Transnet National Ports Authority

Standard Operating Procedures

ENGINEERING: ASSET MAINTENANCE PRINCIPLES & PROCEDURES

Part 2 – Maintenance Procedures

Policy Ref:

REVIEWED BY Kabelo Modipane Snr Engineer Sibusiso Nhlabathi Deputy Chief Engineer	27/09/2016 DATE
RECOMMENDED BY Dorian Bilse Chief Engineer	29/9/2016 DATE
APPROVED BY Hamilton Nxumalo GM: Infrastructure	3/10/2016 DATE
NEXT REVIEW	**AS AND WHEN REQUIRED**

AMENDMENT RECORD

REV.	SECTION AFFECTED/REFERENCE	DATE
8	7.3 Oversite Role updated	12-09-2016
8	7.5 Review Process Changed	12-09-2016

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1 PURPOSE

The purpose of this document, AMP&P Part 2a, is to give substance to the philosophy and the fundamental principles in Part 1. This document details the procedures to be followed in undertaking maintenance in order to prevent the erosion of asset value as a result of inadequate maintenance.

2 BACKGROUND

The inherent value of the TNPA is lodged in its asset base which comprises mainly of Infrastructure, Real Estate, Marine, Dredging and Lighthouse Services assets. This demands appropriate maintenance procedures that ensure sustained asset functionality, safe conditions for port users, as well as the facilitation of safe navigation along the coast of South Africa.

3 SCOPE

This document is intended to cover the following class of assets:

- Civil, electrical, mechanical assets falling under the Infrastructure department; and
- Leased buildings falling under the Real Estate Department.

Dredging, Marine and Lighthouse Services have their own comprehensive maintenance manuals that cover their respective assets.

4 RESPONSIBILITIES

Control of the maintenance process and planning are in-house functions and shall not be outsourced without permission. The provision of physical maintenance services on the other hand is not a core activity and outsourcing is encouraged in cases where in-house capacity is lacking.

The Port Engineering departments shall be responsible for and control the budget for the maintenance of port infrastructure assets, including ship repair facilities. No infrastructure maintenance shall be carried out without the approval of Port Engineers or their delegates.

Real Estate is responsible for and controls the budget for the maintenance of all leased assets.

The Maintenance Managers shall be responsible for all maintenance to be carried out to assets under their custody.

5 DEFINITIONS

Definitions relating to maintenance are included in Part 1 of the AMP&P.

6 ABBREVIATIONS

- AC: Alternating Current
- AIA: Approved Inspection Authority
- AMP&P: Asset Maintenance Principles and Procedures
- BOM: Bill of Materials
- BOQ: Bill of Quantities
- BW: Business Warehouse
- CFO: Chief Financial Officer
- CSIR: Centre for Scientific and Industrial Research
- CURA: Risk Management Software
- DAC: Divsional Acquisition Council
- DC: Direct Current
- DIFR: Disabling Injury Frequency Rates
- ER: Employee Relations
- FAR: Fixed Asset Register
- GM: General Manager
- HR: Human Resources
- HV: High Voltage
- ILP: Individual Learning Plan
- IMO: International Monetary Organisation
- IMS: Information Management Services
- ISPS: International Ship and Port Facility Security
- KPA: Key Performance Area
- KPI: Key Performance Indicator
- LV: Low Voltage
- MDS: Market Demand Strategy
- MOU: Memorandum of Understanding
- MRP: Manufacturing Resource Planning

- NEMA: National Environmental Act
- OCIMF: Oil Companies International Marine Forum
- OEM: Original Equipment Manufacturer
- OHTE: Overhead Traction Equipment
- OPCO: Operations Committee
- OPEX: Operational Expenditure
- OHS Act: Occupational Health and Safety Act
- PAC: Port Acquisition Council
- PPE: Personal Protective Equipment
- PPM: Procurement Manual
- RME: Rail Maintenance Engineering
- RUL: Remaining Useful Life
- SANS: South African National Standards
- SAMSA: South African Maritime Safety Authority
- SAP PM: Systems, Applications and Products Plant Maintenance
- SAP PMIS: Plant Maintenance Information System
- SHERQ: Safety Health Environment Risk Quality
- SOP: Standard operating Procedure
- TCP: Transnet Capital Projects
- TFR: Transnet Freight Rail
- TNPA: Transnet National Ports Authority
- TRH: Technical Recommendations for Highways

7 MAINTENANCE METHODOLOGY

7.1 MAINTENANCE PROCESSES

The maintenance process refers to the fully inclusive series of procedures and events that will ensure optimally maintained and well cared for assets.

A detailed description of the process is tabled below. The steps are shown in approximate sequence but some tasks will in practice be executed in parallel.

Note: "job" refers to a specific maintenance project; in most cases a job will be the work required on a particular asset during a financial year and will result in an individual works order.

Process Element	Description / Steps	Outputs	Comments
Regular or Annual Inspection	Inspect assets as prescribed. Compare actual & target conditions. Decide whether remedial action is required. Consult users and sign off requirements.	Entries in inspection form. Completed preventive maintenance order detailing inspection and asset inspected.	Some inspection intervals may be less than one year. Critical work may have to be carried out in current year. All assets requiring inspections must have an appropriate maintenance plan.
Determination of Workload	Assessment of physical work required. Describe job elements. Consult environmental department to identify requirements, if any. Forward maintenance requirements for leased assets to Property Manager.	List of tasks per asset.	
Planning	Determine resource requirements. Prioritise jobs. Obtain inputs regarding occupations and other user requirements where relevant. Amend personnel structure if required.	Prioritised list of jobs.	
Costing	Determine cost of job per resource requirements	Prioritised list of jobs with cost per resource (labour, material, plant, contract, other)	

Process Element	Description / Steps	Outputs	Comments
Budgeting	Prepare outline schedule for all jobs. Calculate cash flow per job. Summarise job cash flows to get total cash flow. Enter into system according to budget guidelines. Obtain approval / amend using priority list as guide if required.	Draft maintenance schedule. Monthly cash flow. Approved budget.	
Organisation	Prepare final schedule. Implement personnel structure.		
Execution	Procure resources according to schedule. Carry out work. Monitor quality, legal compliance, progress and spending and take appropriate action as required. Enter relevant information into SAP.	Transfer approved maintenance schedule into SAP by way of maintenance plans and detailed task lists. Schedule approved maintenance plans. Process released maintenance orders to completion.	
Audit	Regular inspections of processes and assets Monitor progress on SAP system	Call BW and SAP PMIS reports	

It should be noted that whilst reference is made to annual inspections, there are assets that require more frequent specific types of inspections. This is covered either in legislation or OEM specifications.

7.2 STAKEHOLDER INVOLVEMENT

For relevant asset maintenance such as quay walls, buildings, etc. stakeholders may be required to be consulted and involved in maintenance planning and occupations in order to minimize disruptions to business and lower the costs of downtime.

7.3 OVERSIGHT ROLE

The oversight role is related to TNPA assets leased to Third Parties and to Parties operating on TNPA property. The Port Real Estate Manager acting on behalf of TNPA will ensure that the leased assets are maintained to the appropriate standards, as set by the Manager in charge of TNPA Real Estate.

The Rail Regulator requires that interface agreements are signed with all lessees and Private Siding Operators of the Port to ensure maintenance and safety management of rail infrastructure. Ensure regular Sidings inspections are conducted by ports personnel.

7.4 COMPLIANCE

Nothing stated in this manual shall be construed to supersede, supplant or override any existing legislation or any Transnet or TNPA policies. Instances where conflicts or apparent conflicts are indicated must be referred to the Chief Engineer without delay.

All existing legislation and related regulations shall be adhered to in the execution of the maintenance processes. In addition, all existing Transnet policies, guidelines and regulations shall also be adhered to in the execution of the maintenance processes. For convenience and guidance a list of relevant legislation, regulations, policies and guidelines is given in Appendix 2.1.

The port environmental office must be consulted after the determination of the maintenance workload to ensure compliance and to identify special requirements. If any special measures are required to meet environmental standards, the costs must be included in the Port Engineer's maintenance budget.

7.5 REVIEW PROCESS

The Chief Engineer is the custodian of this document. All errors, omissions and proposed additions and improvements must be communicated to the Chief Engineer in writing. No amendments will be effective unless included in the latest version of the manual or unless communicated in writing by the Chief Engineer.

The Asset Maintenance Principles and Procedures Part 1 will only be reviewed in the case where circumstances have changed to the degree that these principles need to be revised. Should amendments be necessary, these will be discussed with the GM:

Infrastructure and submitted for ratification to OPCO. Amendments will be effected in an updated version of the Principles document which will be distributed to all relevant stakeholders. The Asset Maintenance Principles and Procedures Part 2 will be reviewed as and when required by the Chief Engineer. An updated version of the document will be distributed following approval of the updated version. Amendments of a critical nature will be dealt with on an ad hoc basis.

7.6 MAINTENANCE CYCLE

The maintenance cycle discussed in this section is depicted in the figure below.

7.6.1 PLANNING

The main benefits of proper planning are that the organization uses resources effectively, safety improves and plant and equipment has a higher uptime. Maintenance planning must take into account the latest Strategic Initiatives such as the MDS. The next table lists the critical planning elements that must be addressed during the course of planning for maintenance activities.

Item	Aspect	Comment
SAP PM	Alignment between FAR and SAP PM	Finance is the custodian of the FAR and is responsible for managing the process to keep this register up to date. Maintainable assets shall be allocated at Port Manager level to the appropriate Departmental Heads within the Port. The Port Engineer should ensure that there is alignment between the FAR and the SAP master data. The relevant Maintenance Manager must ensure that maintenance regimes are created on SAP PM for all maintainable assets.

Item	Aspect	Comment
		Where TNPA assets are leased to third parties, the lessee must ensure that the assets are maintained to the appropriate standards. It is the responsibility of Real Estate to manage this matter.
	Inspection frequencies and task lists	All assets must be inspected as per statutory, OEM, Transnet Codes of Practice or departmental procedures. All inspection frequencies must be loaded onto SAP through detailed task lists assigned to active maintenance plans.
	Asset condition monitoring	All categories of assets should be assessed as stipulated in Section 9. Asset condition monitoring schedules must be integrated with the SAP PM system to enable the overall condition of assets in ports to be displayed by the system.
	Remaining Useful Life	Appendix 2.2 outlines the asset management framework and Appendix 2.3 details the determination of RUL. The determination of RUL should eventually form part of the asset condition monitoring activities.
	Targets	The list of KPI's that should be monitored is included in Appendix 2.4.
Financial Planning	Preparing annual budgets	Budgets for each of the operating functions must be performed strictly in accordance with the guidelines issued by the Finance Department. The zero based budgeting approach should be adopted as a general rule for planned maintenance activities.
	Life cycle costing	Life Cycle Costing considers the total asset cost from conception to disposal. The principles of life cycle costing should therefore be applied from the conceptual design stage, especially during the development and consideration of alternatives.
Human Resources	Organogram	Each Port must have an updated organogram that supports the maintenance strategy. An ideal organogram is included in Appendix 2.5. Maintenance planning should form the core of the maintenance team. Inspectors feed into the planning role and execution teams carry out work given by planning. There may be instances whereby the Inspector and Executor is the same person. Although this is not ideal, it may be necessary for the short term structure. Where a major portion of the maintenance work is outsourced such as in building and civil maintenance, adequate Contract Managers/ Technical Officers must be brought into the maintenance structures to manage outsourced work. It is the responsibility of the relevant Managers to formally notify Management of the risks/consequences of not filling critical posts.
	Roles and responsibilities	The typical duties for the various staff members are outlined in Appendix 2.6. If this varies from the HR Job Profiles, then the profiles must be adjusted to include the additional tasks
Procurement	In house versus outsourcing	In-house maintenance resources must be fully utilized before work is to be outsourced.

Item	Aspect	Comment
		In the event of work being outsourced, Procurement is to advise Line Managers on the relevant procurement strategy. This process must be strictly managed to minimise delays.
	Scope of work	The scope of work to be outsourced must have sufficient detail so that it is clear to tenderers what they need to do so that they can quote accordingly and also that upon completion of the project, the right deliverables are achieved.
	Technical specifications	Technical specifications must be clear and where necessary they must refer to the relevant Codes of Practice, statutory requirements or OEM specifications for completeness. SHERQ specifications must be included based on the scope of work of the particular maintenance operation.
	Bills of quantities	BOQs must be as comprehensive as practically possible since this is key to the successful completion of the works. However, it may not always be possible to inspect all components before the Tender documents are completed e.g. overhaul of a floating dock. It is only once the component is fully stripped, will one will know the extent of repairs. In order for work to proceed smoothly, provisional sums and contingencies must be considered in contract documents and BOQ, and appropriate delegation of authority must be granted to the person appointed to oversee the contract.
	Stock items	Material and spare parts that are used repetitively must form part of the inventory list. Even if items are used at low frequencies, they need to form part of the inventory and can be kept at zero value; when needed, a reservation is created and the item is ordered for the job on a just in time basis. All material and components used repetitively should be structured in SAP by way of a PM Bill of Material to assist in the procurement of materials and spare parts through maintenance orders
	Confinement to agents	There are many assets that can only be repaired by the relevant Agents, who are also the sole provider of replacement parts. In these instances, the Maintenance Team needs to spend adequate time and effort with the Procurement Department to prepare a motivation to confine work to the Agent. This motivation must be submitted to the relevant authorities for approval.
	As and when contracts	These contracts are useful when there are staff shortages to deal with unplanned or breakdown type repairs. These contracts have a limited value or timeframe in which they exist.
	Communication and turnaround time	The date on which a service or material is required by the depot must be inserted on the relevant maintenance order. The Procurement Department needs to follow up with suppliers so as to ensure that the service/goods are delivered in time for executing the maintenance tasks.

Item	Aspect	Comment
		The obligation lies with the maintenance department to regularly request progress reports from Procurement to ensure that materials/services are delivered timeously.
SHERQ	Legislation	All maintenance teams must ensure that maintenance work is executed in accordance to the OHS Act and is relevant Regulations. Furthermore, the work must be planned and executed in compliance with all environmental legislation. If there is any doubt, the Environment Department must be approached for advice.
	Risk assessments	All Maintenance Managers should ensure that risk assessments are completed on maintenance work and aligned with Transnet's Risk Assessment System (CURA). In the event that any new operation/activity/task is undertaken, a risk assessment needs to be completed prior to commencement of operation/activity/task. A risk assessment treatment plan needs to be developed to reduce or mitigate the risks. Use of the SAP PM permit system assigned either to technical objects or maintenance orders must be adhered to in instances where safety or work conditions are required before work is commenced or on work completion. In the event an asset is unsafe, defective or in a state of disrepair, maintenance teams must issue a stop certificate and inform the relevant Parties. Arrangements for alternative options, if required, must be made for business continuity and to minimise disruptions.
	Involvement of Risk	Maintenance Managers must use the TNPA Risk department on a regular basis to assist with facilitation of risk assessment and mitigations measures, consultation with legal issues, management of SHERQ IMS system, auditing and monitoring. Where Specialist Consultants (AIAs) are required, these should be sourced as per PPM procedures, with input from the Risk Department.
	Personal Protective equipment	TNPA Management and First Line Supervisors should ensure that all PPE is compliant to General Safety Regulation 2 and is worn at all times on the job or as specified by different construction sites. TNPA staff supervising Contractors working on TNPA Property and assets should also ensure that the required PPE requirements are worn at all times.
	Environmental Authorisations	Environmental regulations and requirements are constantly changing. Maintenance teams must ensure that their activities meet the requirements of these regulations. Where there is doubt around requirements, maintenance teams must consult the TNPA Environment Department for guidance. No maintenance work may proceed without the necessary approvals, permits, processes, procedures in place.

Item	Aspect	Comment
	Quality requirements	Planned work must meet original design or OEM specifications or requirements. Where modifications are made, these modifications must be signed-off by a competent person; a person with the relevant qualifications or by a relevant AIA which-ever is relevant.
	Record keeping	Records of all inspections, tests, modifications, maintenance and repairs must be kept safely and shall be open for inspection by Senior Management or Inspectors from Department of Manpower.
	Permits	No work will commence without the relevant permits being in place. Examples of such permits include hot work, gas free, entry to restricted areas, dredge material dumping permits, security, etc.

7.6.2 EXECUTION

This chapter will cover the relevant themes related to the execution of maintenance. It is here that the Maintenance Manager will coordinate and direct resources to meet the objectives of the maintenance plan. The executing process keeps the maintenance plan on track for the duration of the financial year. The table below lists the critical execution elements that must be addressed during the course of executing maintenance.

Item	Aspect	Comment
Maintenance	Scheduling Maintenance Plans	Maintenance plans must be created on SAP PM for all assets that require recurring maintenance/inspections as well as planned work arising from recurring inspections.
	Maintenance Orders	Shop papers are printed once the maintenance order has been released. Shop papers detail the maintenance/inspection to be carried out, completion confirmation slip and material withdrawal slip.
	Weekly Meetings	Weekly technical planning meetings must be held with Technical Supervisors and Management. The team can review and assess the week's workload and request changes if necessary.
	Schedule Adjustments	Schedules can be adjusted in SAP PM to allow for the prioritizing of unscheduled work. Care must be taken to ensure that statutory maintenance/inspections are not compromised.
Finance	Adequacy of budget	All maintenance work undertaken must be funded from the approved budget. Should additional funding be required, the necessary approval procedures must be followed.

Item	Aspect	Comment
	Unplanned work approval	All unplanned work should firstly be approved by an official with the correct delegation of authority together with the necessary funding requirements before execution of work commences. Should there be no funds for critical unplanned work then planned work must be reprioritised on the existing budget to free up funds.
	Emergency work orders	Emergency work should be treated in the same manner as unplanned work. Approvals may be verbal but should be within the relevant delegation of authority of the individual. This verbal approval must be formalized at the earliest opportunity.
	Operational costs	Measures shall be taken to ensure that operational costs of assets are not accounted for as maintenance. Operational costs may include the costs associated with facilities management, TNPA water consumption, etc.
	Cost recovery	Measures shall be implemented to recover maintenance costs of services provided to both internal and external port users.
	Overhead costs	All administrative, supervisory and management maintenance personnel who are not directly (physically) engaged in maintenance work are regarded as indirect labour. Indirect labour costs must be added to direct labour rates to form part of the inclusive labour rates used in the SAP system. The inclusive labour rates shall be reviewed annually and cost centre activity values updated in SAP by the end of March of each year.
	Insurance cover	Where necessary, PCI must be budgeted for and arranged.
	Forward Cover	This is rarely encountered in day to day maintenance but it may be relevant to acquisition of parts or equipment that is imported. The Finance and Procurement Departments will assist the maintenance teams with this matter.
Human Resources	In house teams	It is a generally accepted rule across many leading organizations that all inspections, breakdowns and emergency work are done in-house. Therefore maintenance structures must cater for in-house resources to execute such work. In-house teams must be given preference to execute planned workload should the capacity exist.
	Staff shortages	Where a shortage of staff or skills exists, it is advisable to supplement manning levels with short term contract workers. The Maintenance Department should arrange with the HR Department to have contractual arrangements in place to source potential contract-workers within an acceptable timeframe. Alternatively, other Transnet Divisions can be appointed for the execution of maintenance work. Maintenance teams must adhere to policies and procedures for the appointment of these divisions.

