the plant to shut down the plant if a critical parameter is exceeded. Absence of adequate condition monitoring systems leads to reactive maintenance practices rather than pro-active maintenance practices. Condition monitoring at the plant with priority basis will facilitate the induction of proactive maintenance at the plant.

Condition Monitoring should result into condition Monitoring Plan which would include check-lists and frequency for equipment monitoring. Equipment monitoring would require a wide selection of techniques including among others Vibration monitor, Shock-pulse monitor, sensors for lubricant oil pressure and temperature.

2.4.6 Pro-Active Maintenance

For a power generating plant to perform well, there should be successful efforts to establish a pro-active maintenance program. The plant Managers should use their equipment reliability, cost and efficiency data to supplement the recommendations of the equipment manufacturers and the utility's first-hand experience.

2.5 Reasons for carrying out risk based maintenance

Maintenance activities are carried out on a utility in order to ensure that it continues to perform its intended functions, or to restore its optimum operating condition. Maintenance is conducted in order to extend equipment lifetime, or at least the mean time to the next failure whose repair may be costly. Furthermore, it is expected that effective maintenance policies can reduce the frequency of service interruptions and many undesirable consequences of such interruptions. Maintenance impacts components and plant performance.

Best practice on management of plants describes maintenance stages as: the process involving planning, execution, monitoring, and control of equipment maintenance activities as shown in Figure 2.1. It is expected that effective maintenance policies can reduce the

frequency of service interruptions and undesirable consequences of such interruptions.

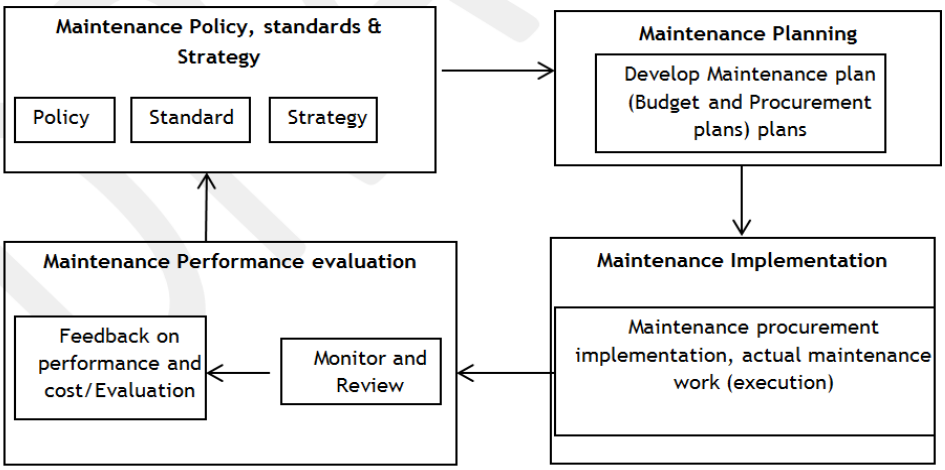

Figure 2.1: Maintenance process

Source: Auditors Analysis

The power plant maintenance system is generally made up of interrelated processes. These include maintenance, documentation of maintenance history, maintenance planning, and prioritization of maintenance area, condition monitoring and conducting pro-active maintenance.

2.6 Sources of funds for TANESCO

The Business Plan 2016/17 took into account the Capital Investment Plan (CIP) to procure, fund and serve an investment stream of TZS 5.314 trillion over the next 5 years. The CIP has assumed sources of funds from but not limited to TANESCO funds (through tariffs), Government subsidies, Development partners' grants and loans (concessional and commercial), REA and other financing institutions.

Table 2.1: Approved budget for plant repair and Maintenance versus Corporate Budget

Financial Year	Corporate Budget (in Billion TZS)	Repair and Maintenance Budget (in Billion TZS)	Percentage(%)
2015/16	1,429.42	30.34	2
2016/17	1,369.51	56.66	4
2017/18	2,262.36	87.99	4

Source: MTEF budget 2017/18

2.7 Monitoring by TANECO and MoE

2.7.1 Monitoring by TANESCO

Monitoring of maintenance activities is stipulated in section 6.5 of TANESCO Corporate Business Plan (2016/17). TANESCO applies tools including computerized tools to capture all required information for management decision. These are tools that are also applied to inform maintenance team and plant management to easily monitor maintenance activities. Information managed using these tools is applied to enable effective maintenance. Reports are then produced using standardized format in order to capture all necessary maintenance information from power generation plants. This helps power plants to minimize unnecessary breakdowns, downtime, and running cost.

2.7.2 Monitoring by the Ministry of Energy

Monitoring process is done by the Ministry of Energy as a parent ministry responsible with policy management. This is done through maintenance reports scrutiny as well as visitation to the power generation plants to make physical observations. Monitoring reports are then produced through standardized reporting structure to capture all necessary maintenance information. Feedback is provided to TANESCO and performance trend tracked using performance indicators by the Ministry. Formalized follow-up mechanism is applied to ensure maintenance is adequately conducted to ensure electricity availability in the country at relatively reduced cost.

CHAPTER THREE

FINDINGS

3.1 Introduction

This chapter presents findings of the audit which address the audit objectives stated in Section 1.3.1 of this report. The audit findings cover four major parts which provide insight regarding maintenance of power generation plants to ensure sustainable power generation. The areas covered are:

i. Procurement of spare parts and vendors for maintenance of power generation plants with due regard to time, cost and quality;
ii. Capacity of TANESCO to conduct and MoE to oversee and monitor the maintenance of power generation plants;
iii. Risk based approach to maintenance; and
iv. Monitoring and Evaluation by TANESCO and Ministry of Energy.

3.2 Inadequate Management of procurement of spare parts and vendors

According to Section 1.3.1.1(a) of TANESCO Strategic Plan (2017/18-2020/21), TANESCO is required to conduct maintenance of all power generation plants to ensure maximum plant availability and efficient utilization of all generation assets. To ensure maximum plant availability, the required spare parts must be available when needed.

Also, Regulation 5 (2) (c) of PPR (2013) requires the goods to be delivered, the services provided, and the works are completed in a timely manner in accordance with TANESCO priorities.

The audit found that: TANESCO inadequately implemented annual procurement plans; there were delays in procurement of required spare parts; the existing TANESCO'S Procurement system (TAPROS) was not implemented at plant levels and TANESCO did not carry out adequate market price research for Procurement of spare parts. The details are as explained below:

3.2.1 Inadequate implementation of Annual Procurement Plans.

The review of procurement status of all visited power plants showed that, for the period under the audit 2015/16 to 2017/18, annual

procurement plans were not implemented as expected. According to the visited plant officials, this was contributed by various factors such as cost of items to be procured exceeding the given budget ceiling, lack of prioritization, late submission of specifications to PMU and long procurement process at PMU HQ.

However, responsible staff at the plants did not clearly understand the procurement chain and the timings for submitting specifications to PMU in order to acquire the required spare parts before specified preventive maintenances

Review of 2017/18 report on procurement implementation status prepared by PMU showed that, some procurement was not initiated. According to Manager-PMU, this was because the user department (i.e. Generation) did not timely submit specifications for the items that were supposed to be procured.

For instance, at TANESCO headquarters, the audit sampled and reviewed 59 tenders of financial year 2017/18 for the generation department. The audit noted that, 27 tenders, equivalent to 46% of the tenders reviewed, were not initiated because of inadequate specifications from user departments. These were the tenders which were supposed to be initiated on the first quarter of FY 2017/18.

Non implementation of Annual Procurement Plans affected maintenance schedules. The effects of not following maintenance schedules resulted into frequent plant failures, loss of revenue, customer complaints and the increase of maintenance cost.

3.2.2 There were delays in procurement of required spare parts and maintenance vendors

Regulation 5 (2) (c) of PPR (2013) requires the goods to be delivered, the services provided, and the works are completed in a timely manner in accordance with TANESCO priorities.

Review of 2017/18 report on procurement implementation status prepared by PMU showed that, there were delays in initiating processes for procurement of spare parts and vendors. According to PMU HQ, this was because the user department (i.e. Generation) did not timely submit specifications for the items that were supposed to be procured.

The team reviewed the status of procurement of Kinyerezi I, and noted that, two tenders for supply of electrical spare parts and for repair and servicing of chiller plant under frame work contract were delayed due to the fact that, the user had to re-submit the specifications because of additional scope. The procurement was delayed for one year. Furthermore, three tenders for Procurement of Mechanical and Electrical spare parts were delayed since 2016/17 due to inadequate approved budget, and two tenders for Supply of spares for compressed air system for instrumentation and control and for repair and servicing of gas boiler and instruments including controls/sensors were subject to re-tendering as they were not completed during the expected financial year. These delays are partly due to lack of corporate priorities when financial resources are not adequate to cover the full budget requirements.

At Mtera Power Plant, two tenders for Supply, installation, testing and commissioning of generator air coolers for unit 2 and for rehabilitation of power house chlorination system were delayed since financial year 2015/16 due to the expiry of budget year.

Also, at Ubungo II Plant, delays were mainly contributed by lack of necessary provisions in the standard bidding document and bidders not responding to the bidding document such as contract No.PA/001/2014/HQ/N/10 for servicing instruments and No.PA/001/2014/HQ/N/1 for repair of gas pressure and preheating system. The Contract for overhaul of 3 gas turbines by Siemens was not implemented timely due to delay of customizing the bidding document to TANESCO's particular requirements.