Item	Aspect	Comment
	Training	Training of staff must be done as per agreed ILP's so as to ensure that there are sufficient skills for maintenance activities. There must be sufficient manning levels in place to allow for the release of staff for training.
Procurement	Tender process	All tenders must be managed by the Procurement Department. Maintenance teams must obtain their local tender committee cycle program for planning and ensuring timeous approvals of tenders. The Procurement office must be extensively consulted for guidance on tenders and their approvals.
	Tender evaluation	The technical teams are required to compile the technical specifications as well as the bill of quantities. Specifications must be clear, comprehensive and provide the basis for the best technical solution for asset maintenance. Specifications should not be biased towards any particular Supplier. The safety and environmental specifications must be compiled with the assistance from the SHERQ Department. Multi-criteria analysis techniques are used for most tender evaluations. The technical team will usually evaluate the technical aspects of the bid and compare to the tender specifications.
	Loading contracts	Loading of contracts once approved by the PAC/DAC is a direct function of the procurement department.
	Variation orders	Variation orders must be avoided or minimised through continuous improvement processes. Once a contract is loaded on SAP, it becomes impossible to make payments that exceed the contract value. Unfortunately, history in engineering has shown that variations will happen, and these can be accounted for in the contract via the BOQ.
	Contract extension	Extension of contracts should be avoided as far as practically possible. In the event of an extension, sufficient planning must be in place to ensure timeous approval of the extension
	Stock levels	The Manager in conjunction with the Procurement Manager and MRP Controller must ensure that stock levels are acceptable. It is recommended that the Maintenance Managers, Procurement and Finance meet on at least a six monthly basis to analyse the stock levels and to agree on optimum levels for each function
	Lead times and re-orders	Items with long lead times should generally be kept in stock as opposed to items that are readily available of the shelf from local vendors
SHERQ	Tool box talks	Maintenance teams start off the day with a tool box talk around the work for the day and must incorporate safety measures that are linked to the job and the location where the operation is to be undertaken.
	H&S meeting	The Safety, Health and Environmental meeting is compulsory by law and must be held at least quarterly at the maintenance depot, with appropriate representation of the maintenance teams.

Item	Aspect	Comment
		Standing items on the agenda must include health & safety appointments, development and review of work instructions and SOPs in place, DIFR statistics, contractor safety, PPE, records of audits, safety representative reports and rail safety issues.
	PPE	Appropriate PPE must be supplied, maintained and worn at all times for relevant sites and for tasks that require specialized equipment. Managers must ensure that appropriate levels of PPE is in stock and is readily available to staff. Workers and visitors to sites must adhere to the site rules and the use of PPE.
	Hazardous waste certificates	The SHERQ department must be consulted for guidelines on processes, procedures and approvals that may be required for dealing with hazardous wastes or working in vicinities containing hazardous wastes. All medical certificates must be filed and managed by the SHERQ department as per policy and legal requirements on behalf of the Manager. Dumping and disposal certificates must also be managed and filed as per policy and legal requirements by SHERQ department.
	Occupation	Occupations may be required for inspections and repairs, for example for quay walls. In order to minimize disruptions and to enable execution of maintenance work, careful planning between the asset user and the maintenance team is a prerequisite. Where water supplies or other services may be disrupted for planned maintenance, the maintenance teams must make arrangement for alternative supplies if required.
	Housekeeping	It is of utmost importance that maintenance and procurement teams focus on good housekeeping at the workshops and stores as this creates an environment where teams can operate effectively. It is recommended that teams use the Japanese 5s system and Environmental Regulation 6 as a guideline for this exercise. A brief outline of the 5s system is attached in the Appendix 2.7.
	Oversight role	Assets owned by the TNPA which are leased or concessioned to port users (including other Transnet Operating Divisions) and assets constructed by lessees, concessionaires or other port users which will ultimately become the property of the TNPA, are covered by this policy. Real Estate is responsible for the management of the maintenance processes of these assets. In cases where the TNPA is responsible for the maintenance and repair of these assets, the processes set out above under Maintenance shall be followed. In cases where the lessee is responsible for the maintenance, the annual inspection and determination of workload as described in Maintenance above shall be carried out by the Port Engineers, at the request of the Real Estate Manager. The details and maintenance requirements shall be conveyed to the local Real Estate Manager for communicating to the lessee. The TNPA requirements must be categorised as follows: • Essential work that the lessee must carry out. Typically, this will include mandatory maintenance, restoration of assets to safe

Item	Aspect	Comment
		conditions, and any other maintenance work that cannot be deferred. As a lease agreement approaches the end of its tenure, all work required to satisfy the conditions of lease shall be listed as essential works. • Work that is recommended for execution. Typically, this will include work that will increase in scope if deferred; from a financial perspective, it would therefore be advisable for the occupant to carry out the work.

7.6.3 MONITORING AND CONTROL

This chapter covers the relevant themes related to the monitoring and control of maintenance. During this phase, maintenance performance measurements are taken and analysed to determine if the team is performing as per the maintenance plan. The importance of this is to identify problems as soon as possible so that action can be taken to correct deviations which will contribute to successful completion of the maintenance activities. The table below list the critical monitoring and control elements that must be addressed during the course of maintenance activities.

Item	Aspect	Comment
Maintenance	Reports drawn	At least the first four reports outlined in Appendix 2.4 must be drawn on a weekly basis and discussed with the maintenance team. This must include monitoring of physical progress against planned progress.
	Analysis of reports	Reports must be regularly analysed with the managers and supervisors for performance measures and deviations from set standards.
	Action plan	Action plans must be developed with timelines to close-off items that negatively affect the maintenance programs. Items that require intervention must be brought to the attention of the Port Engineer who will table the issues at relevant forums.
	KPA inputs	Tracked maintenance KPI's should form part of the KPA's for First Line Supervisors and Maintenance Managers.
Finance	Year to date spending	Each cost centre Manager must scrutinize all general ledger line items that appear on the monthly income statement. Variance analysis must be undertaken and appropriate action plans put in place to correct both positive and negative variances.
	Records	Records must be kept of all unplanned expenditure approvals.
	Monthly income statement	It is a financial and audit requirement to sign-off monthly income statements after analysis and formulation of steps to be taken to control spending.

Item	Aspect	Comment
Human Resources	Attendance	It is important for line managers to run and analyse monthly HR reports that include start times, time and attendance, sick leave and absenteeism.
	Morale	Low morale affects performance and could even compromise safety in the workplace. Should management require assistance on personnel management matters, the experts should be called in i.e. the ER Department.
	Vacancies	A team that has several vacancies cannot perform optimally. Maintenance management must meet with the HR department as regularly as required in order to ensure that there are quick and efficient placements.
Procurement	Supply delivery performance	Managers should request a monthly status report from Procurement for every tender or contract. The report should include confirmation of approval to proceed, date of tender closure, status of tender adjudication, date of contract award, contract sign-off, outstanding SAP matters (releases etc.), cumulative payments to date, physical progress to date, list of all claims and disputes, with the current status.
	Meetings	Where necessary meetings should be held where matters arising and the above progress report is tabled and discussed. It is not sufficient to just send a person an email or SAP request and then stand back and wait. The matters must be followed up on a regular basis.
	PPM refresher training	Managers should request Procurement to arrange on-going refresher training for their teams.
SHERQ	Status report	Managers are to request monthly status reports from SHERQ that cover at least the list of all incidences over the previous period complete with findings and action plans, list of all non-conformances, DIFR statistics and status of medicals.

7.6.4 CLOSURE

This is a task that is probably most often skipped by maintenance personnel and leads to inaccurate reporting. Closure brings a formal and orderly end to the various maintenance activities that were undertaken in the preceding chapters. The closure of SAP and financial processes must be done in the specified manner.

However, the post project review and lessons learned approaches are considered to be best practice and we should strive towards achieving this methodology. It is unlikely that all the ports will be able to do this for each and every maintenance task. It is recommended that a few of the major maintenance jobs are selected each year to be subjected to these close-out procedures. The table below list the critical closure elements that must be addressed at the end of a maintenance job.

Item	Aspect	Action
Maintenance	Order closure	Orders must be closed (technically and for business) through SAP PM if no further costs are to be posted. Notifications assigned to the orders must also be completed with respect to breakdown duration, damage and cause.
	Post project review	Cross section of maintenance projects should be reviewed to get a sense of where things are going right and where they are going wrong. Typical items to review include schedule, costs, SHERQ, procurement and labour issues.
	Lessons learnt	Review of information and documents gathered during the course of executing a maintenance plan that can be used to the benefit of the current plan or future year plans. May include positive or negative lessons and is most valuable if undertaken at the end of a major maintenance project or financial year.
Finance	Contract	All contracts must be closed financially once all payments and retentions have been processed and completed. Maintenance orders cannot be closed if the associated purchase order still has outstanding commitments.
	Year-end provisions	If there are maintenance tasks /projects that are in progress in the current year with completion only after 25 March and they involve a material/service value; a progress certificate as at 25 March should be obtained from the supplier as a basis to raise provision for the completed portion, the documentation must be credible and of such a standard as to be able to withstand audit scrutiny. Provision can only be made for materials/services received before 25 March. Failing to make adequate provision will mean that invoices will be settled out of the new financial budget.
Human Resources	Structure review	Approved staffing structure should be reviewed at least annually for alignment to maintenance requirements. If changes are required, then HR must be engaged to manage the process and obtain the necessary approvals.
	Training	Each member of staff must have an individual development plan and this training must be checked and signed-off by the line manager.
Procurement	Contract	All contracts must be formally closed after work has been completed. If there are outstanding issues, these must be documented, with time-frames, to have them resolved for contract closure. The project manager must ensure that the hand-over certificates are signed.
	Supplier Database update	Where contractors have not performed in terms of the contract requirements, Procurement must be advised and full details provided. If there is need to blacklist suppliers, maintenance teams must bring this to the notice of their local Procurement Office.

Item	Aspect	Action
SHERQ	Findings	All findings must be formally closed off and all the actions taken must be fully documented.
	Risk register	Items that have been actioned and closed-off must be updated on the risk register and signed off by the relevant persons. Updated register must be circulated to all relevant stakeholders for notification and action by the applicable parties.

8 CIVIL ASSET MAINTENANCE

8.1 MODULE: NAVIGABLE AREAS

8.1.1 Background

Dredging of navigable areas of the ports is an integral part of the maintenance of the water depth of channels, basins and berths. The maintenance dredging in the TNPA ports is usually done by Dredging Services, a sister company within the Transnet group but external equipment may also be hired. The following types of dredgers are available: Suction hopper, grab, suction pump and plough. The need for dredging work in a particular area is identified by soundings.

8.1.2 Purpose

This document provides guidelines for the dredging activities within the ports of South Africa with specific attention to the following:

- Identification of areas which require dredging;
- Measurement of areas and quantities of dredging required/completed;
- Formalised obligations between the Service Provider and the employer;
- Planning of the work programme for the agreement period;
- Monitoring of the depths and drafts within the harbour and entrance channels; and
- Planning of the day to day dredging requirements of the port.

8.1.3 Policies and legal requirements

- The London Convention 1972
- The 1996 Protocol (Supports the London Convention)
- Department of Environmental Affairs (annual dumping permit)
- Dumping at Sea Control Act 1980
- National Environmental Management Act

- Coastal Management Bill (drafted & issued)
- Ports Act
- OHS Act

8.1.4 Planning the Dredging Programme

The annual inspection is related to the OPEX budget process and is usually carried out by September each year in order to meet the budget deadlines of October.

Clearly it is not possible to do a physical inspection of the condition of the navigable areas but this can be done indirectly by inspection of the sounding charts. The most recent soundings must be used for this purpose and they should not be older than 6 months. The channels and basins are usually divided into sections or zones for the preparation of charts and it is suggested that a logical approach is used for the sequence of inspections of the charts. Every chart should be studied in detail to identify all areas that are not down to the required depth (comparison of actual and target conditions). These areas should be clearly marked for further investigation. It is equally important to check the soundings for signs of over-depth or undermining of structures.

The ports must prepare a budget to maintain channels, basins, berths and sand traps at the published depths.

The calculation of the volume to be dredged in the next financial year must be carried out as follows:

- Using the areas of under-depth as identified from the sounding charts, determine the volume of material that is currently under-depth;
- Subtract from this volume, the volume of material that is planned to be dredged in the current financial year;
- Add to this, the volume of the expected inflow of material into this area.

Remember to take into account the factors for bulking of the sediment.

This then defines the workload. This workload or "user requirement" must be formalised and signed off, together with priorities. This work is done by the Port Engineer in consultation with the Harbour Master. The outputs from this process element will be:

- A completed set of asset inspection forms that clearly indicate which areas do not comply with the required water depths. The area (square metres) and amount of under-depth (m) should be specified;

- A user requirement, approved by the Harbour Master, that clearly states the areas to be dredged and the depth of water required; and
- A schedule of quantities of material to be dredged in the various areas.

Planning

More detailed planning is then required for both the dredging as well as the soundings. This planning is done in order to balance the workload and to avoid large fluctuations (in workload and costs). The port must make clear statements if dredgers are required in port on specific dates or with maximum durations between dredging campaigns (i.e. sand trap dredging must be done every 4 months). The requirements for soundings must be clearly described – how often each area is to be sounded, the line spacing, the frequency of echo sounding, etc.

This planning is done by the Port Engineer in consultation with the Harbour Master.

Agreement with Dredging Services

Dredging Services is then responsible for preparing detailed schedules with deployment programmes being drafted for each craft. It is likely that it will be necessary to adjust certain priorities or schedules to balance the requirements from all the ports. This final programme must then be converted into one Agreement per port, that clearly describes all the necessary elements (what must be dredged where, when, how much, where to dump, rates, soundings, etc.). These Agreements must be prepared by the Port Engineer and be signed-off by the Harbour Master, the Port Engineer and Dredging Services before any work begins.

This Agreement must contain at least the following: Text " agreement document", programme of dredging & sounding (craft deployment schedule) for the port, priced schedule of quantities.

The progress of the programme should be monitored and discussed (done on a weekly meeting in Durban given the high volume of work).

There should be an annual soundings programme for each port to ensure that all channels, basins and berths are surveyed. The soundings programme may vary from port to port.

Dredged spoil may only be dumped at sea if the area being dredged conforms to the Dumping at Sea permit as issued by the Department of Environmental Affairs.

Application for Dumping Permit

In terms of international protocols and national regulations, it is necessary to apply annually for a permit to dump any dredged material at sea. There is a standard permit application form that must be completed. Details of the physical and chemical characteristics of the sediments, that are to be dredged and dumped, are required to be provided in this application form. This is done by taking samples of the sediments, in the areas to be dredged, and having a series of laboratory tests carried out.

This process needs to begin in about June with the aim of appointing the service provider (currently only the CSIR laboratories are accredited) in July so that the completed Permit Application documentation can be provided to Marine and Coastal Pollution Management for consideration by November.

Dredging Services must be issued with a copy of the Dumping at Sea permit.

The quantity of dredged spoil dumped at sea must be reported to the Department of Environmental Affairs and Tourism at the end of each year.

8.1.5 Financials

The annual dredging budget is determined jointly between the Port Engineer and Dredging Services. The Port Engineer will provide the Bill of Quantities and Dredging Services will provide the rates for the work required.

The final workload is submitted to Dredging Services for the preparation of detailed budgets, schedules and cash flows for each port, as well as the combined programme for all the ports.

Note: This is an iterative process and whilst Dredging Services must provide an estimated budget for each port, this is subject to the CFO's final approval. Each port is responsible for the motivation and approval of the requested OPEX budget.

8.1.6 Monitoring

Dredging Services is to confirm the dates for dredgers to be in a specific port within a reasonable time before craft mobilisation, in order for the port to make the necessary arrangements. The Harbour Master and Port Engineer must continually reassess the need for the dredging and issue Dredging Services with a priority list for each craft. (e.g. TSHD Priority 1: Sand Trap, Priority 2: Inner Entrance Channel, Priority 3: Basin YYY, etc.). Dredging Services is responsible for ensuring that the

craft are fully operational. The Harbour Master shall arrange the necessary occupations for dredging.

Monthly meetings (can be more often where necessary) must be held, between Dredging Services, Harbour Master and Port Engineer to manage the execution of the works. The following items must be standing items on the agenda:

- Dredging progress – actual versus planned,
- Sounding progress - actual versus planned,
- Evaluation of latest soundings,
- Occupations required,
- Re-prioritisation of works,
- Standing time and delays.

Regular "working soundings" must be done by Dredging Services and issued to the Port Engineer so that the progress of the dredger can be monitored. Dredging Services are to ensure that they comply with all regulations/approvals/permits in the execution of sounding, dredging and dumping.

Dredging Services may not demobilise a dredger from a specific port without the approval of the Harbour Master. Dredging Services must provide soundings to the Port Engineer that indicates that the workload has been completed before the dredger may be released.

The Dredging Services Project Manager must ensure that the Dredging/Dumping is done strictly according to the Dumping Permit and the terms of the application.

8.1.7 Assessments

Navigable Areas

Item	Weight	Rating	Weighted Average
Entrance Channel	25%		
Sand trap/s	10%		
Channels	20%		
Basins	20%		
Berths	25%		
		O/H Rating	

Notes:

- The ratings for all areas, except the Sand traps, shall be determined by calculating the area (m^2) that is down to the advertised depth and divide this by the total area (m^2) of this berth, channel or basin. This will yield a percentage of the area that meets requirements.
- The condition of the Sand trap is related to the volume rather than areas as mentioned above. The rating is determined by calculating the volume of the trap that is down to the design depth divided by the total design volume of the trap. This yields a percentage of the trap that is down to depth.

8.1.8 Communication

The success of the dredging programme for a port is largely dependent on effective communication between the parties concerned i.e. the dredging managers from the Port Engineer's Department, Dredging Services and the Harbour Master's Department. It is recommended that these parties meet regularly to discuss the progress of the work programme and to reschedule priorities on the short term programme as required.

Problems must also be communicated to the various parties as soon as they arise e.g. when occupations at berths cannot be obtained.

8.1.9 Use of Divers

The service provided by the Port Engineer's divers is vital to the effective running of the dredging programme. The divers may be requested to inspect localised under-depth or over-depth areas which appear on soundings with the purpose of determining the nature of high spots which could be cargo/product or silt/sand build-up. Over-depth areas must also be inspected by the divers to determine any potential under-mining of berthing structures. They may also be called on to remove hazardous objects from the harbour bed.

8.2 MODULE: BREAKWATERS

8.2.1 Background

Breakwaters perform an important function by providing safe water for the navigation of vessels in/out of the port. They ultimately end up protecting the inner channel of the harbour entrance.

Entrance channels in most South African ports offer single lane traffic hence the impact of closure of the port due to breakwater failure is an economic catastrophe. It is critical that adequate measures are taken to ensure that this asset never fails to an extent that navigation through the channel is prohibited.

8.2.2 Purpose

The purpose of this module is to guide inspections and maintenance planning/execution of breakwaters based on some of the current practices in the ports.

8.2.3 Policies and legal requirements

Most relevant to this module:

- Construction Regulations Act
- OHS Act
- Water quality
- TNPA Environmental Policy

8.2.4 Inspections for Breakwater maintenance

Two types of inspections are usually undertaken viz.:

- Eyeball
- CSIR survey

a) Eyeball method

This method is a visual inspection of the breakwater on a routine basis as well as after a severe storm has occurred. The eyeball inspections should be carried out at least once a year preferably during the low spring tides. Each port may want to undertake more inspections as relevant to their requirements.

A general walk-about and careful inspections of the components of the breakwater are undertaken. Any severe damages or concerns are recorded e.g. broken / missing armour. Displacement/settlement of armour in a section of the breakwater could be an indication of toe failure. Immediate action is taken if necessary for further investigations and/or repair.

b) CSIR Survey

An MOU exists between Transnet and the CSIR for various projects. One of the projects considered therein is the monitoring of the breakwaters at all ports. This

involves the use of aerial photography of the breakwater at pre-set coordinates. A helicopter is used for the photography of the breakwater sections at low spring tide.

The breakwater is broken-up into various stations for identification and consistency of measure. By comparing past photographs of the last 2 years, one can identify changes to the breakwater amour. Analysis of the current versus past-year photographs will highlight amour units that have moved, broken or lost from the slope. A table of current and cumulative damage must be drawn up for comparison. This table is useful for analysis/highlighting of problem areas.

8.2.5 Assessments

The following table should be used as a summary for the weighted rating of the breakwater structure. This table could be used for the assessment of the individual or combined breakwaters keeping in mind that most ports have a primary as well as a secondary breakwater.

Breakwater

Item	Weight	Rating (%)	Weighted Average
Armour outer	55%		
Armour inner	10%		
Toe - outer	8%		
Toe - inner	5%		
Splash wall	10%		
Top structure	10%		
Services	2%		
	100%	**O/H Rating**	

Whilst the toe is an important part of structure, it is rarely inspected in most ports. Wave conditions at sea usually prevent diving operations for inspections.

Top structures include:

- Mass capping
- Crane rails – if fixed

Services include:

- Water supply
- Service ducts

8.2.6 Financial

Based on the work that needs to be carried out as informed by the assessment report, one would prepare a detailed budget. It is important to note that the assessment phase itself may require a budget e.g. CSIR photo survey. The main costs for the repair work arise from:

- Casting of dolos;
- Crane hire; and
- Labour for placing of dolos.

8.2.7 Undertaking repairs

A team with relevant experience must be employed to undertake repairs. Should additional training be required, then do train personnel. It is usually a good idea to learn from ports whom have done extensive breakwater maintenance e.g. Richards Bay, Durban.

Weather conditions play a big role as when repairs are carried out. Top structures are probably the easiest to repair whilst toe repair might require low spring water tides. Again this may vary from port to port. Hence it is essential to have material, plant and labour carefully planned for the execution of repairs.

8.2.8 Monitoring

It is essential that the following are monitored to understand the behaviour of the breakwater in order to take appropriate action if necessary:

- Year on year damage;
- Areas of damage;
- Storm monitoring; and
- Storm damage.

The CSIR report must be fully understood and recommendations considered.

8.3 MODULE: SEAWALLS

8.3.1 Background

Seawalls, also known as revetments, are commonly constructed in ports for slope protection against water/wave action. These structures are commonly found in ports but their type of construction has varied. The most common type is the stone pitched slope with a concrete plaster also known as the closed-type seawall. Many problems

have been experienced with this type of seawall especially as some of them are quite old. Some of the common problems are:

- Failure/collapse due over-dredging the toe area; and
- Settlements of embankments protected by the seawall as a result of fines leaching through the seawall.

In order to eliminate the above problems some of the ports have opted for an alternative design consisting of an open structure. The design consists of a filter fabric overlain with hand-stone on the slope/embankment.

Seawalls play a critical role in protecting embankments especially in backup areas consisting of developed infrastructure and installations. Therefore these structures must be carefully monitored and maintained to avoid failure.

8.3.2 Purpose of this module

The purpose of this module is to guide inspections and maintenance planning/execution of seawalls based on some of the current practices in the ports.

8.3.3 Policies and legal requirements

Most relevant to this module:

- Construction Regulations Act;
- OHS act;
- Water quality; and
- TNPA Environmental Policy.

8.3.4 Inspections for seawall maintenance

Three types of inspections are usually undertaken viz:

- Eyeball
- Diving
- Instrument measure

a) Eyeball method

This method is a quick visual inspection of the seawall on a routine basis as well as after a severe storm has occurred. The eyeball inspections should be carried out at least once a year preferably during the low spring tides. Each port may want to undertake more inspections as relevant to their requirements.

A general walk-about and careful inspections of the components of the seawall are undertaken. Any severe damages or concerns are recorded for example damaged/

missing protective layer. Displacement/settlement of the embankment in a section of the seawall could be an indication of toe failure. Immediate action should be taken if necessary for further investigations and/or repair.

b) Diving

It is useful to have diving inspections done at least annually or at shorter intervals as may be required. These inspections are useful for identifying:

- Prop-wash;
- Toe integrity, scour protection; and
- Condition of structure below water level.

c) Instrument measure

After the eyeball inspections, it may be necessary to use instrument measures to further evaluate certain conditions. Instrument measuring is mainly used for:

- Measuring settlements by the use of survey equipment; and
- Sonar survey to determine sea bed levels and existence of prop-wash.

8.3.5 Assessments

The following table should be used as a summary for the weighted rating of the seawall structure.

Seawall

Item	Weight	Rating (%)	Weighted Average
Armour	50%		
Toe	25%		
Backup area	15%		
Services	10%		
	100%	**O/H Rating**	

8.3.6 Financial

Based on the work that needs to be carried out as informed by the assessment report, one would prepare a detailed budget. The main costs for the repair work arise from:

- Materials – filter-fabric, hand-stone;
- Crane hire – excavation, fill, slope preparation; and
- Labour for placing of bidim, hand-stone, toe and cope construction.

8.3.7 Undertaking repairs

A team with relevant experience must be employed to undertake repairs. Should additional training be required, then personnel must be trained. It is usually a good idea to learn from ports whom have done extensive seawall maintenance e.g. Durban.

8.3.8 Monitoring

It is essential that the following are monitored to understand the behaviour of your seawalls in order to take appropriate action if necessary:

- Year on year damage;
- Areas of damage;
- Storm monitoring; and
- Storm damage.

8.4 MODULE: QUAYS AND OTHER BERTHING STRUCTURES

8.4.1 Background

Quay walls, jetties and dolphins are the primary interface between the water and land. They perform an important role in supporting the transfer of cargo between the vessel and the landside facilities, berthing of the vessel, as well as loading/unloading equipment. These important structures must be available at request in order for the port to function efficiently.

The type of structure used at the berth is primarily dependant on the soil conditions, type of cargo being handled, vessel requirements. Quay-walls constructed in South Africa generally consist of caisson walls, block-walls, steel sheet-pile walls, deck on pile walls and counter-fort walls. Jetties are usually deck on pile structures constructed perpendicular to the land. Dolphins generally consist of caissons, block-work, concrete deck on piles

8.4.2 Purpose

The purpose of this module is to guide inspections and maintenance planning/execution of quays, jetties and dolphins based on some of the current best practices in the ports.

8.4.3 Policies and legal requirements

Most relevant to this module:

- Construction Regulations Act;

- OHS act;
- Water quality; and
- TNPA Environmental Policy.

8.4.4 Inspections done for quays, jetties, dolphins

Three types of inspections are usually undertaken viz.:

- Eyeball (structure above water)
- Diving
- Instrument measure

a) Eyeball method

This method is a visual inspection of the structure on a routine basis. The eyeball inspections should be carried out at least once a year, preferably, during the low spring tides. Each port may want to undertake more inspections as relevant to their requirements. A general walk-about and careful inspection of the structure and various associated elements are undertaken. Any severe damages or concerns should be recorded for example cracks, settlements behind quay. Immediate action should be taken if necessary for further detailed investigations and/or repair. General aspects/items to consider in inspections:

- Cope-line levels (indication of settlements);
- Signs of cracks;
- Severe spalling;
- Drainage;
- Surfacing;
- Services (tunnel);
- Bollards;
- Fenders; and
- Ladders.

b) Diving

It is useful to have diving inspections done at least annually or at shorter intervals as may be required. These inspections are useful for identifying:

- Prop-wash;
- Toe integrity, scour protection;
- Condition of structure below water level; and
- Unwanted material e.g. tyres, cables, containers.

c) Instrument measure

After the eyeball inspections, it may be necessary to use instrument measures to further evaluate certain conditions. Instrument measuring is mainly used for:

- Determining concrete cover of reinforcing steel in structures;
- Determining salt ingress;
- Measuring settlements by way of survey equipment;
- Accident damage; and
- Sonar survey for sea bed levels, prop-wash, unwanted material e.g. tyres, cables.

8.4.5 Assessments

a) Quay wall

Item	Weight	Rating (%)	Weighted Average
Wall / piles	30%		
Cope / deck	20%		
Toe, scour protection	15%		
Bollards	8%		
Fenders and chains	10%		
Ladders	2%		
Service Tunnel	10%		
Services	5%		
	100%	**O/H Rating**	

Services include:

- Infrastructure supporting electrical systems
- Water supply
- Drainage

b) Jetties

Item	Weight	Rating (%)	Weighted Average
Deck	25%		
Pile structure	25%		
Scour protection	15%		
Hand rails	10%		
Bollards	8%		
Fenders and chains	10%		
Ladders	2%		

Item	Weight	Rating (%)	Weighted Average
Services	5%		
	100%	**O/H Rating**	

Services include:

- Water supply
- Telecoms

c) Dolphins

Due to the various types of dolphin structures, the table below should be modified accordingly for the inspections e.g. a deck on pile will be different to a caisson/block-work dolphin.

Item	Weight	Rating (%)	Weighted Average
Deck/caisson/block work	25%		
Pile structure	25%		
Scour protection	15%		
Hand rails	10%		
Bollards	8%		
Fenders and chains	10%		
Ladders	2%		
Services	5%		
	100%	**O/H Rating**	

Services include:

- Water supply
- Telecoms

8.4.6 Financial

Based on the work that needs to be carried out as informed by the assessment report, one would prepare a detailed budget. The main costs for the repair work arise from:

- Replacement of fenders and chains;
- Spalling;
- Materials; and
- Labour.

8.4.7 Undertaking repairs

A team with relevant experience must be contracted to undertake repairs. Should additional training be required, then do train personnel. It is usually a good idea to learn from ports that have done extensive similar maintenance.

Occupancy of the berth is probably the most important factor for undertaking repairs. Careful planning must be done in consultation with the berth planners and terminal operators so that disruptions are minimised.

8.4.8 Monitoring

It is essential that the following are monitored to understand the behaviour of your quays, jetties and dolphins in order to minimize total life-cycle costs.

- Accident damages;
- Spalling;
- Corrosion;
- Fender maintenance; and
- Year on year damage.

8.5 MODULE: ROADS AND PAVING

8.5.1 Background

Roads are the main mode of transport in and out of ports. Without them the supply chain cannot function. There are various types of roads in ports e.g. paved, gravel, concrete, bitumen etc. The intricate infrastructure of roads in ports is there to sustain transport throughout and assist in development of existing and new business. All backup areas behind quays are also included as part of paved areas.

8.5.2 Purpose

The purpose of this module is to assist all ports to determine the current condition of their roads and paved areas. This will be done through an inspection schedule. These inspections will be done on an annual basis. Some areas might need more checking than others, but this is for each port to determine.

These inspections will assist in determining areas for repairs and maintenance. If all inspections are done correctly and timeously, trends can be identified and addressed. This module assists with guidelines for repairs.

8.5.3 Policies and legal requirements

Policies and requirements applicable for paved areas and roads are as follows:

- Local governments standards and requirements;
- Construction regulations;
- OHS Act; and
- TNPA Environmental Policy.

The TRH Guidelines and Design Manuals should be referred to for investigations and repairs.

In some ports, roads within the port boundary are maintained and managed by the City Council. There should be a clear distinction as to which roads are maintained by the TNPA and/or City. Each Party should maintain to their standards until an alternative agreement is reached.

8.5.4 Inspections

It is important that qualified personnel with the relevant experience are used to do all inspections and assessments.

a) Eyeball Method

This method is a visual inspection of the roads/paving on a routine basis to identify problems and workload. All roads and paving should be inspected at least once a year.

During the inspection one should look out for potholes, signs of cracks, rutting, binder condition, aggregate loss, pumping, riding quality, unpaved shoulders, surface drainage, traffic signs and road markings.

b) Instrument Method

When necessary, the following equipment can be used:

- Taper gauges for width of cracks;
- Measuring wheel;
- Survey equipment; and
- DCP.

Tests can also be used to determine the condition of base and sub base layers as well as the road surface layers.

8.5.5 Assessments

It should be noted that the roads within a port must be divided into sections and sub-sections. These sections must be evaluated as a unit as indicated on the inspection sheets.

The back-up areas behind quays that have premix surfaces can also be inspected accordingly and evaluated with the roads per quay or specific areas.

From the inspection sheets the overall assessment for the roads can be determined in relation to the evaluation criteria or the overall condition of sections.

8.5.6 Overall Assessment

The average ratings determined on the individual inspection sheets needs to be consolidated into an overall rating as shown in the table below.

Item	Weight	Rating	Weighted Average
Main entrance - East	35%		
Main Entrance – West	30%		
East boundary road	20%		
Gravel roads	10%		
Road xxx	5%		
	100%	**O/H Rating**	

8.5.7 Financials

Based on the work that needs to be carried out as informed by the inspection report, one would prepare a detailed budget. The main costs for the repair work arise from

- Labour;
- Plant; and
- Materials.

Continuous maintenance to a certain section or stretch of road needs to be investigated and then a decision on repairs versus capital replacements must be made.

8.5.8 Undertaking/executing repairs

Establish a maintenance team that can do the work.

- Check resources for the availability of tools & plant and equipment.
- Benchmark for conformance – by not deviating from the original design of the structure standards.
- Use practical procedures and manuals.

- Use contracts when internal resources cannot cope with the work.

8.5.9 Monitoring condition/performance

Monitoring of repaired areas is also necessary to establish:

- if work was done correctly;
- if repair methods are correct;
- if the correct materials were used;
- to determine the root cause of the problems if they continue; and
- to maintain appropriate standards.

8.6 MODULE: PERWAY INFRASTRUCTURE

8.6.1 Background

Railway transport plays an important part in the process of exporting and importing goods in South Africa. Most ports make use of rolling stock to transport break bulk goods, containerized goods or bulk goods such as coal, fertilizers etc. to the quayside or sheds.

8.6.2 Purpose of this module

- The primary purpose of this module is to ensure that TNPA perway infrastructure network is maintained according to required standards of the Manual For Track Maintenance 2000.
- To optimize rail maintenance.
- To give guidelines for maintenance repairs at all South African ports.
- To standardize the track maintenance in the South African ports.
- To provide a safe and reliable network with sufficient capacity and availability.

8.6.3 Policies and legal requirements

- Manual for Track Maintenance 2000;
- Construction Regulations;
- OHS act;
- Specification for Welding;
- Green book handbook for Civil Engineering;
- TNPA Environment policy;
- SANS 300 – 1:2005 edition 1 (RSR);
- South Africa Road Traffic Signs Manual – Chapter 7 (Signing for railway crossings); and

- Electrical Safety Instructions (High-Voltage).

8.6.4 Responsibilities

- In some ports TNPA maintains the entire Perway infrastructure, whereas in other Ports, TFR or TCP through RME maintains the Perway infrastructure on behalf of TNPA. TFR maintains private sidings in the port area but the lessee carries the costs. This is an agreement between TFR and the lessee. Normally, the take-off set is owned and maintained by TNPA; however lease agreements do vary in certain circumstances.
- Quayside rail - Common user areas are maintained by TNPA.
- Private sidings - The railway line in private use and/or ownership which is connected to TNPA/TFR railway lines by means of an agreed turnout and includes, without limitations, any shunting yard, marshalling yard, the siding and the siding extension or any section of the railway line which provide access between TNPA/TFR railway lines and any premises which belong to the Client.

  The maintenance scenarios:
  - Siding (inside TNPA boundaries) owned by Client, maintained by TNPA/TFR at clients cost (Take off Set)
  - Siding (inside TNPA boundaries) owned and maintained by Client
  - Siding extension (outside TNPA boundaries) owned and maintained by client

8.6.5 Inspections required

Due to the connection of the vehicle (wagon) and the track through the wheel-rail interface it is critical to perform regular inspections to ascertain the condition of the track and also to determine the annual and long term work load.

Types of inspections:

- Eyeball
- Instrument measures
- On-track Vehicle

a) Eyeball method

This method is a visual inspection of the track and associated infrastructure on a routine basis to check whether circumstances have arisen which may jeopardize safety of the railway traffic.

b) Instrument measures

When necessary, handheld equipment - used mainly for:

- Track Geometry;
- Wear - Crown & side; and
- Track Gauge (1065 mm).