Delays in initiating procurement or submitting inputs to PMU HQ resulted from insufficient budget, suspended tenders, change of scope and provisions for budget when need arises. Table 3.1 shows tenders which were not initiated due to insufficient funds in financial year 2017/18 amounted to TZS 2,308,000,000. According to Generation Department, tenders which were not initiated due to insufficient funds were deferred to the following year Annual Procurement Plan.

Table 3.1: Tenders not initiated due to insufficient funds in 2017/18 financial year

S/N	Description	Estimated Cost(in Million TZS)
1.	Tender No. PA/001/17-18/HQ/G/29 for supply of spare parts and services of gas pressure reduction and metering station	80
2.	Tender No. PA/001/17-18/HQ/G/53 for supply of spare parts for caterpillar Generators	420
3.	Tender No. PA/001/17-18/HQ/G/55 for Supply of tools for operation & maintenance of caterpillar power plants	600
4.	Tender No. PA/001/17-18/HQ/G/56 for supply of tools for Mirrlees Blackstone generators	100
5.	Tender No. PA/001/17-18/HQ/G/57 for supply of tools for operation &maintenance	1,000
6.	Tender No. PA/001/17-18/HQ/G/61 for supply of steam cleaners for use in service of isolated stations	80
7.	Tender No. PA/001/2017-18/HQ/N/19 for Hiring of scaffolding and canvas covering of Gas Turbine No. 1 for Level B Maintenance	28
	TOTAL	**2,308**

Source: 2017/18 procurement status, TANESCO HQ

Consequently, the intended maintenance activities which were expected in financial year 2017/18 were not performed.

3.2.3 The existing TANESCO's Procurement system (TAPROS) was not implemented at some plants

TANESCO Corporate Business Plan- 2016/17 requires Information and Communication Technology (ICT) Business Unit to spearhead acquisitions of ICT related assets, supporting ICT systems, and ensuring availability of business systems to internal/external users. This is also required by International Standards, best Practices and Maintenance Management Models. These include ISO 9001:2008 and supervisory control and data acquisition framework (SCADA).

TANESCO intended to strengthen the Procurement Management Unit, enhance projects supervision and management by re-enforcing the use of TANESCOs Procurement System (TAPROS).

However, it was noted that, TANESCO did not apply TAPROS at power generation plant level. The system was only applied at Headquarters, Zonal Offices as well as regional offices. This reduced real-time visibility of procurement activities in maintenance of power generation plants due to usage of manual system. This resulted to tedious tracing of stages to which initiated procurement process has reached.

Consequently, risks and mitigation measures pertaining procurement of works, spares, working tools and vendors could not be visible from Headquarters and Zone offices. This was non-adherence to requirements by Power Sector Reform Strategy and Roadmap (PSRS) 2014-2015 as well as Corporate Business Plan 2016-17 resulting to untimely maintenance.

3.2.4 TANESCO did not carry adequate market price research for the Procurement of spare parts.

Section 63 (2) of PPA (2011) requires all procurement to be conducted in a manner that maximizes competition and achieve economy, efficiency, transparency and value for money.

Also, Section 69(6) of PPR (2013) requires TANESCO to prepare its estimates based on prevailing market prices and updated from time to time.

Before the budget preparation, each department or unit is required to conduct a market survey of some common use items in maintenance. They are supposed to review different catalogues and price list as they are updated from time to time in order to identify the price for budgeting purposes.

The team visited seven power generation plants and found in each visited plant, there were some items which were over budgeted or under budgeted. For example, there was over budget of up to 99% in Kidatu while under budgeting of up to 116% in Mtera power plant was noted and as detailed in the selected procurements in Table 3.2.

Table 3.2: Budgeted versus actual expenditure for selected procured items in FY 2015/16-2017/18

Plant Name	Detail of item	Budgeted Amount in Million TZS	Actual Amount in Million TZS	Percenage increase/decrease
Kidatu	Preventive Maintenance	120.00	21.84	82
	Gate repair	20.00	7.18	64
	Loading and unloading thrust collar of unit no.1	306.39	1.12	99
	For power house (Castro perfecto XEP 68) topping up	267.13	7.99	97
Nyakato	Consumable spare parts for engines e.g. air filters, lubricating filters etc.	150.00	90.00	40
	Spare Parts and services for ABB Turbochargers(PA/001/2016/HQ/G/70)	400.00	226.20	44
	Consumable spare parts for engines & it's auxiliaries	350.00	70.00	80
	Running spare parts for engines (PA/001/2016/HQ/G/51)	400.00	211.07	47
Mtera	Supply of power supply card (PA/001/2015/CZN/G/034)	30.00	13.07	56
	Improving drainage system in the Powerhouse	50.00	55.93	(12)
	Rehabilitation of Chiller plant	30.00	64.85	(116)
	Replace floating booms	1,200.00	1,395.23	(16)
Mtwara	Running spare for all Generating Set	1,226.02	737.91	40
	Strategic Spare for G3520	1,100.00	323.50	71
	Supply of running parts for gen set no. 1, 2 and 3	269.65	294.75	(10)
Kinyerezi I	Supply of Generator Lube Oil for Kinyerezi I Gas Plant (PA/001/2016/HQ/G/074)	719.78	198.82	72
	Air Filters (PA/001/2017-18/HQ/G/44)	3,000.00	2,183.21	27
Ubungo II	(PA/001/2016-17/HQ/N/11) Supply of spare parts and provision of related services	21,660.24	43,320.49	(100)

	(PA/001/2016-17/HQ/N/11) Procurement of service contract for Instrument air system	225.07	295.96	(32)
	(PA/001/2016-17/HQ/N/01) Provision for reconditioning of turbines hot parts	2,782.77	3,352.31	(21)

Source: Visited plants procurement status reports, 2017/18

The effect of over budgeting is such that, the resources will be prioritized on few items and so deny other items. For example, at Nyakato Plant, there was an increase of 918% from the budgeted amount (1.2 Billion) to the bid amount (12.2 Billion). Also, there was a risk of *over-pricing* of bids in case of leakage of budget for single sourced items.

Because of the huge escalation, the audit noted that, the Plant Manager complained and enquired changing the method of procurement.

Another example was procurement of cylinder head cleaning machine. This was budgeted at TZS 220 Million but the lowest bid was at TZS 335 Million (52% increase). The provision of servicing and supply of spare parts for air compressor equipment was budgeted at 81 Million but the lowest bid was at TZS 184 Million (an increase of 127%). This resulted into delayed procurement and hence maintenance of the plant.

3.3 TANESCO was lacking specialized skills in thermal plants

According to section 1.3.1.1(a) of TANESCO strategic Plan 2017/18-2020/21, TANESCO are required to conduct maintenance of all power generation plants to ensure maximum plant availability and efficient utilization of all generation assets. Ensuring maximum plant availability goes hand in hand with capacitating plants in terms of budget, skills and tools.

The audit noted that TANESCO did not adequately execute training plans for specialized skills in maintenance of power generation plants; conducted Training Needs Assessment (TNA); and prepare to cope with changes in technology as explained hereunder:

3.3.1 Inadequate training on specialized skills in maintenance of power generation plants

According to TANESCO's Corporate Business Plan 2016/2017, TANESCO is supposed to manage training plans as well as coordinating all corporate trainings to meet competency requirements of the company. Also, Section 6.2.2 (a) of ISO 9001:2008 requires TANESCO to ensure necessary competence is acquired by personnel performing technical work (operation and maintenance).

Review of training documents at TANESCO HQ showed that, TANESCO conducted TNA. However the TNA report lacks assessment for specialized maintenance skills. Consequently, review of training reports showed Technical staff were rarely trained on the basis of their gaps and needs despite the fact that, the technology is changing and there is a need to be up to date with the change of technology.

Table 3.3: Specialized skills trainings conducted for the period of 2015-2018 for the visited plants Staff

Plant	Specialized training conducted	Specialized trainings needed	Number of trained Staff	Number of certified staff
Kinyerezi I	• Package control • Package familiarization • Package maintenance	• Woodward Control Systems • Package Maintenance • Excitation System • Cold and Hot Maintenance • Borescope Inspection	15	0
Ubungo II	• NIL	• Gas Turbine Course • Control and Instrumentation system in gas turbine, GPRS, Gas turbine maintenance and repair. • PLC Power, Protection course	0	0

		• Vibration monitoring system		
Mtwara	• Hydraulics • Electrical trouble shooting and testing • Lubricant and fuel • Condition Based • Maintenance	• Condition Based Maintenance • Natural Gas Pressure regulation • Fundamental Systems on Caterpillar Generating sets	5	0

Source: Visited Plants training records 2015-2018.

Based on Table 3.3, TANESCO lacks certified staff in specialized skills in thermal power plants. This was evidenced by lack of performance assessment based on specialized skills requirements. As a result, in the plants visited areas which require specialized skills are serviced/ maintained by certified staff from the manufacturer/ suppliers.