8.6.6 Assessment should be done on:

a) Turnouts

- Sets on N3 lines and yards must be inspected at least once every 4 and 6 months.
- Evaluate the condition of the stock & switch, rods, cover plate & box, heel bolts, tumbler parts, joint bolts, crossing bolts, stock & guard, crossing timbers and frog.

b) Lines

- Inspection to evaluate the track condition in detail must be undertaken at least once a year.
- Evaluate the condition of the sleepers, fishplate joints, track gauge, horizontal and vertical alignment, rail fastenings and rail wear.

c) Stop Blocks

- Inspection to evaluate the condition of the stop block must be undertaken at least once a year.
- Evaluate the condition of the joints, gauge, alignment, rails, sleepers, buffer beam and block, struts and paint.

d) Level crossing

- All public and departmental level crossings must be evaluated every 3 months.
- Check compliance as per South Africa Road Traffic Signs Manual Chapter 7. (Signing for railway crossings)
- Track must be opened up, inspected and maintained when necessary at least every two years.

e) Welding

- Inspection to evaluate the welding condition in detail must be undertaken at least every 6 months on turnouts and once a year on lines.
- Check for wear and wheel damage on the frog and wing, switch blade, wheel spin burns, battered rail ends, sagged flash butt welding joints and defective exothermic welding joints.

f) Earthworks, the formation and drainage

- It must be inspected at least once per year.
- A dry formation is a pre-requisite for a stable track structure.
- Storm and ground water must be quickly and effectively drained away from the formation
- All drains must be kept clean to allow water to flow freely

g) Structures

- Bridges, culverts and lined tunnels must be inspected at least once per year. Unlined tunnels must be inspected monthly by the Track Inspector.
- Look out for scour under piers or abutment and at inlets and outlets of culverts. Structural damage, cracks, loose rivets or bolts, corrosion and movement of bedplates. Loose or ineffective handrails and/or walkways and where bridge or culvert openings are inadequate.

h) Clearances

- Annual inspections must be carried out and ensure that the condition set out in chapter 8 of the Clearance and Dimensions manual are complied with.
- Minimum clearances between track and structures, height of contact wire, track centres and clearance marks.

All the above is the responsibility of individual track maintenance personnel to ensure that:

- Inspections are carried out by competent personnel, at the required frequencies.
- Written inspections reports are prepared and systems are used to ensure actions are taken and appropriate records are kept.

8.6.7 Track Maintenance

Tracks need regular maintenance to remain in good order. Track maintenance strategy is based on short term emergency and systematic maintenance and long-term pre-programmed preventive maintenance and relaying operations, performed by mechanized maintenance gangs and heavy on-track machines. To ensure uniform maintenance standards, class A and B track quality have been defined in terms of track geometry. When track quality deteriorates to below class B standard, maintenance action to restore it to class A standard is required. It has been found that track maintenance effort increases with the square of the increase in axle loud and/or tonnage carried.

Maintenance is the general day-today upkeep of the railway which keeps the trains running. Track maintenance includes track renewal, re-railing, re-sleepering, screening work, replacement of set components and upgrading of sidings (with the use, in each case, of new or second-hand material), all in accordance with the requirements of track maintenance standards. The crane tracks, rails in the quay wall and the slipways are also included.

The goal for track maintenance is to strive for the most economical but safe balance between resource input, track condition and required level of operational readiness.

8.6.8 On-Track Vehicle

- Tamping machine is used to rectify the geometric condition of the track
- Track measuring car is used to measure the condition of the track
  - Specialize
  - Contract work
  - Electronic data

An assessment table is shown below.

Item	Weight	Rating	Weighted Average
Shunting lines	10%		
Running lines	15%		
Sets	20%		
Ballast/ concrete	15%		
Sleepers/ chairs	10%		
Warning signs	5%		
Surfacing	5%		
Tumbler	10%		
Cover plate &box	5%		
Welding joint	5%		
Stop blocks	5%		
	100%	**O/H Rating**	

8.6.9 Financials and Reports

- **Condition reports -** Inspection of turnouts lines, stop blocks.
- **Selecting critical repairs –** Critical works (below required standards) must be

done first.

- **Multi-year planning –** this for budget purposes and for long term planning e.g. upgrading an entire yard (screening).
- **In-house/contract repairs –** If capacity does not allow, then contractors can be used.
- **Order material –** Most of the Perway material is procured from assigned suppliers but if it is not available purchased privately. Lines in the yards can be replaced by good second hand rails, which have minimal wear.
- **The main costs for the repair work arise from –** replacing of turnout, rails and screening processes.
- **Turnouts** – are expensive to replace, costly to maintain and the weak links in the track structure.
- **Level Crossings** - Before any work been performed on a public level crossing, one needs the authority from TFR and the City Council or Municipality. The cost is borne by TNPA if it is a feeder line or by the lessee if it is a private siding. It should be maintained at least every two years.

8.6.10 Undertaking repairs

- **Benchmarking for conformance -** Inspection of level crossings 3 monthly, turnouts 6 monthly, lines and stop blocks 12 monthly. Based on inspection reports, maintenance is planned accordingly.
- **Establishing a team**- Typical rail maintenance team in TNPA- 1 Track Master, 15 Track workers, 3 Flagman, 1 Welder and his/her 2-processor worker.
- **Resources –** Track team and machines- couch screw, rail drills, sleeper drill and disc cutter.

8.6.11 Monitoring

The reason for monitoring is usually twofold. The first, immediate reason is obviously to detect irregularities that could endanger the safety and reliability of railway traffic. However, if a monitoring technique is continuous and fast enough to allow consecutive monitoring at regular time intervals, an extremely important temporal aspect is obtained which is of essential importance to a successful condition-based management. This means, that such a monitoring technique could provide insight

into the infrastructure element's behaviour over time. And this could allow condition forecasting and consequent maintenance planning. This concept usually represents the ultimate goal of any condition monitoring.

8.7 MODULE: BUILDINGS AND SHEDS

8.7.1 Background

Buildings are specially designed structures, constructed from suitable materials to provide shelter and storage for cargo, equipment and machinery. Buildings also provide accommodation for office personnel and their necessary furnishings.
Buildings within the ports include administrative buildings, workshops, garages, mess and ablutions, sheds, stores, substations and houses.

8.7.2 Purpose

This module covers all types of building structures such as wood and iron, brick, steel and concrete and pre-fabricated.

- To inspect the condition of both the interior and exterior of the building structure as far as defects, repairs and maintenance are concerned.
- Suggests guidance as how to "Determine the Workload and Maintenance" for any particular type of building structure.
- Provides a standard of "Condition Measures" for the asset components.
- TNPA versus TPT maintenance of assets and equipment agreement.

8.7.3 Policies and legal requirements

- OHS Act and Regulations
- National Building Standards Act
- SABS requirements regarding materials used
- Hazardous Substances Act and Regulations

8.7.4 Inspections done for building maintenance

A competent and qualified person with experience and knowledge of the building trade should do the inspections. Types of inspections done:

- Eyeball
- Detailed inspections
- Instrument measures

a) Eyeball method

This method is a visual inspection of the building on a routine basis to identify problems and workload. Inspections should be conducted at least once a year. During the inspection one should out for:

- Foundation -line –indication of settlements;
- Signs of cracks;
- Spalling;
- Drainage around the building;
- Deflections in the roof structure; and
- General surfacing around the building.

b) Detailed method

This method is a visual inspection done thoroughly to identify serious defects.

A competent engineer should perform this inspection after a storm, fire, and accident or on request.

What should one look for:

- Signs of stresses and strains;
- Structural failures; and
- Collapse or movement.

c) Instrument measuring

After the eyeball inspections, it may be necessary to use instrument measures to further evaluate certain conditions. Instrument measuring is mainly used for:

- Determining concrete cover of reinforcing steel in structures;
- Determining salt ingress;
- Measuring settlements by use of survey equipment; and
- Assessing fire or accident damage.

8.7.5 Assessments for asset

Sheds, Workshops, and Garages

	Condition actual			Condition after repairs		
Item	**Rating**	**Weight**	**Weighted**	**Rating**	**Weight**	**Weighted**
Floors		20%			20%	
Doors & Windows		10%			10%	
Sprinkler system		15%			15%	
Roof/Gutters/Fascias etc.		20%			20%	

Walls interior		15%			15%	
Walls exterior		15%			15%	
Plumbing		5%			5%	
	Total	**100%**		**Total**	**100%**	

Substations

		Condition actual			Condition after repairs	
Condition of item	**Rating**	**Weight**	**Weighted**	**Rating**	**Weight**	**Weighted**
Floors		20%			20%	
Doors/Windows		15%			15%	
Roof/Gutters/Fascias		25%			25%	
Walls interior		20%			20%	
Walls exterior		20%			20%	
	Total	**100%**		**Total**	**100%**	

Public image/ Admin Buildings/ Mess & Ablution/ Houses

		Condition actual			Condition after repairs	
Condition of item	**Rating**	**Weight**	**Weighted**	**Rating**	**Weight**	**Weighted**
Floors, stairways,		10%			10%	
Doors, windows		10%			10%	
Tiled walls		10%			10%	
Roof/Gutters/Fascias		15%			15%	
Walls interior		15%			15%	
Walls exterior		15%			15%	
Sanitary ware, plumbing		10%			10%	
Blinds all types		5%			5%	
Ceilings		5%			5%	
Signage		5%			5%	
	Total	**100%**		**Total**	**100%**	

- **Actual Condition** is the condition of each item at first inspection
- **Condition after** is the condition of each item after maintenance has been done

8.7.6 Determining the workload

The following guidelines should be used to determine the workload:

- Do checks of the asset condition both inside and outside by looking at the

condition of the paint work and the components to get a general feel for the building.

- Look at the roof structure for any sagging or abnormalities.
- Look for any serious cracks or movement in the superstructure and foundation walls.
- Consider the reason for doing the Maintenance/repairs as mentioned below:
  - Operational - Required for effective working, protection of cargo, machinery, equipment etc.;
  - Preventative - Prevent higher maintenance costs in the future
  - Safety - Safety of personnel and integrity of buildings and structures
  - Aesthetic - Appearance of assets to maintain or enhance public image
  - Legal - Required by local, provincial or national statute or by Transnet / TNPA policy
- Condition measures for components: do the component checks in detail (i.e. gutters, doors, walls, windows etc.) by adhering to the Condition measures for components
- Service type "A" – Done every two years
- Functionality check "B" – done annually

8.7.7 Financials

Based on the work that needs to be carried out as informed by the assessment reports, one would prepare a detailed budget. The detailed budget will reflect the total cost of labour, material, plant and contract work of all the various assets captured on the assessment reports.

8.7.8 Undertaking repairs

- Establish labour resource team that can do the work.
- Check for the availability of tools, plant and equipment.
- Benchmarking for conformance – by not deviating from the original design of the structure or building standards.
- Use practical procedures.
- Use contracts – when depot resources cannot cope with the work.

8.7.9 Monitoring

During inspections one should look out for:

- Cracks and defects;

- Structural movement;
- Spalling concrete;
- Dampness; and
- Rust and corrosion.

8.8 MODULE: OTHER STRUCTURES AND UTILITIES

8.8.1 Bridges and Culverts

a) Background

Bridges and culverts form a vital link between cities and ports where it is separated by rail lines and crossing of obstacles such as rivers and channels dividing port areas. It provides safe access to pedestrians over roadways and rail lines within port areas. It completes the logistics chain of the port.

In SA ports concrete bridges and culverts are commonly used with a few exceptions for instance the lattice steel rail-over-river bridge at East London and steel pedestrian bridges linking stations to ports.

Bridge structures provide access to and from ports to a variety of vehicles from passenger vehicles, light delivery vehicles to extra heavy load transporters.

Maintenance of bridges in the past focused on major failing of main members and cracking that was visible during annual inspections. Little attention was given to chloride ingress attacking reinforcing steel and hairline cracking of surface concrete causing spalling of concrete.

b) Purpose

Before maintenance or repair works are carried out it is fundamentally important to know what caused the defect, so that inappropriate remedies, which will be both time- and cost-consuming, are avoided.

The purpose of this module is to assist all ports to determine the current condition of their bridges and culverts. This module will also assist with guidelines for repairs and the documentation will assist with the budgeting process. Inspection documents for this module are standard documents. It should be used for all ports with the criteria staying the same but the areas for the inspections must be changed per port to suit their specific need.

c) Policies and legal requirements

The following policies and guidelines must be used in determining conditions and on the planning and execution of work. It is imperative that these are used to ensure consistency and compliance to these requirements throughout the ports.

Policies and requirements applicable for bridges and culverts are as follows:

- Construction Regulations Act;
- OSH act;
- Perway instructions;
- Bridge codes; and
- Municipal by-laws.

It is the responsibility of each port to ensure that all local legislation, if applicable, is complied to.

d) Inspections done for bridge maintenance

It is important that qualified personnel with the relevant experience are used to do all inspections and assessments.

Types of inspections done:

- Eyeball
- Instrument measures

Eyeball method

This method is a visual inspection of the bridges and culverts on a routine basis to identify problems. Useful equipment for the inspection includes a torch, camera, ruler, tape, binoculars, chipping hammer and steel brush. These inspections should be done at least once a year.

Special attention must be given to inspection of the bridge bearing pads. There are various types of pads and one needs to check for distortion, alignment, delamination of rubber, corrosion of steel, spalling of bearing pads, etc.

Instrument measuring

When required, used mainly for:

- determining concrete cover;
- determining salt ingress;
- steel thickness – steel bridges;
- ultra-sonic testing – cracks in steel members; and
- survey equipment – levels (possible settlements).

All concrete structures suffer a degree of damage and defects manifest themselves during their design life to a greater or lesser extent. With bridge structures close to the marine environment a number of defects can occur due to the aggressive environment.

Typical defects that may occur can be split into short-term i.e. during construction or longer term after maintenance/defects correction period. Such defects are detailed in the table below.

Typical defects in concrete structures

Type of defect	**Causes**	**Timescale**
Spalling	Impact damage Reinforcement corrosion	Short to long
Damage to joints	Poor bond between materials Incompatible service life Inappropriate materials Vandalism	Medium to long generally
Material deterioration	Surface abrasion Chemical attack	Medium to long generally
Cracking	Shrinkage of concrete Settlement of concrete Thermal movement	Short to medium
Blow-holes/ Honeycombing	Inadequate compaction	Generally short
Minor surface defects	Trapped air/water against formwork Grout loss Insufficient release agent applied	Short
Rust stains on concrete surface	Careless removal of formwork Pyrites in aggregate Ends of tie wires not turned in Rain streaking from adjacent unprotected reinforcement	Short to medium

Type of defect	Causes	Timescale
	Reinforcement movement during concreting	

e) Assessments

Item	Weight	Rating	Weighted Average
Bearing pads	20%		
Abutment	15%		
Abutment Foundation	10%		
Wing Walls	5%		
Parapet / Handrails	5%		
Deck slab	15%		
Expansion Joints	10%		
Surfacing	10%		
General Drainage	5%		
Kerbing / Sidewalks	5%		
	100%	**O/H Rating**	

The common problems on bridges appear on the:

- hand rails;
- parapet walls;
- concrete (spalling);
- expansion joints; and
- bearing plates.

The most common problems in culverts are as a result of:

- siltation;
- overgrown vegetation;
- approach slabs;
- cracking; and
- spalling.

f) Financials

Based on the work that needs to be carried out as informed by the assessment report, one would prepare a detailed budget. It is important to note that a detailed assessment itself e.g. instrument measures, may require a budget.

The main costs for the repair work arise from:

- Labour
- Plant
- Materials

g) Undertaking repairs

- Establish labour resource team that can do the work.
- Check the availability of tools, plant and equipment.
- Benchmarking for conformance – by not deviating from the original design of the structure standards.
- Practical procedures
- Contracts – when depot resources cannot cope with the work (see item 11)

h) Monitoring

It is essential that the following are monitored to understand the behaviour of your bridge/culvert in order to take appropriate action if necessary:

- Year on year damage; and
- Areas of damage.

i) Guidelines to Perform Inspection :

Walk over the bridge or culvert and check the following:

- Deck drainage. Look for leaks in seals and water stops in joints between and at end of span. Bearing sills should be dry.
- Foreign material in expansion joints which may prevent these from functioning correctly.
- Surface crazing, cracking, spalling or encrustation of concrete, and exposed reinforcing steel, particularly in coastal areas. Thin parapet members must be specially checked.
- Corrosion of steel handrails, bearings, joint covers and other steel items and the necessity for repainting.
- Levels of handrails and parapets – possible settlements.

Examine the bridge/culvert from below:

- Overstrain, movement or other deterioration of elastic or patent bearings.
- Signs of cracks in main members
- Check the deck drainage as in 1 above.
- Dirt and debris on bearing sills
- Corrosion of exposed flanges in half-girder and concrete or rail and concrete

- decks.
- Weathering, cracking and shaking in masonry or concrete arches.
- Any faults in sills not visible during inspection of the upper part of the bridge or culvert.
- Weathering, cracking or shaking masonry or concrete abutments, piers or wing walls.
- Scouring of foundations.
- Settlement of/or cracked foundations.
- Movement in wing-walls

Examine foot bridges:

- Horizontal alignment and any signs of sagging.
- Buckling of panels, particularly at or near the joints.
- Loose rivets and bolts.
- Alignment of towers and trestles, and any movement or distortion of decks or
- stairways.
- Slack or damaged bracing.
- Corrosion, especially in under floor members, and necessity for repainting.
- Badly seated or displaced stairway treads or floor slabs.
- Asphalt deck surface for wear, potholing, kicking out or thickness exceeding
- the design thickness.
- Adequacy of deck drainage.
- Openings in decks or sides where wires can be pushed through to make
- contact with live wires on electrified lines.
- Settlement or cracking of foundations.

8.8.2 Dry-Docks

a) Background

South Africa has some of the major ship repair ports in the Southern Hemisphere and has sufficient infrastructure and opportunities to keep it that way. It is the legal requirement no matter which society the ship belongs to that every 4 years it must come to the Dry-dock for hull (body) inspection or condition survey. Ship maintenance includes the breakdowns such as problem with propellers. This is also done for insurance purposes. If the ship has not met legal requirements, SAMSA can stop the ship from sailing.

The ship repair business is generally made up of a Dry-dock and/or Floating Dock and a Workshop.

b) Purpose

This module standardises maintenance of the dry-docks. This manual does not cover the floating docks as they are generally privately owned. The dry dock workshop is covered in the buildings module.

c) Most relevant policies and legal requirements relevant to Dry-dock

- Construction Regulations;
- OSH act;
- Atmospheric Pollution Act;
- Marine Act;
- Hazardous Act;
- Lifting Equipment Act; and
- Harbour Regulations.

d) Inspections for Dry-dock maintenance

Types of inspections done:

- Eyeball
- Instrument measures

Eyeball method

This method is a visual inspection of the dry-dock on a routine basis to identify problems and to ensure that assets are maintained to relevant standards. Inspections should be done at least once a year.