According to the Ministry of Energy TANESCO was supposed to attach its staff to manufacturers so as to acquire specialized skills. However, this was not adequately implemented. Reports showed that, for the last three years, 15 (fifteen) staff from Kinyerezi I were trained abroad on issues of package familiarization, control and maintenance instead of skills that were necessary for them to be certified experts in turbine plant maintenance.

However, TANESCO focused on the numbers of personnel to be trained instead of quality and items for training. This required the contracts to be worded to reflect the level of quality expected. Also, contracts should have stated clearly the level of supervision during training, monitoring and evaluation after the training which is result based. For overseas training, staff do not put adequate emphasis rather they take it as a study tour.

The audit reviewed a contract between TANESCO and Siemens Industrial Turbo machinery AB (SIT AB) signed in November 2017. According to the contract, the role of Siemens, among others, was to conduct training on the use and inspection of bore scope instrument on turbines. However, this contract was found to lack training on

maintenance. Siemens only offered personnel to participate during the respective bore scope inspections but they did not include any certification training requirement.

According to the TANESCO TNA, one of the training programs proposed was to attach Staff to other organizations in a similar job to learn practically how to handle some aspects of works. Example, Engineers were to be attached to counterpart engineers in Norway where gas technology was used, to learn practically about gas turbine operations. However, the review of training reports did not show the implementation of this.

3.3.2 Training needs assessment was partially conducted

The audit noted that, in all visited power generation plants, the training needs were prepared and submitted to Human Resources Unit by Plant Managers or Principal Engineers with inputs from heads of sections without involvement of lower level staff.

In addition, review of TNA of September, 2017 for the financial year 2017/18, noted that, the human resources department identified key training needs for staff by distributing 2,358 questionnaires to Power Plants, Regions and Head Office Departments. The distributed questionnaires were only 36% of the Company's workforce meaning that, 64% of the work force was not covered. Although it was not clear to what extent the questionnaires were reflective of training requirement by the Strategic Plan and who prepared the TNA questionnaire forms (qualification and skills) and how they were analysed.

This implies that, the training needs assessment was not comprehensive and reflective of key training requirements for the generation department as it was also represented by less than half of the TANESCO work force and some key personnel were not involved.

3.3.3 Lack of preparedness to cope with changes in technology

Given the fact that technology is rapidly changing, TANESCO was supposed to have proactive plans that prepare its staff to keep in pace with power generation technologies. The practice requires TANESCO to put a clause that ensures each contractor has an item of technology transfer and capacity building.

The audit found that, in all visited hydro power plants there was a challenge of obsolete technology. According to visits to the plants, wherever there was a breakdown, TANESCO could not repair on time as sometimes manufacturers were untraceable. The audit found that, the issue of untraceable manufacturers was likely to be a result of lack of close and constant communication.

Though, there was no proof of untraceable manufacturers from Plants management. This was due to the fact that, the audit team failed to assess the level of efforts the plant management put in tracing these manufactures. Most of manufacturers had web sites, journals, and communication portals as part of after sales services. There was no evidence that such communication links were established, maintained and used by plant management.

There were spare parts which were not obtained because either the manufacturer had ceased to manufacture or the technology has changed. This necessitated TANESCO to modify some of the spare parts. Examples of modifications made in Mtera plant were:

i. Pipe works and the mounting base of the cooling water Pumps which were no longer produced by the manufacturer;
ii. Fabrication of aluminium plate to reduce the discharge diameter of the water pump as the supplied one had bigger diameter;
iii. Additional strainers due to excessive blockage of cooling water filters; and
iv. Reducing number of pins from seven (7) to Four (4) for Electro Hydraulic servo valve. The old servo was no longer manufactured.

Further, all the visited power generation plants, were inadequately equipped with workshop machines and tools for modifications and production of spare parts. With power plants running out of their economic life span, it is expected the manufacturers will no longer be producing parts of old models thus preparedness was needed for future modifications and maintenance.

3.4 TANESCO inadequately conducts risk based maintenance

Power generation plants maintenance system qualitative and quantitative approaches are applied to achieve quality performance

as stated in International Standards Organization (ISO). In ISO 9001:2015 the approach is applied for planning, implementing and monitoring maintenance activities for continual improvement of the quality management system. This is also applied to maintain useful life of power generation plant as well as its processing units. This approach depends on such parameters like manufacturer's instructions, failure duration from experience, frequency of failure and failure conditions and reasons.

During audit, we noted that although TANESCO had been conducting preventive maintenance, the breakdowns were occurring, resulting to power disruption and other associated risks. The following were noted on TANESCO maintenance practices:

3.4.1 Inadequate identification of maintenance risk

International Standards Organization (ISO) 9001:2015 requires application of Risk Based Maintenance approach to attain effective conditional based maintenance and manage timely replacement/retirements. In this approach, risk estimation is applied to provide a basis for effective implementation of maintenance decision (shutdown, repair, or replace). This is applied to enhance electric power reliability and life of installed parts as well as plant.

Optimal power generation system operation requires Risk Based Maintenance involving proper analysis of technical condition, residual life, risk and profitability and optimal timing of maintenance and reinvestments of particular equipment. Postponement of comprehensive renewal may be profitable provided that this does not lead to failure with huge consequential costs. By adequately implementing risk based maintenance, the plant is able to minimise costs and hence increasing profitability of its operations.

Standards require risk assessment to be done, and then followed by maintenance planning on the basis of the calculated risk. Using this approach, TANESCO was supposed to develop the following:

i. Risk definitions for power generation;
ii. Condition issues identification;
iii. Risk calculation based on damage level;
iv. Preparing a maintenance and procurement plan to address key assessment results

v. Updating risk calculation, and
vi. Effectively implementing the maintenance plan.

During audit, the team noted that TANESCO lacked maintenance risk framework. All visited TANESCO power generation plants had their own risk registers. They also didn't show performance trends and failure analysis and history for power generation plant machines and spare parts. To ensure continual improvement, we expected TANESCO to have a register showing critical spares, faults and related causes, processes and services showing levels of criticality, possible causes and proposed remediation approach.

Plant Risk Register

1. KIDATU

Financial Year	Registered maintenance risk	Frequency of occurrence	Category (High, Medium Low)	Remarks
2015/16	Unit 1 failure due to vibrations	Three times a year	Medium	Replacement of vibration monitoring equipment (sensors)
2017/18	Broken shear pin on unit no.2	Three times a year	Medium	Replace shear pin
2018/19	Vibration on turbine unit 2	Rare	Medium	Proposed for fatigue analysis and major overhaul of turbine unit 2

2. MTWARA

Financial Year	Registered maintenance risk		Frequency of occurrence	Category (High, Medium Low)	Remarks
2015/16	Cooling system	Failure of cooling water	6	High	Rebuild every 12000-20000hrs
		Flexible rubber flag	5	High	Inspect every 10,000hrs. replace when required
	Lubrication system	Lubricating Oil	23	High	Change every 3,000 running hours
		Oil filters	23	High	Change every 3,000 running hours
2017/18	Air intake system	Turbo charger	1	High	Inspect every 8000 – 12,000 hours. Major overhaul every 50,000hrs.
2018/19	Air intake system	Turbo charger	1	Low	Replace when needed

3. MTERA

Financial Year	Registered maintenance risk	Frequency of occurrence	Category (High, Medium Low)	Remarks
2015/16	Leakages of Generators air coolers	Every after 3 months	High	Air cooler has not been replaced awaiting for procurement process
	Damage of generator thrust bearing and collars	Once since installed	High	Bearing was replaced
2016/17	Leakages of Generators air coolers	Every after 3 months	High	Air cooler has not been replaced awaiting for procurement process
2017/18	Leakages of Generators air coolers	Every after 3 months	High	Air cooler has not been replaced awaiting for procurement process
2018/19	Leakages of Generators air coolers	Every after 3 months	High	Air cooler has not been replaced awaiting for procurement process

TANESCO only kept records of preventive maintenance activities, but did not keep failure analysis, failure frequency and impacts.

For instance, vibration increase was noted in the turbine for unit 2 of Kidatu power plant, indicating possible breakdown. This incidence called for fatigue analysis test, and possibly another overhaul. However this was neither comprehensively recorded nor consolidated.

In Nyakato power generation plant, there had been failure incidences recurrence for bearing breaking down in four power generating machines as shown in Table 3.4. However, these breakdowns were not registered as risk as there is no formal procedure to register risks.

Table 3.4: Reccured Breakdown incidences in Nyakato

Generator number	Breakdown incidences	Running hours
07	The incident occurred: on 20th July, 2016. Failure was due to 4B big end bearing seizure.	9,421
02	The incident occurred on 15th September 2015.Failure was due to 4B&5B big end bearing seizure.	6,596
08	The incident occurred on 09th June 2015. Failure caused by engine overspeed	5,490
01	The incident occurred on 17th November 2014.Failure was due to 3B big end bearing seizure.	2,427

Source: Nyakato maintenance reports (2015/16-2017/8)

3.4.2 Non-prioritization of risks for conducting maintenance of power generation plants

TANESCO intended to ensure adequate and timely power generation as noted in its 2016/17 strategic plan. In response, preventive maintenance as well as conditional maintenance activities have been done to its power generation plants. However, the audit team noted that TANESCO did not do maintenance timely which was against manufacturer recommendations.