General items of inspection:

- Condition of handrails
- Signs of cracks
- Severe spalling
- Drainage
- Condition of the crane rails
- Escape ladders
- Hatches, doors
- Tunnels
- Conduits
- Fire hydrants

- Landings, steps, ledges
- Settlements

Instrument measuring

After the eyeball inspections, it may be necessary to use instrument measures to further evaluate certain conditions. Instrument measuring is mainly used for:

- Determining concrete cover of reinforcing steel in structures;
- Determining salt ingress;
- Measuring settlements – use of survey equipment; and
- Fire or accident damage.

e) Assessments

Dry-dock

Item	Weight	Rating	Weighted Average
Walls	15%		
Gates	15%		
Steps, landings, ledges	10%		
Tunnels, conduits	10%		
Fenders	10%		
Crane-rails	10%		
Hydrants	5%		
Markings	5%		
Hatches, manholes, crane-boxes	5%		
Handrails, escape-ladders	10%		
Flood and emergency valves	5%		
	100%	**O/H Rating**	

There are electro-mechanical items that need to be inspected e.g. flood and emergency valves, slipway cables track (all covered under the electro-mechanical section) which together with the civil and electro-mechanical inspection will contribute to the final dry-dock report.

Slipway, synchrolift

They are mainly operated by winch. Slipways are used to slip boats in/out of the water. These boats usually include fishing trawlers and tugs.

Item	Weight	Rating	Weighted Average

Rails	20%		
Rail beams and piles	20%		
Bollards	10%		
Fenders	5%		
Leading jetty	10%		
Cradle	25%		
Floors and walls	10%		
	100%	**O/H Rating**	

Winches are to be maintained by electro-mechanical department.

f) Financials

Based on the work that needs to be carried out as informed by the assessment report, one would prepare a detailed budget. The main costs for the repair work arise from:

- Labour
- Plant
- Materials

g) Undertaking repairs

- Establish labour resource team that can do the work.
- Check availability of tools, plant and equipment.
- Benchmarking for conformance – by not deviating from the original design of the structure
- Contracts – when depot resources cannot cope with the work contractors should be engaged.
- Occupation for undertaking repairs must be carefully planned since these facilities have a high utilization.

h) Monitoring

It is essential that the following are monitored to understand the behaviour of your dry-dock/slipway in order to take appropriate action if necessary:

- Year–on-year damage
- Areas of damage
  - fenders
  - ledges
  - drainage
  - gates

8.8.3 Fencing

a) Background

At SA ports security fences are erected on the boundaries of the port to prevent illegal entrance to ports. They are necessary to curb vandalism of the port's assets and theft of cargo. The degree of security provisions necessary is dependent on the location, strategic importance and potential for vandalism of the area. Regardless of the size or location of the area, some security is required.

b) Purpose

Before maintenance or repair works are carried out it is fundamentally important to know what caused the defect, so that inappropriate remedies, which will be both time and cost consuming, are avoided.

The purpose of this module is to assist all ports to determine the current condition of their fencing and gates. This will be done through an inspection schedule. These inspections will be done on an annual basis and on a quarterly schedule. Some fencing and gates might need more frequent monitoring, but this is for each port to determine.

These inspections are done to assist in determining areas for repairs and maintenance. If all inspections are done correctly and timeously, trends can be identified and addressed.

c) Policies and legal requirements

The following policies and guidelines must be used in determining conditions and on the planning and execution of work. It is imperative that these are used to ensure consistency and compliance to these requirements throughout the ports.

Policies and requirements applicable for fencing and gates are as follows:

- IMO;
- Security policy;
- ISPS; and
- OHS Act.

It is the responsibility of each port to ensure that all local legislation, if applicable is complied to.

d) Inspections

It is important that qualified personnel with the relevant experience are used to do all inspections and assessments.

Eyeball inspections are done for fences and gates. They are a visual inspection of the fencing and gates. They should be done at least once a year in order to identify problems.

e) Type of assessments

Mesh Wire Fencing

Item	Weight	Rating	Weighted Average
Corner Posts	30%		
Interim Uprights	30%		
Straining Wires	10%		
Mesh Wire	20%		
Barbed Wire	10%		
	100%	**O/H Rating**	

Palisade Fencing

Item	Weight	Rating	Weighted Average
Corner Posts	30%		
Uprights	30%		
Fastenings	10%		
Panels	20%		
Concrete Plinth	10%		
	100%	**O/H Rating**	

Gates

Item	Weight	Rating	Weighted Average
Corner Posts	25%		
Straining Wires	25%		
Fencing Wire	10%		
Mesh	20%		
Hinges	15%		
Locks	5%		
	100%	**O/H Rating**	

f) Common problems

The common problems found on wire mesh fencing include:

- Straining wires rusted through;
- Mesh wire rusted through;
- Steel posts rusting;
- Vandalism; and
- Vehicle damage.

The common problems found on steel palisade fencing are due to:

- Vandalism;
- Vehicle damage; and
- Cargo handling damage.

g) Financials

Based on the work that needs to be carried out as informed by the assessment report, one would prepare a detailed budget. The main costs for the repair work arise from:

- Labour
- Plant
- Materials

h) Undertaking repairs

- Establish labour resource team that can do the work.
- Check resources for the availability of tools & plant and equipment.
- Benchmarking for conformance – by not deviating from the original design of the structure standards.
- Practical procedures.
- Contracts – when depot resources cannot cope with the work.
- Access to restricted or prohibited areas such as electrical sub-stations should be provided under supervision of a competent person as per the provisions of the OHS Act.

i) Monitoring

It is essential that the following are monitored to understand the behaviour of the fencing/gates in order to take appropriate action if necessary:

- Year on year damage; and
- Areas of damage.

8.8.4 Underground Services

a) Background

Underground services include:

- Water supply networks from point of receipt from service provider up to and including points of consumption; includes water tanks, storage tanks, and hydrants.
- Sewerage networks from and including points of generation to point of receipt by service provider; includes rising main components such as storage chambers and pumps.
- Storm water networks, drainage canals and channels.

b) Purpose of this module

The purpose of this module is to guide inspections and maintenance planning/ execution of underground services.

c) Policies and legal requirements

- OSH act;
- Atmospheric Pollution Act;
- Marine Act; and
- Harbour Regulations.

d) Inspections

It is important that inspections and assessments are carried out on a regular basis (at least once a year). The equipment manufacturer's inspection and maintenance specifications must be adhered to.

Types of inspections done:

- Eyeball
- Instrument measure

Eyeball method

This method is a visual inspection on a routine basis to identify problems and to ensure that assets are maintained to relevant standards.

Since these services are largely underground, there are few sections that are visible. However the route of the service should be inspected for signs of leaks, sink-holes, cracks in paving, etc., which would indicate possible failures. In these cases it will be necessary to carefully excavate by hand to expose the pipes / culverts. All valves, tanks, pumps, hydrants, manholes must be inspected and assessed.

Instrument measure

After eyeball inspections, it may be necessary to use instrument measures to further evaluate certain conditions. Instrument measuring is mainly used for:

- Determining concrete cover of reinforcing steel in structures;
- Determining salt ingress;
- Measuring settlements – use of survey equipment; and
- Accident damage.

e) Assessments

Item	Weight	Rating (%)	Weighted Average
Water supply network	35%		
Storm water networks & Drainage	30%		
Sewerage networks	35%		
	100%	**O/H Rating**	

f) Financial

Based on the work that needs to be carried out as informed by the assessment report, one would prepare a detailed budget. The main costs for the repair work arise from:

- Labour
- Plant
- Materials

Repair work that would increase the network's life span could be classified as capex work.

g) Undertaking repairs

A team with relevant experience must be contracted to undertake repairs. Should additional training be required, then do train personnel. It is usually a good idea to learn from ports that have done extensive similar maintenance.

- Establish labour resource team that can do the work.
- Check the availability of tools, plant and equipment.
- Benchmarking for conformance – by not deviating from the original design of the structure standards.
- Practical procedures.
- Contracts – when depot resources cannot with the work.

h) Monitoring

Monitoring of repaired areas is also necessary to establish:

- if work was done correctly;
- if repair methods are correct;
- if the correct materials were used;
- to determine the root cause of the problems if they continue; and
- Maintain appropriate standards.

8.8.5 Off-Shore Buoys and Moorings

a) Background

Mossel Bay has two off-shore moorings for the handling of bulk liquid products. Both moorings fall within the Port Limits and are under the jurisdiction of the Harbour Master. The maintenance of the Single Point Mooring (SPM) is the responsibility of PetroSA and the Conventional Buoy Mooring (CBM) is the responsibility TNPA.

b) Purpose and Scope

The purpose of this document is to define the inspection and maintenance procedures required to ensure the safe and reliable operation of the CBM.

c) General Description of the CBM

The CBM consists of the following main elements:

- 5 mooring buoys connected by chains to anchors;
- 2 Flexible sub-marine hoses;
- A pipeline end manifold; and
- Sub-marine pipelines.

d) Planned Inspection and Maintenance Process

The Inspection and Maintenance procedures recommended in this document are based on the OCIMF publication titled "Single Point Mooring Maintenance and Operations Guide".

The Port Engineer shall ensure that procedures described in this document are carried out as specified. All defects that are detected must be remedied as soon as practically possible. Detailed records shall be kept of all inspections and maintenance carried out.

Inspection and maintenance of the CBM shall be carried out by competent persons that have the relevant experience in off-shore moorings.

e) Inspection and Maintenance Schedules

The Port Engineer is responsible to ensure that the inspections are done in accordance with the schedules and that the associated maintenance work is performed.

f) Responsibilities

TNPA is responsible for the mooring system and PetroSA for product handling equipment/pipelines.

- The Diving Supervisor shall complete and signoff the detailed inspection reports;
- The Diving Supervisor/Contractor that has been delegated the responsibility for carrying out maintenance or repairs, shall prepare and signoff a report that details this work;
- The Port Engineer shall audit these reports at least once a quarter and ensure that copies of the reports are filed for record purposes.
- The port shall also prepare an annual report that summarizes the checklists and all maintenance work carried out during that period. The port engineer shall also highlight any deviations and non-conformances.

g) Records

The Port Engineer shall keep records of all inspection and maintenance reports. Copies shall also be sent to the SHERQ Officer.

9 ELECTRICAL ASSET MAINTENANCE

9.1 MODULE: SUBSTATION EQUIPMENT

9.1.1 Background

Port activity is dependent on the presence of a stable electricity supply to ensure that transportation of cargo can take place and to facilitate associated maintenance, logistical and communication systems. The electricity distribution network in ports, of which substation equipment forms a critical component, is thus integral to

successful port operations and a vibrant economy. Substation equipment typically consists of the following main components:

- Main switchboard/circuit breakers;
- Transformers;
- Substation earthing systems;
- Batteries and battery chargers;
- Protection relays; and
- Voltage transformers and current transformers.

In addition, other auxiliary components to enable monitoring of the electricity network and electricity consumption are:

- Metering and instrumentation;
- Power factor correction equipment; and
- Testing equipment and portable earthing equipment.

9.1.2 Special Requirements, Standards and Codes of Practice

SANS Specifications

- IEC Codes/Specifications;
- British Standards Codes/Specifications;
- Electrical Engineering Instructions (CEE prefix);
- Transnet Electrical Safety Instructions;
- Safe Work Procedures;
- OHS Act; and
- NEMA.

9.1.3 Planning

In addition to routine monthly maintenance tasks, this work needs to be integrated with testing and calibration of protection equipment and other preventative maintenance programmes. Substation maintenance planning would need to consider the following:

- Task lists
- Schedules
- Budgets
- Asset condition assessments
- Integration with SAP including feedback reports
- Evaluation of the number of faults/breakdowns

9.1.4 Assessment of Substation Equipment Condition

- Visual assessment
- Review of infra-red scanning, load recordings, installation testing
- Insulating oil sample analysis
- Number of OCB trips (load/fault conditions)
- Reliability of equipment and fault report analysis
- Age analysis and availability of spares
- Battery load tests and specific gravity readings

ASSET CONDITION ASSESSMENT

NETWORK (30%)	WEIGHT	CONDITION	VALUE %	a	b	c	d	e
Cables and Overhead lines	5%							
Transformers	5%							
High Voltage Switchboards	5%							
Low Voltage Switchboards	5%							
Battery Chargers & Batteries	5%							
Protection Relays	5%							
	30%							

9.1.5 Execution

a) High Voltage Switchboard, Circuit Breakers, Transformers and Batteries

In addition to the monthly visual inspection of the switchboard to ascertain the status of circuit breakers, protection relays etc. other regular routine preventative maintenance activities need to be carried out. This is necessary to determine whether equipment is performing correctly, and to detect problems that could lead to major faults occurring. There are also more miscellaneous checks included in monthly inspections such as substation lighting, emergency control diagrams, warning signs, fire extinguishers, tools, checker plates etc. to ensure alignment with safety management programmes.

Routine monthly servicing would include the following:

- Enter substation and disarm CO^2 equipment (where applicable);
- Complete logbook and scrutinise other entries for that month;
- Check for alarm indication on all protection relays including checking of control

circuit fuses;

- Check operation of metering and panel indication;
- Check substation battery condition, battery terminals for tightness and corrosion including recording of specific gravity readings, electrolyte levels;
- Check operation of battery charger and charging rates;
- Where spare circuit breakers exist, trip test these circuit breakers to check for correct battery/trip operation;
- Check "Emergency Switching" and "Substation Distribution" diagrams for accuracy;
- Check substation building physical condition (doors, windows, water leaks etc.)
- Check substation lighting (internal, external and emergency), fire extinguishers;
- Check safety signage, emergency numbers, labelling, circuit breaker numbering;
- Check security items such as locks, fences; Oil hinges where applicable;
- Check circuit breaker operating tools, portable earthing equipment;
- Sweep/dust substation equipment; and
- Remove weeds in outdoor yard.

In addition to the above, the following routine transformer maintenance is also carried out during monthly substation inspections:

- Visual inspection for any leaks;
- Investigate any unusual odours present;
- Check the oil level and record any deviations;
- Check the colour of the Silica gel;
- Take the oil and winding temperatures (where applicable); and
- Check the earth connection.

Preventative substation maintenance (annually) over and above the normal monthly checks includes the following:

- Infra-red scanning of switchboard to determine hot spots on busbars, poor connections, insulation failure. This would include transformers.
- Removal and checking of all circuit breakers and trip testing; with reference to "Electrical Control".
- Checking of circuit breaker auxiliary contacts.
- Check battery voltage per cell, carry out load tests (where possible).
- Checking of all earthing systems to ensure impedance is within limits (maximum 7 ohms). An Approved Inspection Authority must do this. Checks include

common earth, earth spikes and earth mat, panel earthing integrity, cable earths on end boxes.

- Take oil samples and submit these for analysis by an Approved Inspection Authority to determine the extent of dielectric strength, acidity, sludge, water and other contamination (dissolved gas analysis). Oil sampling and analysis is a reliable and cost effective preventative maintenance measure that should always be implemented as it provides early warning signs of transformer failure. Oil analysis reports must be carefully scrutinised to assess the severity of oil contamination and the necessary remedial action instituted. Oil filtering may be sufficient; or alternatively the oil should be replaced.
- Transformer oil sampling and testing must comply with Engineering Instruction GI.012 Issue 2. Alternatively, a competent authority can be contracted to take the oil samples.
- Insulating oil shall comply to SANS Code of Practice 555.
- It is recommended that independent suppliers are used for oil regeneration and oil supply. In addition to normal oil testing, it is important to verify that the PCB content of oil is within allowable limits. Written confirmation must be provided from oil suppliers.
- It is recommended that the database of the oil tests be kept so trends in the transformer performance can be reviewed and analysed.

b) Substation Protection Relays and Metering

Protection systems are needed to isolate the faulty part of the power network so as to ensure minimum effect of the fault on the entire network. Protection relays detect the abnormal conditions and initiate the operation of the circuit breaker. Substation protection relays typically include:

- Inverse and Very Inverse Definite Minimum Time (IDMT) earth fault and overcurrent relays;
- Solkor and Translay feeder protection relays;
- Instantaneous earth fault and overcurrent relays;
- Zone and busbar protection relays;
- Unit (current differential) protection relays;
- Transformer protection relays; and
- Arc protection relays.

In addition to protection relay systems, it is important that effective electricity metering equipment is installed for billing purposes, and that electricity networks are optimised in line with port operations. Electricity consumption meters should be checked for accuracy at least as frequently as protection relays. Specific cost-cutting initiatives must be employed in order to reduce electricity consumption. Such initiatives include the installation of power factor correction equipment and harmonic filters.

Routine testing and calibration of substation protection equipment, protection relays, associated transducers and other electrical testing and measuring instruments must be carried out on a bi-annual basis. The appointed responsible person for each port must ensure that steps are implemented to outsource these services from an independent Approved Inspection Authority where in-house resources are not available. Protection relays must be routinely checked and tested to determine their electrical characteristics, and evaluated against system configuration, loads and faults. These settings must be revised to ensure integration with the load profile of the network to minimise nuisance tripping and ensure protection of personnel and property in the event of electrical faults arising in the system.

Later generation relays (electronic) have a self-diagnostic test facility and give an indication of a faulty relay. The self-diagnosis check on the relays must be done during monthly visits. Checking of relay characteristics typically includes:-

- Reliability – the relay will always initiate a trip when it is supposed to.
- Selectivity or discrimination – only the minimum number of circuit breaker required to eliminate the fault.
- Sensitivity or accuracy limits – accuracy in determining faulty currents or voltages, especially on border lines.
- Speed of isolation (time delay) – the relay should operate according to the time settings.
- In addition, routine tests must also be performed to check levels of deterioration of protection components, correctness of tripping circuit connections, and overall fault free operation of the relay.

When carrying out testing and protection setting review, primary and secondary injection should form part of this process. When testing protection systems, NEVER open circuit a current transformer or short circuit a voltage transformer. Test blocks

or plugs should be used. Secondary injection Tests are done on the relays using the secondary injection Test Set.

Secondary injection Tests typically include:

- Secondary injection Tests should be done according to the specific application of the relay to test the required fault condition.
- The faulty condition shall be simulated according to the application of the relay.
- The test block should be used where applicable.
- The test sheet and settings sheet must be available prior to the test.
- The test results must be compared with the settings and previous data in order to establish some trends and attend to unacceptable deviations.