TANESCO conducted limited scheduled maintenance activities. It was further noted that some worn parts were not repaired/replaced when there was a scheduled preventive maintenance.

In Kidatu Power Plant, unit 2 was found to underperform as it generates 45 MW instead of 50MW which is 90% contrary to the standard set point for the machine. Plant management informed the audit team that abnormal vibrations of the turbine were caused by the full opening of guide vanes allowing water passage to the runner. This indicates that there is turbulence in the water system. Cause for water turbulence could be: -

a) Unaligned guide vanes,

b) Cavitation on lining of the spiral casing or guide vanes or turbine runners blades or upper draft tube lining,
c) Worn guide upper, middle or lower bearings (vibration sensor could point out area with severe vibrations)

The audit team was informed that major overhaul of Turbine 2 was under tender No. PA/001/2016-17/HQ/W/02. This overhaul also could not have been done, till fatigue analysis for Turbine unit 2 was completed under Tender No.PA/001/2018-19/CZN/W/13.

Other examples of lack of priority for maintenance of power generation plants were noted for Nyakato plant as shown in Table 3.5:

Table 3.5: Emergency breakdown in Nyakato plant

Equipment name and function	Date of fault
Damage of engine No.1 big end bearing shell for cylinder No. 3B	17/11/2014
Damage of engine No. 2 big end bearing shell for cylinder No. 4B & 5B	15/9/2015
Damage of engine No. 7 big end bearing shell for cylinder No. 4B.	20/7/2016

Table 3.5 above shows that there had been frequent damages of the same nature on engine No.1, No.2 and No.7 big end bearing shell for cylinders. However, TANESCO failure to attend these failures led to damage recurrence and consequently increased cost.

Furthermore, the audit noted risk areas that require immediate management attention pertaining maintenance but they were not attended. Plant management decided to cannibalize broken down machines by taking working spare parts in order to maintain similar machines with different equipment failures. This ultimately resulted into higher frequency failures.

3.4.3 Inadequate Execution of Risk based Maintenance

In every visited power plant, there were plans for maintenance of the plants guided by preventive maintenance schedules and maintenance routines. However, the audit team found that TANESCO did not conduct risk based maintenance but it rather conducted Preventive maintenance. Optimal asset management of power system components based on analysis of technical condition, residual life,

risk, profitability and optimal timing of maintenance and reinvestments was not done.

The planned schedules for maintenance were not followed as expected. None of the visited plants, fully complied with its shut down maintenance schedule. The following were noted issues showing inadequate execution of Risk based Maintenance:

i. Inadequate spare parts and maintenance working tools

In all visited power generation plants, the audit noted missing spare parts as well as working tools. This included spare parts needed for substantial maintenance activities. For instance, in Ubungo II power plant critical spare parts for fuel gas systems was not available as it was not supplied due to delay of procurement process (tender No. PA/001/2016-17/HQ/G/13 in 2018).

ii. Lack of certified Staff to perform specialized maintenance

TANESCO was equipped with special equipment which needs specialized skills to maintain such as turbines, alternators, governors, programmable logic control (PLC). The audit revealed that TANESCO engages contractors with specialized skills to conduct maintenance of special equipment. This involved procurement process that consequently increases cost as well as plant downtime. During the audit, it was declared by management that TANESCO didn't have staff with specialized skills to conduct specialized maintenance. Using its training centre (TANESCO Training School), TANESCO had been providing orientations to its staff. However, it was declared that these were theoretical skills and neither practical skills nor specialized skills were provided by this school. The audit also revealed that lack of specialized skills was caused by lack of TANESCO training strategy for the acquisition of professional skills to its staff.

iii. Inadequate funds

Review of maintenance budget showed that there was inadequate release of funds requested for maintenance activities in all visited plants. Table 3.6 shows tenders not initiated under annual procurement plan in the year 2017/18. These tenders were not initiated due to lack of funds.

Table 3.6: Activities not performed due to lack of fund

DESCRIPTION	ESTIMATED COST
Supply of spare parts for caterpillar Generators at Mpanda	440,000,000
Supply of spare parts for caterpillar Generators	600,000,000
Supply of spare parts and service of gas pressure reduction and metering station at Somanga Gas plant	80,000,000
Supply of steam cleaners for use in isolated stations	80,000,000

Source: Annual Procurement Plan (2017/18)

Consequently, this led to non-execution of planned maintenance and increased risk of continued equipment breakdown.

An example of unattended maintenance activities are as shown in **Table 3.7** for Nyakato Plant which were scheduled but not conducted up to the time of this audit.

Table 3.7: Engines running hours and required maintenance-Nyakato plant.

Maintenance required	Running hours	Status
Engine No. 5 - Major Overhaul	20,130	Working but overdue for overhaul
Engine No. 6 - Major Overhaul	19,354	Working but require overhaul
Engine No. 10 -repair of outstanding equipment skipped during execution of Top Overhaul e.g. Fuel Injector Nozzles	17,979	Working
Engine No. 4 - repair of outstanding equipment skipped during execution of Top Overhaul e.g. Fuel Injector Nozzles	17,880	Working
Engine No. 3- repair of outstanding equipment skipped during execution of Top Overhaul e.g. Fuel Injector Nozzles	17,228	Working
Engine No. 9 - repair of outstanding equipment skipped during execution of Top Overhaul e.g. Fuel Injector Nozzles	15,625	Working

Maintenance required	Running hours	Status
Engine No. 7 - needed crankshaft journal machining(Cylinder No.4B) and repair of some engine components	9,421	Not working
Engine No. 2 needed crankshaft journal machining(Cylinder No.4B&5B) and repair of some engine components	6,596	Not working
Engine No. 8 - total engine rebuild up	5,490	Not working
Engine No.1- crankshaft journal machining(Cylinder No.3B) and repair of some engine components	2,427	Not working

Source: Nyakato power generation plant, maintenance status, 2019

Table 3.7 shows that, engine number 1,2, 7 and 8 were having a few working hours compared to engine number 5 and number 6. This was because they were damaged and required major maintenance. Engine number 5 was overdue for major overhaul while engines number 3,4,6,9 and 10 required major overhaul.

Another example is 60 MW Nyakato Power Plant which was commissioned and handed over to TANESCO for operation on 25th November, 2013. The Plant consists of 10 Rolls Royce diesel engine generating sets with installed capacity of 63MW and available capacity of 60MW. At the time of this audit, the available capacity of the plant was only 36 MW from six generating sets which was equivalent to 60 percent. The four generating sets No.1, 2, 7 and 8 were not operational since July, 2016 due to various damages which required repair and replacement of damaged bearing shells.

The effects of not following the planned shutdown maintenance schedule resulted into frequent plant failures and the increase of maintenance cost as well as other related problems. **Table 3.8** shows the date Nyakato machines failed and the repairs were still pending.

Table 3.8: Engine damages and elapsed time since damage

Engine No.	Type of damaged/breakdown	Date of fault	Time elapsed (days)
1	Damage of end bearing shell	17/11/2014	1,528
2	Damage of end bearing shell	15/9/2015	1,226
7	Damage of end bearing shell	20/7/2016	915
8	Damage of engine internal parts	9/6/2015	1,324

Source: Maintenance records, Nyakato plant, 2019.

Table 3.8 shows that, more than four years had elapsed since the first breakdown happened and up to the time of the audit, the engines were abandoned and turned into "spare part machines". It should be noted that, the plant was constructed so as to improve power quality to Lake Zone grid, adding generation capacity to national grid and to act as Lake Zone grid base load whenever there was transmission network failure (Island Operation). All these purposes could not be served if maintenance was not timely conducted to the damaged engines.

Another example was the Sumbawanga plant which was required to undergo major maintenance (major overhaul) since year 2016[5].

Review of maintenance program revealed that, after every 12,000 hours or two years of running the generators required a complete overhaul of cylinder heads (top overhaul) and every 24,000 hours or three years a complete overhaul. However, the plant had been operating without the scheduled overhaul maintenance. According to the station officials, maintenance was skipped due to lack of spare parts/procurement of vendors.

[5]A letter to Senior Manager Generation with reference number RUK/RM/GENERATION/07 of 13th February, 2018 with the heading, "request to carry major overhaul on four generators set Sumbawanga". The letter claimed that, the generators urgently needed major overhaul bearing the fact that they did not go for top overhaul when time was up to do so.

Table 3.9(a): Hours the machine has been operating without maintenance –Sumbawanga Plant

Generator number	Hours required for top overhaul	Actual machine running hours	Hours running beyond maintenance schedule
1	12,000	20,900	8,900
2	12,000	19,851	7,851
3	12,000	16,788	4,788
4	12,000	18,109	6,109
Average	12,000	18,912	6,912

Source: Maintenance program, Sumbawanga plant, 2019.

Table 3.9(b): Hours the machine has been operating without maintenance – Ubungo II

Engine No.	Hours required for maintenance	Actual machine running hours	Hours running without maintenance
01	30,000	40,356	10,356
02	40,000	53,918	13,918
03	40,000	44,651	4,651

Source: Maintenance program, Ubungo II plant, 2019.

Based on Table 3.9(a) and 3.9(b), four generators had operated for an average of 6,912 hours at Sumbawanga and 9,641 hours at Ubungo II, respectively, more beyond the time for maintenance. This was likely to damage the engines' internal parts and may result into major failure leading to higher cost of reinstating them and loss of generation time and revenue.