Primary injection tests typically include:

This type of test involves testing of the entire circuit; i.e. current transformer secondary winding, relay coils, trip and alarm circuits, and all intervening wiring checked. The high current source must be used for this test.

c) Other protection system checks and tests to be carried out

- Where a SCADA system is installed, remote equipment controls, equipment status and alarms should be tested to check the integrity of the SCADA system indication in relation to equipment (circuit breaker, protection relay) status.
- For each of the tests performed, the testing circuit arrangement should simulate the faulty condition. The tests can either be done on the individual component (e.g. Solkor Relay) or the whole system (Feeder protection).
- Safety procedures must be adhered to when testing equipment. (Must be done with reference to "Electrical Control").
- The effect of viruses should be monitored on all software related applications.
- Where relay settings are reviewed, it is important to keep a record of the existing relay settings for reference purposes before amending these to provide an historical "trail" of system performance.
- The risk of trip must be communicated to "Control" where the tests are going to be done without de-energising that section of the electrical network.

d) Voltage and Current Transformers

During monthly substation visits, visual inspections should be done. The instrument transformers must be tested bi-annually with the protection relays or after a fault. Testing of Current transformers should include:-

- Ratio Test on all instrument transformers
- Polarity Test on CT's
- Magnetizing curve test on all instrument transformers
- Phasing test on VT's
- Care must be taken not to open circuit a CT and not to short circuit a VT. Test blocks should be used.
- These results must be compared with the previous results (or commissioning results) in order formulate a trend.

e) Metering and Instrumentation

Monthly substation visits should include the following:-

- Meters must be checked for loose connections.
- Any inconsistent meter readings must be checked as they might indicate a faulted meter.
- Meters should be checked to verify the settings, multiplying factors etc.
- For programmable meters, the possibility software corruption must be borne in mind. The software and the settings must be uploaded and downloaded to and from the meter according to the manufacturer's specifications and guidelines. Meter self-diagnosis testing should also be performed.

f) Power Factor Correction Equipment

Power Factor Correction installations must be continuously monitored to ensure that electricity consumption is minimised and the electricity network in ports operate efficiently. It is desirable that all electrical installations operate at a power factor that is in accordance with electricity supply standards for the Electricity Supply Industry, and the requirements of the licensed supply authority. Inspections on power factor correction equipment depend on electrical criteria applicable to the particular network, power rating, operational loading etc. Each system must be tailored for the network concerned.

As the load profile of large electrical networks change over time, the programming of power factor correction equipment must be reviewed periodically to ensure adequate capacity exists to effectively control power factor within desirable limits. Routine maintenance for power factor correction equipment would include:

- Visual inspection should be carried out during weekly substation visits and the data recorded in substation reports (status of system, number of switching

operations, protection relay status, power factor readings etc.).

- As most power factor correction relays are digital, they have a self-testing or self-diagnostic facility. A built in alarm function would show a faulty relay.
- The settings of the relay must be checked according to the application of the Power Factor correction equipment.
- It is also recommended that secondary injection tests should be done at least bi-annually as with other protection relays.

g) Cathodic Protection Systems

Cathodic protection entails the utilization of the electrical properties of corrosion of metallic substances to provide a system for the protection of oil pipelines, domestic water pipes or other buried structures to extend their useful life (i.e. to prevent corrosion).

All cathodic protection systems must be monitored and maintained to ensure corrosion protection of the applicable assets. Cathodic protection specialists should be appointed to determine whether the system design is adequate for the particular application and that it is performing correctly. The SABS Code of Practice for Cathodic Protection of Buried Services and the National Association of Corrosion Engineers, Internationally recommended practice RP-02-85-94 should form the basis of cathodic protection systems in ports.

The criteria used to determine the level of cathodic protection required should be available for maintenance personnel to enable routine checks to be conducted to ensure operation of the system. Records of testing and inspection of cathodic protection systems must demonstrate compliance with the testing criteria in terms of the system design. The procedure for verifying compliance must be properly documented.

Cathodic systems must be inspected every 60 days to ensure that the equipment is operating correctly. Measurements on the cathodic protection system should include potential (voltage) readings made at appropriate and adequate locations in both the current-on and current-off situations. These readings must be made relative to a copper-copper sulphate reference electrode. The current-off readings indicate whether the -0.85 Volts criterion has been met or what the starting point for the 100mVolts polarisation decay reading is. If the -0.85 Volts decay is not met, then voltage readings tracking the polarisation decay should also be conducted and recorded.

Cathodic protection system testing shall also include continuity measurements. In addition, voltage measurements should at least be made with a reference cell in at least three locations, e.g. both ends and the middle in the case of a duct or pipe. Voltage measurements should also be taken for each approximately 3 metres a pipe length.

h) Test instruments/equipment

Testing equipment includes:

- "Fluke" multi-meters and "Meggers"
- Phasing sticks
- Surge Generators
- Cable fault location equipment
- Cable tracing equipment
- Voltage and Current Detectors
- Oscilloscopes

Due to the complex nature of such equipment and the need for calibration by accredited laboratories, maintenance and repairs are outsourced to specialists. However, the following regular checks should be performed:

- Visual inspection should be done on the instruments before usage.
- The equipment must be stored in good condition.
- The equipment should be tested according to suppliers manual.
- Faulty equipment should be returned to the suppliers for repairs of major faults.
- Supplier's manuals should be kept with the instruments.
- The inspections should be done according to the suppliers' manuals.
- For equipment powered by batteries, batteries must be checked before usage.
- Equipment shall be operated or used according to the user's specifications. All special precautions specified by the manufacturer shall be adhered to.

9.1.6 APPENDICES

2.2.4 Commissioning Tests for HV equipment

2.2.5 Test Sheet for Feeder panel

2.2.6 Test Sheet for Transformer panel

2.2.7 High Voltage Weekly Report (incl. Power Factor Equipment)

2.2.8 Substation Maintenance Check List

2.2.9 Substation Maintenance Program

2.2.10 Cathodic Protection Equipment Report

9.2 MODULE: DISTRIBUTION CABLES AND TRANSMISSION LINES

9.2.1 Background

Cables and overhead transmission lines are the means with which electrical energy is transported between substations and consumers. Thus the electrical distribution network from substations via the cable networks or transmission lines forms the backbone of all port activity.

Cables have a lengthy life span; provided that the loads and voltages to which they are subjected remain within manufacturer's specifications, they are installed in accordance with accepted engineering practice. It is not uncommon to have cables whose age is in excess of 30 years' operating reasonably reliably. Similarly, overhead transmission lines provide long and reliable service, provided they have been properly designed and operate with design parameters and electrical loads.

Corrosion protection, both electrolytic and environmental, is important factors that need to be considered. Cable distribution systems can be divided into the following categories:

- High Voltage multicore cables - Paper Insulated (PILCSWA) Cables and Cross linked Polyethylene (XLPE) Insulated cables (copper or aluminium conductors)High voltage single core cables
- Aerial bundled conductors
- Overhead Transmission Lines
- Low Voltage Polyvinylchloride cables (PVC ECC SWA PVC), Pilot Cables, Flexible Cords and Surfix
- Jointing and termination of cables
- Cable Tracing, Fault Location, Testing and Commissioning

9.2.2 Special Requirements, Standards and Codes of Practice

Cable maintenance should be carried out in line with SANS, IEC and/or BS Codes of Practice, Specifications; in addition to TNPA engineering standards and instructions. Amongst these are:-

- SABS 1574 : Electrical Cables, Flexible Cords and Cables
- IEC60055-1 : Paper Insulated Metal Sheathed Cable for Rated Voltages up to 18/30kV

- IEC60055-2 : Paper Insulated Metal Sheathed Cable for Rated Voltages up to 18/30kV
- IEC60059 : Standard Cable Ratings for cables
- SANS 1339: Cross-linked Polyethylene Insulated Electric Cables
- BS 6480 : High Voltage Paper Insulated Cables
- SANS 0142-1 : Wiring of Premises Part 1 : Low Voltage Installations
- SANS0142-2 : Draft – Not yet published (High Voltage installations)

9.2.3 Planning

Insulation systems on high voltage cables and their accessories are subject to different kinds of stresses during their service life and thus, to degradation and deterioration. These impair cable life span and by implication lower the reliability of the electrical power system. Therefore, a lot of research effort is directed towards a better understanding of degradation phenomena and finding instruments/tools for diagnosis and reasonable estimation of the remaining life of cables. Cable maintenance planning requires:

- Load recordings and analysis
- Evaluation of records of the number of faults/breakdowns
- Asset condition assessments
- Consideration of existing and future port operations, and port expansion
- Compiling of maintenance task lists and maintenance schedules
- Integration with SAP including feedback reports
- Annual budgeting

9.2.4 Assessment

Typical criteria used to assess condition of cables and transmission lines are:-

- Visual assessment
- Fault report analysis
- Age analysis
- Instrument and Sonic testing/scanning
- Load recordings and analysis

9.2.5 Execution

a) Cable, Jointing and Termination maintenance

This typically includes:

- Reduction of the load (de-rating) in order to extend its life.

- Replacement of cables – replacement of cables is done based on the recommendations from condition monitoring tests or after a fault.
- Cable jointing – cable jointing is done after a cable fault or on a week joint as determined by the tests.

Cable jointing and termination is done during commissioning of new cables or after a cable fault. After a cable fault has occurred it is important not to energise on a fault unless this is done as part of additional tests as specified in SANS documents. Tests must first be carried out to determine the cable insulation resistance between phases and earth/armouring using a suitable instrument such as a "Megger" to ascertain the type of the fault (phase to phase or phase to earth). Cable fault location equipment should be used to locate the cable fault. Reference to "As Built" cable route drawings should be made to determine the route as soon as possible. Alternatively, tracing equipment can be employed. If the resources to do such tests are not available in-house, these services can be outsourced.

When excavations are carried out, every effort must be taken not to damage the cable further. It is preferable to utilise hand digging only as opposed to mechanical excavating plant. Insulated shovels etc. should be used if possible. Reference should be made to the correct method of re-instating high voltage cables once repairs have been carried out as contained in SANS publications and TNPA Cable Laying specifications.

High level inspections during monthly substation visits

Visual inspections should be done on cable terminations during normal monthly substation, mini-substation and kiosk visits. The loading of the cable networks should be monitored all the time to verify the capacity of the cable. All the location of joints on the cable should be marked.

Advanced Cable Condition Assessment

- Competent specialists should be used to perform cable condition diagnosis.
- The appointed person in the port should perform cost benefit analysis before the advanced tests are done.
- These tests will depend among other factors, on the criticality of the service supplied.
- These tests must be done to determine deterioration of the insulation level of the cable and the water content on the XLPE cables.
- Examples of cable tests are Di-electric Response Measurement (tan delta) tests

and Polarisation and Depolarisation current measurement, sheath and bedding tests.

b) Overhead Transmission Line Maintenance

This typically includes:-

- Line patrol or inspection reports are used a guideline for the planning of maintenance of transmission lines.
- Maintenance of transmission lines also includes the clearing of servitude which might cause contact problems.
- Appropriate material should be used for the maintenance of transmission lines.
- Safety procedures must be observed all the time.
- All switching operations should be done in accordance with the Transnet High Voltage Operating Instructions. The maintenance should be done by competent people who have been adequately training on the maintenance of transmission lines.

Inspections on the overhead transmission lines must be done in the form of line patrols. Line patrols should be done at least once in six months, or immediately after a severe storm as determined by the responsible person. During line patrols the following must be inspected:-

- Pole or structural defects and structural stability
- Insulation defects, condition of insulators, dirt
- Earthing wire defects
- Surge arresters
- Condition of the stay wire
- Corona effects
- Sag and tension
- Condition of pole mounted switchgear
- Birds' nests
- Trees developing next to the line
- Pole labelling

9.3 MODULE: LOW VOLTAGE DISTRIBUTION SWITCHBOARDS

9.3.1 Background

Low voltage electrical distribution switchboards are required to enable the termination of low voltage supply cables between substations and local distribution

kiosk/rooms at load centres and/or other large facilities/workshops/plant etc. Low voltage distribution switchboard provide a secondary means of protection of an electrical installation, and afford maintenance personnel greater flexibility to control and isolate the electricity supply feeding individual installations/consumers. Low voltage distribution switchboards form the first line of "defence" against clearing of electrical faults, and protecting the occupants/users of low voltage installations. Low voltage switchboard distribution equipment consists of:

- Large floor mounted low voltage switchboards in substations;
- Large floor mounted switchboards in R28 type brick kiosks(local area distribution);
- Glass Fibre Kiosks (local area distribution);
- Large floor mounted switchboards in workshops, multi-storey buildings etc.;
- Wall Mounted Switchboards (usually supplied from floor mounted switchboards for individual/smaller building, or as sub-distribution points in larger facilities.

9.3.2 Special Requirements, Standards and Codes of Practice

- SANS 10142-1:2003 The Wiring of Premises
- SANS 1765 Safety of Distribution boards
- SANS 1619 Small power distribution units (ready boards) for single-phase service connections

9.3.3 Planning

Visual examination and other checks of large substation low voltage switchboards need to be co-ordinated with monthly maintenance examinations undertaken on the high voltage equipment in substations as these switchboards are the initial means of distributing low voltage power to local load centres. In many cases modern low voltage air circuit breakers and moulded case circuit breakers now allow adjustment of the sensitivity of protection. Such examination should be integrated with testing and calibration of protection of equipment described above (Protection Relays). However, preventative maintenance programmes for such equipment not located in substations must also be provided. Low voltage switchboard maintenance planning would need to consider the following:-

- Compiling of maintenance task lists and maintenance schedules
- Annual budgeting

- Asset condition assessments
- Consideration of existing and future port operations, and port expansion
- Integration with SAP including feedback reports
- Evaluation of the number of faults/breakdowns
- Monthly inspections

9.3.4 Assessment

- Legal Compliance and Safety Aspects
- Availability of Supply/Operating Efficiency
- Number of Breakdowns/Faults/Complaints
- Maintenance Schedule Progress /On Target
- Age/Physical Appearance/Condition

9.3.5 Execution

a) General Inspection and Cleaning

- Inspect general physical, electrical and mechanical condition.
- Tighten all connections and re-torque all bolted connections. Check for any loose connections and re-tighten. Busbars also where feasible.
- Carry out bi-annual infra-red scanning.
- Clean switchboard interior and all active components shall be exercised and cleaned where possible.
- All active indicating devices should be inspected for proper operation, accuracy of indication
- Check that all circuits are labelled and safety signage is provided
- Open panels and inspect for any physical damage and abnormal electrical and mechanical conditions that may be present.
- Clean components with a brush and vacuum interior and exterior of switchboard panels.

b) Wiring and Earthing

- Check that all conductors are of the correct size and rating for the specified application.
- Inspect wiring and connections for signs of heating or damage

c) Load Break Low Voltage Switches (Fused Switches)

- Check each fuse holder for adequate mechanical support of each fuse.
- Check fuse linkage and element for proper holder and current rating.

- Verify proper phase barrier, materials and installation

d) Contactors

- Visual inspection, check for noise/chatter, evidence of overheating, loose connections, excessive dust etc.
- Contactor assemblies should be operated manually by pushing in the contact assembly and checking for binding and friction. Be sure all equipment is de-energised.
- The contacts on the contactor assembly should be checked for excessive carbon deposits, arcing, overheating, welding or any appreciable loss of metal.
- There is no need to replace contacts if they are discoloured which is normal and expected. They should be replaced if only 25% of the contact material remains.
- Carbon on contacts can be removed by using non-abrasive burnishing tools. Separating and filing of welded or damaged contacts is not recommended because it leads to poor contact interface afterwards. Some manufacturers recommend that all springs and screws be replaced along with the contacts.

e) Incoming/Outgoing Cables

- Inspect exposed sections for physical damage.
- Inspect for shield earthing, cable support and termination.
- Visible cable bends shall be checked against national/international or manufacturer's minimum allowable bending radii.
- Visually inspect cable lugs, connectors and all other components for physical damage and proper connections.
- Check all cable connectors for tightness (with a torque wrench) and clearances.

9.4 MODULE: OUTDOOR LIGHTING

9.4.1 Background

In order to facilitate efficient port activity, berthing of vessels, safety of personnel and security of assets, it is extremely important that ports are provided with lighting that conforms to both international and local standards, as well as national statutes. Lighting of outdoor areas should cater both for horizontal illumination levels, colour rendering and glare to ensure that visual conditions over the entire area or street are conducive to effective operations. Lighting should be of a standard that permits the safe use of operational areas, roads, and public areas etc. by workers, pedestrians, vehicle drivers, mechanical cargo handling equipment etc. Street and area lighting is

generally accepted as a major deterrent to crime and vandalism and also creates a feeling of security amongst the general public. It is important that consideration also be given to energy saving measures and the aesthetic appeal of lighting equipment when selecting equipment.

Types of lighting installations to be considered are:

- High Mast Lighting
- Medium Mast Lighting
- Street Mast Lighting
- Track Structure Lighting
- Public Thoroughfare/Decorative Lighting

9.4.2 Special Requirements, Standards and Codes of Practice

- Engineering Instruction P27 - Safety and Maintenance instruction, High and Medium mast lighting, mechanical and electrical equipment
- SABS ARP 035:1993 - Guidelines for the installation and maintenance of street lighting
- SANS 10142-1:2003 regulations applicable to lighting
- SANS 114 -Code of Practice for outdoor lighting
- of 1993 - Regulations pertaining to minimum illumination levels. The appointed competent person for each port must ensure that compliance with the Occupational Health and Safety Act No.85 of 1993 is adhered to.
- Code of Practice 29 (Mechanical).

N.B. See Section 10 of this manual that deals with mechanical aspects of lighting installations.