According to the Station Supervisor, the priority of maintenance was low due to the fact that, the plant was on standby since Rukwa Region gets power from Mbala – Zambia, and the station runs only when power from Zambia goes off. The audit team was concerned as to why maintenance was not conducted while these power plants were not operational.

According to officials of the visited plants, one of the reasons for delayed maintenance of the plants was a result of delayed procurement of spare parts and vendors, high maintenance cost (that exceeded budget ceiling) and not getting outage time.

iv. Denial of shut down permission from Grid Control Centre (GCC)

There were plants which failed to conduct the scheduled shut down maintenance due to denial of permission from Grid Control Center (GCC). According to the visited plants, denial of shut down permission was caused by inadequate grid reserve capacity. For instance a plant such as Ubungo II is profoundly important to Dar es Salaam city. The dependency level reaches an extent that shutdown of only one turbine will result into power rationing to the city.

Electric generation cost determines priorities for dispatching as well as shutdowns for plant maintenance. According to the generation status report submitted to the Ministry of Energy in October 2018, the average cost of generating one Kilowatt-hour ranged from TZS 31 in Kidatu, Hale, New Pangani Falls; TZS 113 Kinyerezi I; TZS 493 Nyakato to TZS 538 at Sumbawanga. This fact affected scheduled maintenance activities. Less priority for shutdown was given to hydro power plants especially during rain seasons. This was due to the fact that, cost of generating one Kilowatt-hour was cheaper when using hydro.

3.4.4 Ineffective prioritization of the budgeted fund to the plants with critical conditions

It was found that, there were inconsistences in the use of funds allocated for maintenance activities. The inconsistences were in spending more than the amount budgeted in financial year 2015/16. In financial year 2016/17, the amount budgeted was almost two times the amount budgeted during the previous year but only twenty percent of the budgeted amount was utilized. This is a sign of lack of prioritization while budgeting for maintenance activities.

Table 3.10: Amount of funds utilized for maintenance in Power generation plants

Financial Year	Amount Budgeted in (Billion TZS)	Amount Utilized (Billion TZS)	Percentage utilized
2015/16	30.34	32.52	107
2016/17	56.66	11.62	21
2017/18	87.99	45.25	48

Source: TANESCO Generation Business Unit, Utilization report 2015/16-2017/18

While utilizing only 21% (2016/17) and 48% (2017/18) of the budgeted amount for maintenance, there were plants such as Pangani, Nyakato and Sumbawanga which needed major overhaul but they were not maintained due to lack of funds.

The team reviewed TANESCO's internal audit report for Pangani plant of September 2017.The report showed a delay in maintenance of plant equipment and machines for up to seven years. Major overhaul for generators and turbine sets were not done. The report recommended to Plant manager to ensure plant maintenance schedules are attended based on manufacturers requirements and specifications.

The management responses of the internal auditors finding and recommendation was that, they have been budgeting for replacement many times but in all cases funds could not be made available. The management explained the need of prioritizing their maintenance requirements due to limited resources.

3.5 Inadequate maintenance reporting mechanism

TANESCO and the Ministry of Energy had inadequate reporting mechanism for maintenance activities of power generation activities enabling management to make informed decisions regarding maintenance of power generation plants.
Section 7.1 of National Energy Policy (2015) covering electricity sub-sector ministry-wise requires the Ministry responsible for energy to coordinate, monitor and evaluate its implementation. Furthermore, Corporate Business Plan (2016/17) required TANESCO to ensure reliable and stable power system through timely maintenance of facilities.

TANESCO power generation plants had been submitting daily, weekly and monthly reports to Deputy Managing Director (Generation) on power generation activities. But the review of submitted generation reports from power generation plants from 2015/16 to 2017/18 shows that the reports contain information on power generation, procurement and finance for maintenance activities. The reports were then submitted to the Ministry of Energy after being compiled by TANESCO.

However, the audit team noted that not all reports submitted to the Ministry of Energy had information on maintenance of power generation activities contrary to National Energy Policy (2015) and Corporate Business Plan (2016/17). Some reports provided information regarding fuel consumption, or energy efficiency.

Consequently, TANESCO and Ministry of Energy lack substantial information for maintenance of power generation plants. Non-existence of reporting structure resulted to lack of emphasis on effective maintenance of plants.

3.5.1 Insufficient monitoring of power generation plants maintenance by TANESCO

TANESCO insufficiently monitor power generation activities. It was also revealed that TANESCO could not meaningfully turn its Corporate Business Plan into actionable plans.
Section 3.1 of Power System Master Plan (PSMP) of 2016 considers the life span of power generation plants to be extended by proper maintenance and interim replacement of major parts. In its Corporate Business Plan (2016/17), TANESCO intended to have adequate electric power generation, transmission and distribution facilities. The company intended to have timely maintenance of facilities.

On attempt to monitor maintenance activities for power generation, the Internal audit Department of TANESCO conducted technical audits. The following were internal audit objectives between 2015/16 and 2017/18:

Table 3.11: Internal audit objectives

Audit year	Power plants audited	Audit objective	Period covered
2015	Off grid plants[6]	Fuel Management and Energy efficiency	2013-2015
2016	Off grid plants, Ubungo I, Ubungo II, Tegeta.	Gas and fuel management and energy efficiency	2014-2016
2017	Pangani, Mtera, Kihansi	System of internal control	2016-2017

Source: TANESCO Internal Audit reports (2015-2017)

[6]Kigoma, Kasulu, Kibondo, Bukoba, Biharamulo, Ngara, Songea, Mbinga, Namtumbo, Tunduru, Mafia, Ngorongoro, Mpanda, Liwale, Somanga and Ludewa

Review of internal audit reports revealed that in three years' time, TANESCO conducted technical audit only once in nearly all thermal and hydro power generation plants that are connected to the National Grid and twice in off grid stations.

It was also noted that although the audit was substantial for technically monitoring maintenance activities, coverage and frequency of the exercise did not give assurance of performance improvement. For instance, it was also noted that the audit was neither conducted at Kinyerezi I nor Ubungo II power plants respectively.

Furthermore, there was no feedback from HQ provided to audited power plants managements. Consequently, there were identified issues that required immediate attention, but they were never included in power plant budget and procurement plans in the years under review. Table 3.12 below highlights risk issues that were provided in technical audit reports but were not included in annual procurement plans.

Table 3.12: Unattended issues reported in the technical audit (2015-2017)

Power plant	Machine/ spare	Overrun years
Pangani	Turbine for machine 1	7
	Turbine for machine 2	
	Alternator for machine 1	
	Alternator for machine 2	
Mtera	Turbine 1	10
	Turbine 2	
	Cylinder gate and guide vanes	
Mtwara	Machine 3 top overhaul	12,111 hours
	Machine 5 top overhaul	9,976 hours

Source: TANESCO Internal Audit reports (2015-2017)

TANESCO power generation plants have been submitting morning status reports, weekly reports, monthly reports, quarterly reports, annual reports, as well as monthly safety reports to headquarters.

However, the audit revealed that submitted reports ware not compiled at TANESCO power generation to provide comprehensive information on conditions of power generation plants. This has been contributed by the organization structure lacking an official

responsible for compiling and coordinating all reports on maintenance of power generation plants. It was also noted that TANESCO Generation Directorate did not consolidate regular reports on power generation plants maintenance to inform management on noted maintenance issues. This could have proactively relieved some breakdowns requiring emergence maintenance.

The audit acclaimed initiative by TANESCO's internal audit department to conduct technical audit. However, the audits were not sustainable and regular. The audit covered only few and selected power generation plants whose selection criteria were also not clear.

3.5.2 Inadequate monitoring tool for maintenance activities

There was inadequate monitoring of maintenance activities by TANESCO and the Ministry of Energy. Section 6.5 of TANESCO Corporate Business Plan (2016/17) requires the management to ensure they apply the business plan to monitor its performance. The plan required management to have mechanism of monitoring actions and controls for uncertainties while pursuing its objectives. The plan required monitoring mechanism to inform on-going progress towards objectives and determine if undesirable conditions occurred or appear likely to occur. Finally, the plan required TANESCO to respond timely and appropriately.

During audit visit in TANESCO power generation plants, it was found that TANESCO deployed Computerized Maintenance Management System (CMMS) at Kihansi and Kidatu power plants only.

This CMMS could have been used as a tool to help other power generation plants to easily execute maintenance activities. Ultimately the system helped the two power plants to minimize unnecessary breakdowns, downtime, and running costs. Our visit at Kidatu power generation plant revealed that maintenance engineers could use CMMS to remotely track maintenance activities but this function was not utilized as CMMS was not updated to enable it to function as required.

However, other visited plants are not using CMMS. These plants manually prepare and monitor maintenance activities. This inhibited TANESCO to have maintenance information to enable prompt reporting and responding to maintenance issues.

It was also revealed by TANESCO Internal audit reports of May 30, 2017 that although TANESCO installed CMMS at Kihansi power plant, but there was software malfunctions. This was noted by failure of CMMS to update work orders for Turbine-3 and Guide control bearing which resulted to delays to conduct maintenance activities.