- CEE.0018 - High Mast Lighting of Outdoor Areas
- CEE.0019 - Medium mast Lighting of Outdoor Areas
- CIE – International Council for Illumination

9.4.3 Planning

Factors such as over-voltage, vibration and excessive heat lead to reduced efficiency of a lighting installation. These factors lead directly to a reduction of lamp life and so to a lower reliability of the electrical lighting system. Considerable research effort is directed towards a better understanding of degradation phenomena in lighting and ways to improve the lifespan and lumen outputs of various types of lamps available

whilst simultaneously providing improved methods of control (dimming) and reducing power consumption. Lighting maintenance planning requires:

- Compiling of maintenance task lists and maintenance schedules
- Evaluation of records of the number of faults/breakdowns
- Asset condition assessments
- Consideration of port operations
- Integration with SAP including feedback reports
- Annual budgeting

9.4.4 Assessment

- Common Problems
- Breakdown/fault data
- Comparison with original lighting design standards (lamp lumen depreciation to be taken in consideration, etc.)
- Asset condition matrix
- Operational needs
- Minimum legal requirements

9.4.5 Execution of Outdoor Lighting Maintenance

Type of inspections:-

- Visual
  - This inspection will consist of a general on-site inspection to determine the status of the asset according to the list of sub-components. Done 3 monthly.
  - Typical indicators would be signs of defective lamps, damaged or broken components, corrosion, etc.
  - Periodic night time (approx. 3 monthly) inspections should be held to get a sense of the effectiveness of lighting installations
- Two yearly intervals (High and Medium masts)
- Four yearly intervals (High and Medium masts)
- Eight yearly intervals (High masts)

Execution of outdoor lighting maintenance would include the following:-

- Foundations and base plates (refer to Mechanical section)
- Lighting columns / masts / poles (refer to Mechanical section)
- Winches and power tools (refer to Mechanical section)

- Steel wire ropes (refer to Mechanical section)
- Earthing and lightning protection (high masts)
- Lamp replacement
- Cleaning of luminaries
- Distribution boards/control circuits/photo cells, etc.

a) Earthing and Lightning Protection

- Each high mast should be fitted with a lightning spike, consisting of a 10mm diameter steel rod, extending at least 800mm above the top of the mast.
- All separate metal components of the mast should be connected to the earth stud on the distribution board. The earth stud on the mast must be connected to the earth stud on the distribution board.
- Earthing electrodes, consisting of 1,2m copper-coated steel rods, should be driven into the ground adjacent to the mast foundation and connected to the mast stud via a 70mm² bare stranded copper earth wire. The earth wire should be routed into the mast through the cable entry ducts.

b) Lamp Replacement

- Lamp replacement can be undertaken by two different strategies; by replacing a lamp when it fails, and by planned group replacement.
- As a guide, if approximately 30% of the total number of luminaires on a particular mast are faulty, lamp replacement should be undertaken to ALL lamps. Cognisance must however be taken of the minimum illumination levels specified in the OH Act of 1993.
- Regular lighting patrols (at least 3 monthly) must be undertaken to assess the extent to which lighting is operating at various terminals/facilities.
- Lighting surveys should be conducted at least 2 yearly to ensure compliance with minimum legal requirements; and for NOSA safety audits.

c) Luminaire Control Gear

Control gear operation should be checked in conjunction with lamp replacement, particularly in the case of high, medium and streetlight mast re-lamping. On high masts it is may be advisable to replace all lamps and control gear at 8 yearly intervals together with wiring, particularly if existing luminaires are retained. It is essential that luminaire control gear conform to an accepted technical standard such as SABS, to ensure compliance with company specifications and legal requirements.

d) Cleaning of Luminaires

- Soft, damp, fluff-free rags or cloths to be used to wipe the bowls and reflectors. However, particular care should be exercised with high purity aluminium reflectors. Under no circumstances should bare hands be used for cleaning of such reflectors, particularly in administrative offices and complexes utilising decorative luminaires;
- A stiff plastic bristle brush should be used to clean the prisms or refractor bowls but care should be taken that the brush does not scratch the bowl.
- Where reflectors are corroded, this should be recorded and arrangements made for replacement.
- Discoloured refractor bowls should be replaced.
- The gasket between the bowl and the luminaire body should be checked to ensure that it is still performing its function (I.E. preventing the ingress of dirt, moisture).
- The catches, screws and hinges of bowls/shades should be lubricated with a dry lubricant and replaced if corroded.

e) Distribution Boards, Control Circuits, Photocells, etc.

- Refer to relevant section above detailing low voltage switchboard maintenance;
- Check general condition of distribution board and test operation of earth leakage relay and circuit breakers.
- COC (loop impedance etc.) to be issued in instances of re-wiring, changes to distribution boards, and routinely every 8 years.
- Inspect electrical cables, junction boxes and "Conmax" type electrical contacts (if fitted).

9.4.6 Appendices

2.10.10 High Mast Lighting - Maintenance Schedule

2.10.11 Medium Mast Lighting - Maintenance Schedule

2.10.12 Street Mast Lighting/Decorative Lighting Maintenance Schedule

9.5 MODULE: BUILDING DISTRIBUTION, LIGHTING AND FIXED APPLIANCES

9.5.1 Background

In general terms, electrical power is required for most activities and the operation of physical possessions that form part of our daily existence as humans. Most commercial and private endeavour require the use of production plant, machinery, office equipment, computers, cooking and heating appliances etc.; all of which are

dependent on electricity. To allow for an environment that is both safe and conducive to productive output, it is necessary that workplace lighting and other electrical infrastructure satisfy certain electrical requirements.

Thus, all buildings provided with an electrical supply and which persons occupy either for private or business purposes, need to have a valid Certificate of Compliance (COC) issued by and accredited installation electrician certifying the safety of the electrical installation.

In this regard, the term "premises" as defined in the OH Act of 1993 has a wider meaning and includes other categories of electrical installations such as lighting installations, temporary construction supplies, supplies to electrical plant and equipment etc.

Building distribution and lighting and fixed appliances include:-

- Distribution Boards incorporating Circuit Breakers and Isolating Switches
- Cabling, Wiring, Earthing and Bonding
- Lighting and Light Switches
- Switch Socket Outlets
- Earth Leakage Protection Relays
- Wireways, Conduits and Power Skirting
- Fixed Appliances (geysers, stoves/fry-tops, hydro-boils)
- Ceiling Fans, Cooker ventilation hoods
- Extension cords
- Building Management systems
- Lightning Protection

For the purposes of this manual portable appliances (e.g. vacuum cleaners, microwave ovens etc.) are excluded.

9.5.2 Special Requirements, standards and Codes of Practice

- SANS Codes of Practice 11042 : The Wiring of Premises; Part 1 (2003) incorporating compulsory SANS Specifications (by Government Gazette) for Electric cables, Flexible cords, Circuit breakers, Earth Leakage units, Manually operated switches, Switch socket outlets;
- South African and International Standards as detailed under normative references in SANS 10142; The Wiring of Premises; Part 1 (2003);
- OH Act of 1993;
- Engineering instructions;

- Safety Management System; NOSA
- TNPA Electrical Policy.

9.5.3 Planning

Maintenance planning would need to consider:-

- Legal requirements
- Condition assessments
- Compilation of maintenance task lists and maintenance schedules
- SAP integration and feedback reports
- Routine testing of earth leakage units
- Periodic issue of Certificates of Compliance
- Annual budgeting

9.5.4 Assessment

- Visual assessment
- Review of installation testing/legal requirements
- Faults/breakdown reports

ASSET CONDITION ASSESSMENT

EL&P (20%)	WEIGHT	CONDITION	VALUE	a	b	c	d	e
L.V.Cable & Distribution	5%							
Area/High /Medium mast	4%							
Tools/Appliances	2%							
Plant and Equipment	4%							
Buildings	5%							
Protection relays	5%							
	20%							

9.5.5 Execution

Electrical systems in buildings and fixed appliances are by their nature reliable and seldom prone to failure. This is most likely due to the stringent standards to which these items are manufactured and the provisions of the and SANS 10142; Part 1 The Wiring of Premises.

Therefore, routine maintenance largely consists of annual visual inspection of the general installation and equipment. Maintenance to specific items of the installation/equipment due to failure are responded to via fault reporting systems as and when such calls are received; where after the necessary maintenance personnel are dispatched to carry out the required remedial work.

a) Distribution Boards

- Notwithstanding the provisions of the of 1993 where certain categories of electrical installation are exempted from issue of a Certificate of Compliance, it is recommended that a time period of not more than 8 years be adopted as a reasonable testing cycle for electrical installations. This would include the issuing of a Certificate of Compliance;
- An immediate programme should be implemented to ensure all TNPA electrical installations are covered by a valid Certificate of Compliance;
- Routine inspection of distribution boards should include assessment of the general physical, electrical and mechanical condition of the distribution board;
- Moulded case circuit breakers must comply with SANS 156;
- Wiring and flexible cords must comply with SANS 1574;
- Low voltage distribution boards (up to 10 kA short circuit rating) must comply with SANS1765. For short circuit rating above 10kA, SANS 1473 – 1 shall apply;
- During visual inspection, check for noise/chatter, evidence of overheating, loose connections, excessive dust etc. (heat, odours, tracking). Clean distribution board interior.
- Check that all conductors are of the correct size for the specified application. Also check earth bar, earth connections and neutral bar and tighten all connections;
- Check that all circuits are labelled and safety signage is provided;
- Contactor assemblies (where installed) should be operated manually by pushing in the contact assembly and checking for binding and friction. Listen for excessive hum when contactor is in automatic operation;
- Check each circuit breaker and/or fuse holders for adequate mechanical support;
- Check circuit breakers and/or fuses are the correct rating for the relevant circuit being protected;
- If the installation has switch socket outlets installed, check for correctly rated earth leakage protection unit. Test operate by pressing the test button;
- Check isolating switches are provided and are the correct rating;

- Check that live contacts cannot be inadvertently touched without protection covers being removed with tools/keys.

b) Luminaires, Control Switches, Dimmers and Photo-electric Cells

- Lighting of installations must conform to minimum requirements in terms of the OHS act of 1993.
- Recommended illumination levels are specified in SANS Code of Practice for Lighting.
- Light surveys should be carried out using a LUX meter that has been calibrated by an approved inspection authority. Such surveys should be carried out every at least 2 years to ensure conformance to the requirements of the OHS act of 1993 and NOSA Management system audits.
- Due to the lengthy lifespan of fluorescent and other discharge lamps, routine re-lamping of administrative and other buildings does not take place. Depending on operational requirements, this is left to the discretion of Maintenance Managers. However, it may be advisable in large complexes to carry out full re-lamping on one occasion rather than attend to many regular calls as lamps approach the end of their lifespan.
- During routine re-lamping a general visual examination and cleaning of the luminaire and reflector should take place; Care must be exercised when cleaning high purity aluminium reflectors. These should be handled with gloves and cleaned with a clean soapy solution and lint free cloth;
- Luminaire control gear should only be replaced with SANS or other internationally (IEC) specified equipment;
- Electric light dimmers must comply with SANS 1012;
- Photo electric control units shall comply with SANS 1777;
- Care must be exercised that light switches are not inadvertently overloaded when extensions to lighting circuits (additional luminaires) are carried out;
- Periodic checks should be carried out during re-lamping that time switches and photo electric cells to ensure alignment with the winter and summer daylight hours, and minimise electricity consumption;

c) Switch Socket Outlets and Power Skirting

- In terms of SANS 10142; Part 1 (2003), all switch socket outlets comply with SANS Specification 164 -1 and SANS 164 -2, and must be protected by a suitably rate earth leakage protection device. (See relevant section below);

- In general, switch socket outlets should not be used for electricity supplies to window or console type air-conditioning units. These should be treated as fixed appliances; preferably with their own dedicated circuit and protection;
- Care must be exercised that the requirements of SANS 10142 are being met with respect to extensions to socket outlet circuits when attending to requests for additional supply points in terms of wiring limitations, the numbers of outlets per circuit and protection device rating;
- In addition to labelling/numbering of distribution board circuits, socket outlets and associated feeder circuits should preferably be numbered to enable easy identification of faulty equipment; particularly in large complexes where numerous personal computers are in use; to minimise disruption and dissatisfaction when carrying out fault identification or circuit isolation;
- Routine inspection of electrical installations should include visual inspection of switch socket outlets to determine whether evidence of over loading is occurring as in the case of heaters or other large portable appliances;
- Routine inspection of electrical power skirting must include checking whether all covers are present and securely clipped in position. Under no circumstances should the separate wireways be used to mix power, data and telecommunication cables;

d) Earth Leakage Protection Relays, Earthing and Bonding

- Earth leakage protection units must comply with SANS 767 – 1; Fixed Earth Leakage Protection Units;
- Earthing of low voltage distribution systems must comply with SANS 10292;
- In addition to the normal earthing requirements for electrical installations as contained in SANS 10142-1, additional measures should be adopted to ensure the safety of users of electrical installations and equipment. Therefore, a regular program to assess the condition and adequacy of earthing systems for all buildings and other electrical installations that are/could be occupied; and for electrical machinery, should be implemented;
- All earth leakage relays should be checked to ascertain that they comply with the minimum requirements with regards to tripping current.. All earthing tests must be clearly documented and available for scrutiny should an electrical inspector require this.
- It is recommended that a time period of not more than 5 years be adopted as a

reasonable testing cycle for earthing systems and earth leakage relays (excluding portable earth leakage equipment which should be tested at least annually).

- It is recommended that earth leakage protection equipment be test tripped on a monthly basis. However, due to the volume of electrical installations in ports, the onus for monthly test tripping of earth leakage protection equipment rests with the user/occupier of the premises. The user must take the necessary steps to report faulty equipment in an electrical installation should this become evident, and/or arrange for the repairs.
- Portable earth leakage protection units

e) Fixed Appliances (Geysers, Stoves/Fry-Tops, Hydroboils, Ceiling Fans, Cooker Hoods, etc.)

- Periodic inspection of all fixed appliances should include assessment of the general physical, electrical and mechanical condition of the appliances. This should include the earthing of all fixed appliances and general condition of wiring and control switches;
- Geyser installations should also be checked periodically to determine the satisfactory operation of thermostats;
- All geysers should preferably be provided with isolating switches within 1metre of the geyser terminal connection box; including existing installations;
- The user must take the necessary steps to report faulty fixed appliances as soon as possible for the necessary repairs to be done.

f) Extension cords

- Extension cords must be visually inspected on a regular basis by the user to determine the status of the socket connection, plug top and cord condition, and to ascertain whether it shows evidence of being overloaded;
- Extension cords should preferably be constructed from cable having a minimum conductor size of 1.5mm^2 ;
- Extension cords should be limited to a reasonable length and preferably be housed on purpose-made extension cord reels. A length in the order of 30 metres is considered to be suitable for most purposes. Additional socket outlets should be provided if this will enable shorter extension cords;
- The practice of extending extension cords by inter-connecting successive cords should be discouraged;
- The user must take the necessary steps to report faulty equipment in an electrical

installation should this become evident, and/or arrange for the repairs. This also applies to control and serviceability of portable electric tools often used with extension cords.

g) Lightning Protection

- Lightning protection systems for structures and buildings must comply with SANS 10313;
- Surge protective devices for low voltage installations should conform to the requirements of SANS/IEC 61643-1;
- Due to the nature of lighting protection, it is recommended that external specialists be commissioned to conduct surveys and install adequate lightning protection for vulnerable installations and structures.

9.5.6 Appendices

2.10.13 Building Maintenance check list

9.6 MODULE: SPECIALISED ELECTRICAL INSTALLATIONS

9.6.1 Background

Specialised Electrical Installations means:-

- Hazardous locations as contemplated in SANS 0108
- Explosive atmospheres as contemplated in SANS 086-1*
- Petroleum industry as contemplated in SANS 089, part 1 to 3.

Typical examples of specialised installations that are maintained and repaired by TNPA are;

Hazardous and Explosive Locations

- Oil and paint storage areas
- Gas storage areas
- Battery charging rooms
- Confined spaces containing explosive gasses
- Service pits that are used to service or repair any self-propelled vehicles
- Service tunnels (e.g. wharf side);
- Bunker tunnels.

Petro-Chemical Locations

- Petro-chemical storage/handling sites
- Petro-chemical tanker berths

9.6.2 Special Requirements, standards and Codes of Practice

- In addition to the general electrical provisions contained in SANS 10142-1, no electrical equipment or machinery may be used in specialised electrical installations/locations such as electrical installations in hazardous areas (SANS 0108; SANS 086; SANS 089).
- A certificate issued by an approved inspection authority must cover all electrical equipment required for specialised electrical installations. I.E. where there is a danger of fire or explosion due to possible emissions arising from the storage or handling of any commodity; unless electrical machinery is of the correct classification for the hazardous location, and meets the requirements of a safety standard incorporated for this purpose;
- A certificate issued by an approved inspection authority must cover all electrical equipment required for specialised electrical installations. In which it is certified that the electrical equipment has been manufactured and tested for the groups of dangerous commodities and substances in terms of the required safety standards;
- The appointed competent person for ports must ensure that such specialised electrical installations are evaluated and categorised, inspected and maintained in accordance with the OHS Act and SANS requirements.
- A database of specialised electrical installations should be available that reflects the classification of the area, the date of the last inspection and a signed schematic diagram of the locality of the installation.
- Classified areas must have signage warning/ informing personnel of the zoning of area entered.
- All Portable equipment must be rated according to zone or under hot work permit by Fire officer.
- All electrical equipment required for specialised electrical installations must be covered by a certificate issued by an approved inspection authority in which it is certified that the electrical equipment has been manufactured and tested for the groups of dangerous commodities and substances in terms of the required safety standards.
- TNPA Electrical Policy

9.6.3 Planning

Consideration must be given to the following when planning maintenance to hazardous locations:-

- Legal requirements;
- Monthly inspections;
- Annual inspection and testing database records;
- Drawing up maintenance task lists;
- Compiling maintenance schedules;
- Annual budgeting;
- Condition assessments;
- SAP integration and feedback reports.

9.6.4 Assessment

- Legal and safety compliance
- Electrical equipment to be selected as per area classification
- Any explosion protected equipment that is repaired or modified must be re-certified by an approved certification body, for example an electric motors that are rewound
- Age analysis and physical condition
- Availability of spares
- Maintenance schedule progress, on target
- Explosion protected junction boxes must be inspected in accordance to manufacture certificate to ensure "Flame Path" is still within the designed tolerances, EXD equipment must not have any paint on the Flame path.
- Glands and shrouds should be inspected and redone if found to be loose or corroded.
- Any replacement part on any classified piece of equipment must have a valid certificate and once repaired the equipment must be re certified

9.6.5 Execution

In addition to monthly visual inspection of the electrical equipment routine preventative maintenance must be carried out as per maintenance task lists. Monthly visual checks must be carried out to ensure integrity of the electrical system is maintained. Possible aspects to check on are. Amongst others check;

- Competent persons, IE persons that have at least passed the Master electrician examination must be used for this work only.

- Signs mechanical damage to electrical apparatus and equipment such as Light fittings, Cable glands and connections boxes Distribution boxes and enclosures, Electric motors, Solenoids and valves
- Weathering and corrosive media
- All electrical devices must be installed such they do not come into flammable substances or heat sources
- Explosion protected junction boxes must be inspected in accordance to manufacture certificate to ensure "Flame Path" is still within the designed tolerances, EXD equipment must not have any paint on the Flame path.
- Glands and shrouds should be inspected and redone if found to be loose or corroded.
- Any replacement part (Lamps/Globes) on any classified piece of equipment must have a valid certificate and once repaired the equipment must be re certified.