The audit team was concerned about lack of CMMS in other power generation plants despite the benefits of the tool. Furthermore, the team was concerned as to why management could not make use of CMMS to monitor power generation plants activities. According to officials, the CMMS was piloted at Kihansi and Kidatu Plants and would be installed in other Plants later.

3.5.3 Inadequate monitoring of power generation plants by the Ministry of Energy

The Ministry of Energy did not adequately monitor power generation plants. The role of the Ministry was to ensure availability of adequate power at relatively reduced cost. To ensure this is attained, the Ministry conducted monitoring of TANESCO power generation activities. Two monitoring approaches were applied by the Ministry of Energy. These were monitoring through performance reporting as well as visitation to power generation plants to make physical observations.

Inadequate scrutiny of submitted reports

The audit found that TANESCO used to submit daily and monthly reports via phone through short message system (SMS) to Ministry of Energy. TANESCO also submitted quarterly reports to the Ministry. However, the audit noted that the Ministry did not analyze submitted reports to establish trend in information regarding maintenance of power generation plant. Consequently, the ministry could not adequately monitor the effect of maintenance on ensuring availability of power generations at relatively reduced cost. It was also revealed by the audit that structure of reports was not geared towards enabling corporate management to timely make effective and meaningful informed decisions to remedy situations.

Physical Observations

The Ministry of Energy conducted visits in TANESCO power generation plants. The visits were made on ad hoc basis and there was no observation reported. There were also no criteria available in the ministry guiding these visits. The Ministry of Energy informed the audit team that criteria applied to decide visited plants was on plant conditions reported. Lack of formalized criteria leaves the Ministry with subjective criteria.

It was also noted by the audit team that from February to and March, 2018 the Ministry of Energy appointed a task force for physical follow-up of maintenance of power generation plants. This was in response to challenges reported by TANESCO on repeated power plants failures. The audit also revealed that the visitation was just an ad hoc activity.

The following were recommended by the task force:

(a) Establishment of dedicated workshop for repairing spare parts,
(b) Improvement of procurement process to speed initiated procurements,
(c) Enhancing specialized skills training to TANESCO maintenance staff, and
(d) Ensure timely availability of funds for the planned maintenance activities.

The audit noted that, although the Ministry provided these recommendations, but there was neither action plan nor follow-up plan for these recommendations.

CHAPTER FOUR

CONCLUSION

4.1 Introduction

This chapter provides the conclusion of the audit. It contains the General conclusion and specific conclusions

4.2 General Conclusion

Based on the findings presented in chapter three, it is concluded that TANESCO does not adequately conduct risk based preventive maintenance as well as corrective maintenance of its power generation plants to ensure sustainable and uninterrupted electric power generation in the country. Furthermore, the Ministry of Energy did not ensure the maintenance of power generation plants for sustainable power generation was effectively implemented. TANESCO did not adequately manage procurement of spare parts and vendors for maintenance of power generation plants with due regard to timely delivery, cost effectiveness and quality. Also TANESCO did not have adequate plans for staff training to have in-house specialized skills needed to conduct maintenance of its power generation plants. Finally both TANESCO and Ministry of Energy did not adequately monitor and institute corrective actions for the maintenance activities of the power generation plants.

4.3 Specific Conclusions

Procurement of spare parts and vendors for maintenance of power generation plants

TANESCO inadequately managed procurement in maintenance of plants and implementation of annual procurement plans.

There have been delays in procurement of required spare parts for power generation plants. TANESCO use TAPROS for managing procurement process in only two power plants and procurement management in all other power plants is manually managed which contributes to inefficient and ineffective procurement information

management. Late submission of specifications or inputs for initiation of the procurement process by power plants resulted to delay in spare parts acquisition.

TANESCO did not adequately do market research for procurement of spare parts. This resulted into price escalation and under budgeting. There was also inadequacy of budgeted funds and prioritization when budgeting for maintenance activities even when plants have critical conditions. There was also inconsistency in the use of funds allocated for maintenance activities. Some noted maintenance was caused by inability for TANESCO to trace manufacturers which was associated with lack of close and constant communication.

Capacity to conduct risk based maintenance

TANESCO had inadequate specialized skills and tools to conduct risk based maintenance of its power generation plants to ensure maximum plant availability.

On human resources development, TANESCO did not execute training plans for specialized skills in maintenance of modern power generation plants. The survey of training needs assessment conducted to staff was not comprehensive as it was represented by less than half of the TANESCO work force. Besides the academic qualification, TANESCO should have benefited from the workforce if trainings needs assessment would have been aligned with corporate objectives as it was not feasible to train each and every staff in whatever one wishes to be trained. Technical working staff lacked creativity as well as pro-activeness.

Risk based maintenance

There is no framework established to register risk conditions, prioritizing them and conduct maintenance based on risk. TANESCO did not have maintenance risk framework showing performance trends and failure analysis and history for power generation plant components. The company does not keep key information such as failure history and analysis, failure duration and impacts. TANESCO does not have a register showing critical spares, faults, processes and services showing levels of criticality, possible causes and proposed remediation approach.

Monitoring maintenance of power generation plants

TANESCO performance reports submitted to the Ministry of Energy did not have information on maintenance of power generation activities. TANESCO did not have sustainable and regular maintenance audits covering all power plants. A review of technical audit reports revealed that in the past three years, only one technical audit was conducted on power generation plants that were connected to the National Grid and twice in off grid plants. Computerized Maintenance Management System (CMMS) was found to have been installed in only two plants, whereas all others were using manual system despite benefits of using CMMS. Furthermore, management did not make use of CMMS to monitor power generation activities.

The Ministry of Energy did not ensure that maintenance is adequately conducted to increase availability of plants. Furthermore there was no guideline to ensure that this objective was met with measurable deliverables.

CHAPTER FIVE

RECOMENDATIONS

5.1 Introduction

This chapter presents recommendations directed to TANESCO on what should be done on maintenance to ensure sustainable power generation.

The National audit office believes that full implementation of these recommendations will significantly improve the way maintenance activities are conducted. The implementation will also ensure that maintenance activities are performed with regard to the 3Es of Economy, Efficiency and Effectiveness in the use of public resources.

5.2 Recommendations to the Ministry of Energy:

Ministry of Energy should:

1. Ensure on a regular basis that they are informed by TANESCO on maintenance and condition of plants and document action to be taken;
2. Put in place guidelines with measurable deliverables to ensure maintenance of power generation plants, including Risk Based Maintenance is adequately conducted to ensure available electricity in the country, generated at lower cost; and
3. Form a team of long experienced experts to periodically do advisory services to MoE management on TANESCO key and critical issues.

5.3 Recommendations to TANESCO

TANESCO should:

1. Ensure procurement processes are conducted under strict adherence to existing laws and regulations and in a timely manner and APPs are initiated immediately after budgets are approved;
2. Ensure Engineering Procurement and Construction (EPC) contracts are exhaustive and to include specialised skills and

certified training of critical systems. Also training courses need to be closely supervised evaluated and monitored;

3. Capacitate the maintenance staff in all it plants and equip its workshops with required working tools to enable in-house repairs and modifications;
4. Implement a computerized procurement system to all plants whereby procurements status can be monitored and accessed at all levels;
5. Put in place a mechanism that will allow innovations and creativity for maintenance activities especially those requiring specialized skills (rewards should be provided for creativity and innovations);
6. Adequately conduct market research for all procurements and high risk machine parts should be prioritized and establish a supplier and vendor data base as well as price data base for each plant;
7. Formulate a risk maintenance framework which shows performance trends, failure analysis and history and analysing failure duration and impact;
8. Ensure sustainable and regular maintenance audits covering all power generation plants;
9. Standardize the format of reporting from power plants to the Ministry such that all issues that need to be monitored by the Ministry are covered and presented in the same manner in all plants;
10. Procure major equipment from original manufacturers and not supplying companies. This shall commit the manufacturers to provide proper specialized training and enhance traceability of spare parts in the future; and
11. Create a power generation forum whereby all generation plants (including private owned plants) will participate and share experience, challenges and successes.

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APPENDICES

Appendix 1: Responses from the Audited Entity

This part covers the responses from TANESCO and the Ministry of Energy. The responses are divided into two parts i.e. general comments and specific comments in each of the issued audit recommendations. This is detailed in appendices 1(a) and 1(b) below:

Appendix 1(a): Responses TANESCO

General Comment

The time allocated to respond for the audit findings was not adequate to pave way for smooth discussions and communication between TANESCO Management and CAG Team

Specific Comments

S/N	Recommendation	Comments of TANESCO	Planned actions	Implementation Timelines
1.	Ensure procurement processes are conducted under strict adherence to existing laws and regulations and in a timely manner and APPs are initiated immediately after budgets are approved	Management has noted the recommendation in the compliance of Procurement laws and regulations in implementing APP. Management will ensure that all internal and external stake holders involved in the procurement process are timely coordinated and in accordance to to the law.	Initiation of procurement immediately after budget and APP approvals. Provision of Progress reports-Monthly and Quartely on APP implementation status.	Annually

S/N	Recommendation	Comments of TANESCO	Planned actions	Implementation Timelines
2.	Ensure EPC contracts are exhaustive and to include specialised skills and certified training of critical systems Also training courses need to be closely supervised evaluated and monitored	Management noted the recommendation. This challenge is mostly on the recent Gas Turbines installations which has maintenance restrictions from original Manufactures as also revealed in the year 2018 in the worker's council. In All previous installations like Hydro Plants and Gas Fired engines no such restrictions are imposed and TANESCO staff have sufficient skills to maintain the Plant.	Training and certification has been considered in the 2019/20 Budgets. The Original equipment manufacturers will be requested for accreditation procedures in order to train our staff accordingly.	Commencing in financial Year 2019/2020
3.	Capacitate the maintenance staff in all its plants and equip its workshops with required working tools to enable in-house repairs and modifications	Most Power Plants have adequate working tools to perform routine repairs works, except for specialized works which are normally carried out with the original equipment manufacturers.	Regular checks and inspection of working tools to ensure availability and good working condition all the time. Revival of Tools day to all Plants to be done Quarterly to reveal the sufficiency and quality of the existing tools	On quarterly basis
4.	Implement a computerized procurement system to all plants whereby its procurement	TAPROS is implemented with the aim of easily monitoring and control all major procurements	TAPROS to be implemented at Plant Level	July 2019

S/N	Recommendation	Comments of TANESCO	Planned actions	Implementation Timelines
	status can be monitored and accessed at all levels	under APP with the exception minor procurement which are conducted under plant or region level.		
5.	Put in place a mechanism that will allow innovations and creativity for maintenance activities especially those requiring specialized skills (rewards should be provided for creativity and innovations)	Management has established Talent Management Policy (TMP) and Performance Accountability Enhancement Program (PAEP) for recognition of talent and reward accordingly.	Implementation of TMP and PAEP	July 2019
6.	Adequately conduct market research for all procurements and high risk machine parts should be prioritized and establish supplier and vendor data base as well as price data base for each plant	The company has supplier and Vendor data base. Price data base for each plant will be established.	Price for machine spare parts to be established through Long Term service Contracts with Original Equipment Manufacturers (OEM)	Starting on Financial year 2019/2020
7.	Formulate a risk maintenance framework which shows performance trends, failure analysis and history and analysing failure duration and impact	Most generating plants are equipped with condition monitoring equipment as part of instrumentations. The instrumentations gadgets provide real time monitored values and there is recommended acceptable	All Old generating plants with insufficient condition monitoring equipment to be upgraded and new Man Machine interface will be installed. Standardized procedures will be instituted on each plant for carrying out and	Starting on Financial year 2019/2020

S/N	Recommendation	Comments of TANESCO	Planned actions	Implementation Timelines
		threshold values for each parameter. Performance trends are observed, recorded and analyzed. Failure analysis to establish Root causes on selected faults is done in form of reports.	reporting the RCA events.	
8.	Ensure sustainable and regular maintenance audits covering all power generation plants	Management has noted the recommendation for implementation.	To prepare Annual Audit schedule to all plants.	Starting July 2019
9.	Standardize the format of reporting from power plants to the Ministry such that all issues that need to be monitored by the Ministry are covered and presented in the same manner in all plants	Standardized reporting format is in place and as of January 2019, report on status and maintenance of generating plants is sent to the Ministry on monthly basis.	To maintain the current reporting system.	Monthly
10.	Procure major equipment from original manufacturers and not supplying companies. This shall commit the manufacturers to provide proper specialized training and enhance traceability of spare parts in the future	Management has already procured LTSA (Long Term service contracts) for some generating plants with original Equipment Manufacturer (OEM). Most of the spare parts and services are now procured directly from manufacturers.	To ensure all generating plants have service contracts with OEM.	Starting on financial year 2019/2020

S/N	Recommendation	Comments of TANESCO	Planned actions	Implementation Timelines
11.	Create a power generation forum whereby all generation plants (including private owned plants) will participate and share experience, challenges and successes	Management has noted Audit recommendation. With exception from IPP SONGAS Gas Plant the country is yet to have big generating Plant for Gas engines and Hydro.	To have generation forum with internal and external stakeholders (Particularly with Songas) Participation in Generation conferences Hydro for example in other part of world. To formalize and extend Generation Business Unit Meetings which currently used as platform to share experience, challenges and successes	Annually

Appendix 1(b): Responses from the Ministry of Energy

Specific Comments

S/N	Recommendation	Comments of the Ministry	Planned actions	Implementation Timelines
1	Ensure that it is informed by TANESCO on the maintenance and condition of plants and document action to be taken on a regular basis	Currently, there is no official reporting structures used for the Ministry of Energy to be informed on performance and maintenance of power generation plants. However, TANESCO shares daily system operation reports that presents the status of power generation plants on daily basis. The daily system operation report among others provides the system generation position, running and standby generation units, and the level of the maintenance required. The Ministry of Energy uses the daily system operation	The Ministry of Energy to direct TANESCO to submit the report on performance and maintenance of power generation plants on quarterly basis. The Ministry of Energy will use the submitted report to follow up and enforce the maintenance of power generation plants to ensure the reliable power supply in the country.	The first report on performance and maintenance of power generation plants will be submitted to the Ministry of Energy by June, 2019.

S/N	Recommendation	Comments of the Ministry	Planned actions	Implementation Timelines
		reports to follow up and enforce initiatives towards procurement of spare parts and maintenance of defective generation units. The Ministry of Energy at any convenient time demands to receive from TANESCO reports on maintenance and condition of the plants and initiative in place to ensure best performance of power generation units.		
2	Put in place guidelines with measurable deliverables to ensure maintenance of power generation plants, including Risk Based Maintenance is adequately conducted to ensure available electricity in the country, generated at lower cost	The operation and maintenance manuals from specific Plant Manufacturers are in place to ensure operation and maintenance of power generation plants are in order. The Ministry of Energy will direct TANESCO effectively	The operation and maintenance manuals from manufacturer of specific power generation plants should be maintained being used as guidelines for performance and maintenance of power generation plants. However, the Ministry of Energy will	The Ministry of Energy to direct TANESCO to effectively apply the Risk Based Maintenance during the maintenance of power generation plants before 31st March, 2019. The experts from the Ministry of Energy to use

S/N	Recommendation	Comments of the Ministry	Planned actions	Implementation Timelines
		apply Risk Based Maintenance during maintenance of power generation plants. The experts from the Ministry will regularly visit the power generation plants to monitor performance and maintenance of power generation units and observe if TANESCO applies Risk Based Maintenance during the undertaking of maintenance of power plants. The key performance indicator to be observed is the efficiency improvement of power plants.	direct TANESCO to apply fully the Risk Based Maintenance during the maintenance of power generation plants.	report on performance and maintenance of power generation plants to monitor application of Risk Based Maintenance during the maintenance of power generation plants by June, 2019.
3	Form a team of long experienced experts to periodically do advisory services to MoE management on	The long experienced experts have been utilized to advice the Ministry of Energy towards	Recommendation is considered. However, the Ministry of Energy will continue	The institutions under the Ministry of Energy will be advised to utilize expertise from long

S/N	Recommendation	Comments of the Ministry	Planned actions	Implementation Timelines
	TANESCO key and critical issues	implementation of power generation, transmission and distribution projects. Currently, TANESCO have deployed these experts to work in the transmission and distribution company (ETDCO) for construction of power transmission and distribution networks in the country. The advices from long experienced experts also are being utilized in team of experts delegated by the Ministry of Energy to supervise the construction of 2,100MW Rufiji Hydropower project.	utilizing expertise from long experience experts depending on the need.	experienced experts on key and critical issues towards development of energy projects.

Appendix 2: Detailed Main audit questions with sub-questions

This part provides the list of audit questions and their respective sub-questions:

Audit Question 1	**To what extent does TANESCO timely manage procurement of spare parts and vendors for maintenance of power generation plants with due regard to timeliness, cost effectiveness and quality?**
Sub Audit Question 1.1	Does TANESCO adequately plan for maintenance of power generation plants?
Sub Audit Question 1.2	To what extent does TANESCO procure the right spare parts for power generation plants at economic costs?
Sub Audit Question 1.3	Does TANESCO ensure procurement process is timely fulfilled?
Audit Question 2	**To what extent does TANESCO have capacity to conduct maintenance of power generation plants?**
Sub Audit Question 2.1	Does TANESCO set aside funds for the maintenance of power generation plants?
Sub Audit Question 2.2	Does TANESCO plan and conduct training for specialized skills in maintenance of power generation plants?
Sub Audit Question 2.3	Does TANESCO ensure specialized skills are disseminated to its staff before plant decommissioning?
Sub Audit Question 2.4	Does TANESCO have adequate tools, equipment and technology for conducting maintenance of power generation plants?
Audit Question 3	**Does TANESCO identifies risks conditions in power generation plants, prioritize risks identified and conduct maintenance as per risk priorities?**
Sub Audit Question 3.1	Does TANESCO prepare and update maintenance risk register?
Sub Audit Question 3.2	Does TANESCO prioritize maintenances of power generation plants based on risk?
Audit Question 4	**To what extent do TANESCO and the Ministry of Energy monitor maintenance of power generation plants?**
Sub Audit Question 4.1	Does TANESCO regularly and timely monitor maintenance activities?
Sub Audit Question 4.2	Does TANESCO evaluate and report on maintenance activities timely?

Sub Audit Question 4.3	Does TANESCO take remedial actions based on monitoring and evaluation reports on maintenance activities?
Sub Audit Question 4.4	Does Ministry of Energy have an insight on how maintenance of power generation plants is managed – as a basis for prioritizing efforts on improvements?

Appendix 3: Detailed Assessment Criteria and Sources

Audit issue	Assessment criteria and Source
Extent to which TANESCO timely manage procurement of spare parts and vendors for maintenance of power generation plants with due regard to timeliness, cost effectiveness and quality	TANESCO strategic Plan (2017/18-2020/21) (1.3.1.1(a): TANESCO are required to conduct Maintenance of all power generation plants to ensure maximum plant availability and efficient utilization of all generation asserts. Regulation 5 (2) (b) of PPR (2013) requires the goods, works, or services to be appropriate to the requirements. Section 63 (2) of PPA (2011) requires all procurement to be conducted be conducted in a manner that maximizes competition and achieve economy, efficiency, transparency and value for money. Regulation 5 (2) (c) of PPR (2013) requires the goods to be delivered, the services are provided, and the works are completed in a timely manner in accordance with TANESCO priorities.
Capacity to conduct maintenance of power generation plants	TANESCO strategic Plan (2017/18-2020/21)(1.3.1.1(a)): TANESCO are required to conduct Maintenance of all power generation plants to ensure maximum plant availability and efficient utilization of all generation asserts. Section 6.2.2 (a) ISO 9001:2008 requires TANESCO to ensure necessary competence is acquired by personnel performing technical work (maintenance). TANESCO Corporate Business Plan 2016/2017: Function of human resources under section no 3 and 4 respectively requires Training and Manpower Development; TANESCO is responsible for managing training plans as well as coordinating all corporate trainings to meet competency requirements of the company The best practice for contracts engagement requires contractor to provide training to enhance staff capacity to procuring entity. TANESCO are supposed to ensure knowledge transfer is part of the negotiation before contract signing TANESCO Corporate Plan: TANESCO are expected to; visualize benefit of use, acquire and utilization of technologies so as to easily conduct and manage

	maintenance. Also they are required to ensure availability of adequate tools, equipment and technology for maintenance of power generation plants.
Whether TANESCO identifies risks conditions in power generation plants, prioritize risks identified and conduct maintenance as per risk priorities	Section 9 of Corporate Business Plan 2016/17 requires TANESCO to avoid equipment performance degradation or failure through operational risk management. Section 9 of Corporate Business Plan 2016/17 requires TANESCO to strategized and conduct operational risk evaluation and mitigation to ensure timely delivery of services. Regulation 63 (1) (c) of PPR (2013) requires TANESCO to identify, specify and prioritize the immediate procurement activities which may be used in the period of the emergency.
Extent to which TANESCO and the Ministry of Energy monitor maintenance of power generation plants	Regulation 114 (b) of PPR (2013) requires TANESCO to monitor the progress and timely completion of maintenance works in accordance with the terms of each contract. According to TANESCO corporate plan, HR through Performance Management; has a responsibility of monitoring and evaluation of all performance improvement projects and programs Section 6.5 of Corporate Business Plan (2016/17) requires TANESCO to ensure that targets are met and promote a better follow up of KPIs within the company. Regulation 114 (c) of PPR (2013) requires TANESCO to take or initiate steps to correct or discipline deviations from observance of contract condition. International Organization for Standardization (ISO) 9004: 2000, Quality management systems-Guideline for performance improvement; Chapter 4; page 86 requires the organization to plan and carry out production and service provision under controlled conditions such as; the availability of work instructions, as necessary, the availability and use of monitoring and measuring devices; and the implementation of monitoring and measurement.

Appendix 4: Methods for Data Collection

This part provides the detailed methods for data collection which are: reviews of documents, interviews and observations.

a) Interviews

To be able to respond to the audit questions and provide conclusions against the audit objective, interview method was used to collect information. The interviews allowed the audit team to get a broader understanding of the audit area and identify existing challenges, root causes and eventually the consequences to those problems.

The audit team conducted interviews and discussions with officials from the Ministry of Energy, TANESCO and visited Power plants. The Table below provides a detailed list of individuals and entities that were interviewed during the audit and the reasons for interviewing each of them.

Table showing list of interviewed officials and reasons for interview

	Interviewed Official	Reason for Interview
	Officials in the Ministry of Energy	
1	Commissioner of Energy	The ultimate accountable official for energy sector at Ministry responsible for Energy
2	Assistant Commissioner for Electricity	Official responsible for monitoring daily electricity activities
	At TANESCO	
3	Deputy Managing Director Generation	Entry Meeting, introducing the audit
4	Senior Manager- Generation	Getting clarification on power generation maintenance issues at corporate level
5	Acting Deputy Managing Director- Investment	Getting clarification on inclusion of skills training for power generation projects
6	Manager- Grid Control Centre	Getting clarification on management of grid during maintenance activities
7	Senior Manager- Training	Getting clarification on training issues for power generation maintenance staff
8	Manager- Thermo	Getting clarification of maintenance issues for off-grid thermo power generation plants
9	Manager- Hydro	Getting clarification of maintenance issues for hydro power generation plants
10	Head- Procurement Management Unit	Getting clarification of procurement issues affecting maintenance of power generation plants

11	Plant Accountants	Getting clarification of Budget and other financial issues affecting maintenance of power generation plants
	At the visited Plants	
12	Plant Managers	Getting clarification of maintenance issues for power generation plants at plant management level
13	Principle Engineers	Getting clarification of technical maintenance issues, plants and challenges for power generation plants at plant management level
14	Maintenance Engineers	Getting clarification of specific technical maintenance scenarios on power generation plants at plant management level
15	Supplies Officers	Getting clarification of involvement of supplies activities on power generation plants maintenance at plant level
16	Accountants	Getting clarification of involvement of accounting function on budgeting for power generation plants maintenance at plant level
17	Human Resource Officers	Getting clarification of involvement of human resources function on skills management for power generation plants maintenance at plant level

b) Review of documents

Documents were reviewed in order to obtain appropriate and sufficient information to enable the audit team to come up with clear findings which are supported by collaborative evidences.
The reviewed documents were those falling within the period under audit i.e. 2015/16 up to 2017/18. Some of the documents reviewed and reasons for review are detailed in the Table below:

Table showing List of reviewed documents and reasons for review

S/N	Reviewed Document	Reason for review
1.	Electricity Act (2008)	Understanding legal requirement for the role of TANESCO in power generation
2.	Public Procurement Act (2011)	Understanding legal requirement procurements in executing procurement for maintenance of power generation plants
3.	Regulations for Public Procurement (2013)	Understanding regulations requirements for procurement in activities while executing procurement for maintenance of power generation plants

S/N	Reviewed Document	Reason for review
4.	TANESCO strategic Plan (2017/18-2020/21)	Understanding mid-term power management as well as maintenance strategies and maintenance plans for power generation plants
5.	Power Sector Reform Strategy and Roadmap (PSRS) 2014-2015	Understanding long-term strategies for power generation and the contribution of power generation plants maintenance in the strategy
6.	TANESCO Corporate Business Plan- 2016/17	Understanding TANESCO plan requirements for power generation plants maintenance
7.	International Standards Organization 9001:2015 and 9001:2008	Understanding quality requirement for service provision guiding maintenance of power generation plans
8.	TANESCO Budget for financial year 2015/16 to 2017/18	Understanding budget and effect of its execution for power generation plants for the year 2015/16- 2017/18
9.	Maintenance Plans	Understanding maintenance activity plans for power generation plants for the year 2015/16- 2017/18
10.	Maintenance Reports	Understanding maintenance activities conducted and challenges for power generation plants for the year 2015/16-2017/18
11.	TANESCO Training plans for financial year 2015/16 to 2017/18	Understanding maintenance activity plans for power generation plants for the year 2015/16- 2017/18
12.	TANESCO Annual Procurement Plans for financial year 2015/16 to 2017/18	Understanding Effect of procurement plans and activities on maintenance of power generation plants for the year 2015/16-2017/18
13.	TANESCO Training Plans for financial year 2015/16 to 2017/18	Understanding TANESCO training plans for maintenance activity plans for power generation plants for the year 2015/16-2017/18
14.	Maintenance Service contracts	Understanding effect of service contracts for power generation plans maintenance
15.	Maintenance tender dispute	Understanding dispute management for maintenance tenders
16.	Training reports	Understanding sufficiency of training contents for maintenance activities

c) Physical Observations

Table below presents visited Power generation plants

Table showing list of visited Power Generation Plants

S/N	Region	Visited Power Plant	Type of Plant
1	Dar es Salaam	Kinyerezi I	Thermal - Gas
2	Dodoma	Mtera	Hydro
3	Tanga	Hale	Hydro
4	Tanga	Pangani	Hydro
5	Morogoro	Kidatu	Hydro
6	Mwanza	Nyakato	Thermal- Heavy Fuel
7	Rukwa	Sumbawanga	Thermal - Diesel
8	Mtwara	Mtwara	Thermal - Gas
9	Dar es Salaam	Songas	Thermal - Gas
10	Dar es Salaam	Ubungo II	Thermal - Gas