Annual inspections and tests must be carried out on all electrical equipment installed in hazardous areas. Results of tests must be recorded. Amongst others check:

- Light fittings
- Socket outlets
- Cabling
- Cable glands and connections boxes
- Distribution boxes and enclosures etc.
- Motors and associated control gear
- Solenoids and valves
- Earthing and earth electrodes
- Flexible hoses used for pumping fuels and oils

9.6.6 Appendices

2.10.14 Specialised Electrical Installation check list

9.7 MODULE: DRIVEN MACHINERY

9.7.1 Background

Dry-dock equipment, sewerage networks, cranes and workshop machinery make up a large portion of a port's maintenance budget.

- Dry-dock equipment
- Sewerage networks
- Cranes

- Workshop machinery

9.7.2 Special Requirements, Standards and Codes of Practice

- Transnet Code of Practice 29
- SANS Codes of Practice and Specifications;
- Engineering Instructions;
- Transnet Safety Instructions;
- Applicable Safe Work Procedures etc.
- OH Act of 1993;
- NOSA Safety Management system

9.7.3 Planning

When planning electrical maintenance to driven machinery equipment, sewerage station equipment and other driven machinery, one would need to consider;

- Operational requirements
- Maintenance task lists
- Planning maintenance schedules
- Frequency of use
- Condition assessments
- Annual budgeting
- SAP feedback reports and integration

9.7.4 Assessment

- Legal and safety compliance
- Visual assessment
- Frequency of use
- Age analysis and physical condition
- Availability of spares
- Maintenance schedule progress, on target
- Number of breakdowns/faults

9.7.5 Execution

a) Dry-dock, Floating Docks, Slipways and Synchrolifts

Monthly preventative maintenance must be carried out on the following equipment:

Pump room

Main pumps (6,6 and 2.2kV) and associated control equipment under the cover of a work permit. In addition, the following motors and associated control equipment:-

- 380v Drainage pumps
- Valves
- Exhausters
- Fire pumps
- Seepage pumps
- Circulating pumps

D.C. and A.C. Capstans

- Motor generator sets
- Capstan motors, control gear and resistance banks

Compressors

- 380v Compressor motors and associated control gear
- Circulating pumps

b) Sewerage Stations

Monthly preventative maintenance must be carried out on the following equipment:

- Submersible pumps
- Control panel including float switches

c) Cranes

Monthly preventative maintenance must be carried out on the following equipment:

- Alternator including control panel and alarm systems
- Travel motors and controls
- Cross travel motors and controls
- Slew motor and controls;
- Hoist and lower motors and controls;
- Thrusters and limit switches

Repair wharf/dry-dock Cranes

- 4Ton pedestal cranes with either drum or frequency control
- 10, 15 and 50Ton pedestal cranes with thyromat control
- Crane plugs
- Workshop Overhead Cranes

d) Workshop Machinery

Maintenance is normally only carried out on workshop machinery when it breaks down. However, should there be a breakdown, maintenance personnel will take the opportunity to check the operation, safety and general condition of electrical wiring, motors, starters etc. in alignment with the checks covered under low voltage distribution section. Electrical maintenance to this equipment is usually aligned with mechanical inspections.

Fixed workshop machinery will include amongst others:

- Lathes
- Milling machines
- Guillotines
- Benders
- Presses
- Pedestal drilling machines
- Welding machines
- Profile cutters
- Circular saws
- Planers

9.7.6 Appendices

2.10.14 Maintenance task list - Dry-docks, Floating docks, Slipways, Synchrolifts, Capstans

9.8 MODULE: OVERHEAD TRACTION EQUIPMENT

9.8.1 Background

In order to facilitate movement of cargo through each port, it is necessary to utilise the rail network system in addition to road transportation of cargo. In non-electrified areas, use is made of diesel locomotives. However, where large volumes of raw material such as iron ore, coal etc.; and marshalling yards exist in ports, use is made of electrical energy for traction locomotion. The overhead traction equipment (OHTE) system thus forms an integral part of the rail network in some ports.

Three systems are in general use within Transnet; namely 3kV Direct Current (DC), and 25 kV and 50 kV Alternating Current (AC). As a general rule, the distribution of electricity for traction purposes for the above mentioned systems rests with Transnet Freight Rail. Although ownership of the OHTE systems in ports should ideally also reside with Transnet Freight Rail, in practice the rail yards and associated OHTE in

ports presently reside with TNPA; as does responsibility for the maintenance of the OHTE system.

The primary purpose of this module is to provide background information on the various elements that form part of the 3kV DC OHTE system, and provide a summary of the most important maintenance aspects that need to be considered in order to effectively plan and execute OHTE maintenance. In addition, the module seeks to formalise the extent to which maintenance is being carried out in accordance with maintenance schedules that are integrated with maintenance management systems that enable evaluation of the condition of OHTE assets. Provision must also be made to allow for long term refurbishment of OHTE. The module also aims to illustrate the work procedures to be followed and precautions to be taken when maintaining overhead track equipment. OHTE maintenance staff should have a thorough knowledge of the contents of this manual and other Transnet reference works applicable to OHTE systems. Maintenance personnel should not deviate from the methods and procedures described unless this has been discussed with the responsible controlling engineer.

For the purposes of this manual, the focus will be on the 3kV DC electrification system as it is in much more widespread use than the AC systems. The latter are confined to the coal line (Ermelo and Richards Bay), De Aar to Port Elizabeth (25kV A.C), and the iron ore line (Sishen to Saldanha (50kV AC); but these assets are owned and maintained by Transnet Freight Rail.

The OHTE system comprises the following elements:

- Catenary/Feeders;
- Contact wire;
- Negative Return circuit;
- Various Supporting steelwork/structures;
- Track switches;
- Earthing, Bonding, Spark gaps, Lightning Arrestors;
- Line Insulators, Section Insulators;
- Steady Arms, Droppers, Jumpers.

9.8.2 Special Requirements, Standards and Codes of Practice

This module should be regarded as a guideline and should be read in conjunction with the Transnet electrification maintenance instruction manuals, namely; "Earthing

and Bonding; 3kV DC Electrification"; "25kV AC Electrification"; "50kV AC Electrification"; "Earthing and Bonding; 25 AND 50kV AC Electrification". This module contains descriptions of the various components of the OHTE system to ensure an understanding of the correct methods and material that are needed to maintain overhead track equipment.

Due cognisance must be taken of applicable maintenance planning schedules, tables and charts for sag, conductor tensions, droppers spacing, clearances etc. to ensure OHTE systems are maintained at the correct standard; as well as other standing instructions applicable to the overall rail network configuration requirements (Permanent Way).

Until advised to the contrary, the Transnet Electrical Safety Instructions will be applicable to all persons associated with maintenance of OHTE systems. The Transnet Electrical Safety Instructions (1999) cover the minimum safety requirements that must be observed to ensure safe working on or near high voltage electrical equipment.

Reference may also be made to the procedures which should be followed (including train working rules) in order to ensure the safe execution of maintenance work, as well as guidelines for the performance of the daily routine tasks of a traction linesman. It is not the intention to cover all the detail of overhead track equipment maintenance in this manual, and where possible, reference may be made to other sources (such as CEE drawings) for further information. In the event of any detail or information found lacking and no reference being made to another source, the Chief Engineer should be approached.

9.8.3 Planning

Type of Inspections:

a) Visual

This inspection will consist of a general on-site inspection to determine the status of the asset according to the list sub-components. Typical indicators would be signs of corrosion, damaged or broken components, excessive wear etc. Such inspections are on-going. I.E. daily/weekly

b) Instrument measurement

This inspection will consist of taking measurements at random points along each electrified road to determine factors such as contact wire stagger, contact wire height, earthing integrity;

c) Ultra-sonic testing

This inspection will include the use of sonic equipment to determine the extent of corrosion in foundation bolts, condition of foundations, extent of cracks in foundations etc. Testing would be conducted on a representative random sample of all steelwork and foundations;

Scheduled inspections (monthly, 6 monthly, annual)

9.8.4 Assessment

a) Assessment Indicators:

- Visual assessment
- Review of infra-red scanning, recordings, installation testing
- Fault report analysis
- Age analysis
- Availability of spares (obsolete)
- Common problems experienced
- Asset condition matrix
- Comparison with original design records, as built drawings, close-out reports
- Breakdowns/fault data

b) Asset Condition

Refer to Section H.1.5 of the manual for overall philosophy of asset condition assessment. The table below pertains to OHTE assets. The table shows typical minimum asset condition that would be attained given the feedback data entered under columns (a) to (e). This data would be based on the weighting criteria and five assessment criteria (availability, safety, faults, age, maintenance planning).

CONDITION ASSESSMENT TABLE

OHTE (15%)	WEIGHT	CONDITION	VALUE %	a	b	c	d	e
Foundations	4							
Steelwork	3							
Contact Wire/|Catenary	3							
Earthing and Bonding	3							

Switches, Insulators etc.	2							
	15							

9.8.5 Execution

a) Description of Overhead Electrification System

All railway electrification systems employed by Transnet consist of an overhead contact wire system constituting the "live" part and the rail constituting the return part of the circuit. While the overhead contact wire system is realised by most as being essential for the system operation, the importance of the return circuit is generally not so obvious and is often ignored. This has the result that proper bonding and earthing of the return circuit is often neglected and a dangerous situation arises which may result in fatal electric shocks or damage to locomotives or other equipment.

The importance of proper bonding is clear from the fact that should the return circuit be completely broken, the full system voltage (3 000 volt) may appear between rail and earth if there is a train in the floating section - a highly dangerous condition.
Even in cases where the return circuit is not completely broken, potentials of several hundreds of volts may appear between rail and earth as a result of current flowing in the rail. The sections to follow are a preview of the bonding and earthing methods used on D.C. electrification and serve as an introduction and definitions of the general terms used with regard thereto.

ESKOM (or the local municipality) provides the main power supply for the OHTE system at the relevant voltage for the traction system employed; (3kV DC, 25kV AC or 50kV AC). This supply is fed to traction substations where it is transformed (and rectified in the case of D.C. systems); and then fed to the overhead track equipment via cables and track switches. The overhead equipment between substations is usually divided into smaller sections by means of section-insulators and track switches; the aim being to enable small sections of the overheads to be isolated in the event of a fault occurring, and to facilitate maintenance.

The most important part of the overhead track equipment is the contact wire. The purpose of the contact wire is to transfer electric current to the locomotive whilst it is moving forward under electrical power. This is achieved via a pantograph on the roof of the locomotive that exerts a continuous upward pressure while sliding against

the contact wire. The contact wire must be absolutely straight and not have any kinks or sag in places. To ensure that the contact wire runs level, it is suspended from a catenary wire using droppers. It is important that the sag of the catenary is correct so that the contact wire may remain level from mast to mast. To prevent the contact wire from sagging excessively during high ambient temperatures, it is usual for either a fixed or other tensioning system to be employed. It is essential that the contact wire never remain in the same horizontal position, but rather that it "zig-zags" across the track centre line so that the pantograph wears evenly and the contact wire does not form a groove in the pantograph contact strip. The horizontal displacement of the contact wire from the track centre line (stagger) should be sufficient to accommodate the width of the pantograph.

b) Elements of the Electrification System

Contact Wire

The contact wire consists of a solid round copper conductor with two grooves on the top and has a nominal size of 161mm^2. To prevent excessive wear, the contact wire has to be very hard (± 105 Brinell). This is achieved either through the addition of Cadmium or through surface hardening. The positioning of the support structures and contract wire knuckles is critical to ensure that the position of the contact wire will be within the permissible stagger (240mm) for both a branch line as well as through lines. At cross-overs or points, the stagger will always be correct if the structure is placed at the 1.75m position (for ordinary knuckles) or the 1.4m position (for cross-contact). At a scissors crossing, structures are only placed at the outermost 1.75m or 1.4m position while the inner knuckles "float" at the 1.75m position. Refer to the relevant diagrams in the manual for further detail.

During normal maintenance and repair activities it is necessary to splice the contact wire. It is very important to follow the correct procedure when carrying out splicing. Where new wire is spliced to old wire, the bolts on the old wire should be tightened first as this is normally thinner than the new wire and can therefore be clamped more securely. After a contact wire has been spliced, or a section-insulator has been cut in, a few kinks usually remain where the wire was gripped by the winch clamps. A special kink-block is used, together with a copper hammer, to remove the kinks. It is very difficult to knock out kinks if the wire is too slack; therefore the wire should be

at the correct tension before the kinks are knocked out. Refer to the relevant diagrams and manuals for further detail for the splicing of contact wires.

Catenary Wire

The most common size of catenary wire has a cross-sectional area of 80 mm2 and consists of seven strands. 100 mm2, 160 mm2 and 250 mm2 catenary wire was also used in the past. Refer to the relevant diagrams for further detail on the cross-sections of the four different sizes as well as the diameter, mass and strength for each size. Aluminium feeders are used on lines that carry heavy trains in order to increase the current carrying capacity and also to obtain the increased circuit breaker settings required by these trains.

The feeders are usually suspended directly above, or directly next to the catenary wire and are connected to the contact wire not closer than 335 m apart by means of a 160 mm2 copper conductor (FCC jumper).

The sag of the catenary is set according to applicable sag-charts. The sag is checked by means of a thermometer (which is suspended from the catenary) and the sag sticks. If it is found that the sag should be adjusted, then the bolts in the catenary suspension clamps should be loosened and the catenary pulled tight at the anchor point. Once the sag has been adjusted the suspension clamp bolts should be tightened and all droppers, FCC jumpers and pig-tails should be adjusted vertically. It is important that the catenary sag is never less than the figure indicated on the sag charts. If the sag is greater than, but not more than 75 mm lower than the sag indicated on the chart (67m span), then no adjustment is necessary. For other span lengths (shorter than 67 m) the tolerance of 75 mm should be reduced proportionately.

Negative Return Conductors, Continuity Bonds and Cross Bonds

The bulk of the return current is normally carried in the traction rail which in turn requires proper continuity over its entire length. It is necessary for this reason to ensure that all joints in the traction rail are bonded through by a copper bond (termed a "rail bond").

These must be installed on the crown of the rail. It is sometimes necessary to add to the rail return circuit a negative return conductor in order to increase the current carrying capacity of the return circuit as well as to reduce the rail to earth potentials

by the reduction of current flowing in the rail. Cases where only one rail is available for traction return currents (i.e. single track sections not using jointless signalling systems) will always require a negative return feeder.

Negative return feeders must be installed by competent personnel in accordance with the applicable instructions and guidelines covered in the Transnet "3kV DC Electrification" manual.

On sections where mast base insulation is not used, the negative feeder must be insulated from the masts by means of a single suspension insulator and the bonds must be replaced by one continuous bond (P.V.C. insulated) between the feeder and the traction rail. Guidelines are available to assist with design or whether allowance should be made for negative feeders or not. Final installation of feeders must however be decided by the responsible Electrical Engineer.

Where more than one track is provided and running parallel to each other, it is common practice to install bonds between the traction rails of the various tracks to share the return current between the tracks. These bonds are normally installed at the end of a line/or lines and at regular intervals along the line and are termed "cross-bonds". Cross-bonds are also provided at traction substations to ensure that the current is evenly distributed between the tracks at the feed-in points.

Electrification Support Structures

Various configuration of support structures are employed in traction networks. These include cantilever structures, portal structures (single and double booms), lattice bridge structures, pull-offs and push-pull structures. On single lines and on certain double lines, the catenary and contact wires (and sometimes the feeder) are supported from cantilever structures. In yards portal structures are generally used. Rails were commonly used in the past for the manufacture of the structures used to support traction equipment. This practice has now ceased following recommendations by Transnet Freight Rail. Rail masts should be replaced by the universal "I" beam/columns.

Portal structures are used when three or more tracks run parallel to one another and there is insufficient space between tracks for cantilever masts. Double boom structures may be used provided the length of the span (between mast centre lines) does not exceed 22m. Lattice bridge structures must be used for span lengths exceeding 22m but less than 32m. Span lengths greater than 32m should preferably

be avoided, but where this is not possible, the matter should be referred to the Chief Engineer for a design. Cross-catenary structures are sometimes used in place of lattice bridges since they are cheaper and easier to erect than lattice bridges. However, they are only used in exceptional circumstances and after approval of the Chief Engineer. Where possible these should be eliminated.

Pull-offs are sometimes used between support structures (cantilevers, portals, etc.) with the sole purpose of pulling the catenary and contact wires (and feeder if provided) in order to obtain the correct stagger. Pull-offs may be used on any number of lines but should preferably be avoided on multiple lines. Push-pull structures are used to pull the contact wire to the correct stagger in the opposite direction to the cantilever mast.

Basic Spans

The spacing between support structures on a straight line is known as a "basic span". The spacing may however be less than the basic span, as is the case on curves and in yards, in order to obtain the correct contact wire stagger. The basic span for solid anchor and spring-tension construction is 67 meters. In marshalling yards, where the catenary and contact wires are solidly anchored, a basic span of 60 metres is used. When the overhead conductors need to be anchored at an overlap span or at the end of a track (e.g. in yards), the mast must be provided with additional support in the form of a raking leg or stay wire.

Note that the anchor mast should be at least 6m behind the stop block and that insulators should be installed directly above the stop block. Refer to the manual on the various methods of terminating and anchoring of conductors utilising raking legs and back-guys. Note also that back-guys may not be used on rail masts to anchor any conductor except the earth wire, and that an insulator must be installed in the upper part of the stay wire; the objective being to prevent currents flow in the stay-wire and causing electrolytic corrosion.

In order to achieve proper current sharing between the different overhead conductors, copper jumpers are connected from one to the other. These jumpers are usually connected between the contact, catenary and feeder (if provided) at anchor points and also at regular intervals over the rest of the line as well as at pull-offs. Jumpers are also connected on either side of section-insulators, between contact wires and catenary wires at overlap spans and knuckles, and also between cross-

span wires and contact wires. Refer to the manual for more detail on method of connection, jumper sizes etc.

Traction Switch Structures

Switches carried on track equipment structures are used for the control of the overhead circuits. Overhead track switches are mounted at high level on the structure and are operated at ground level by means of an operating handle connected to a length of steel pipe (operating rod). It is preferred that each switch be mounted on its own mast to facilitate maintenance. The operating rod of each switch must be connected to the structure by a copper conductor of cross-sectional area not less than $50mm^2$ while the steel structure itself must be connected to rail by two bonds ($96mm^2$ steel). Switches at substations are usually connected by means of underground cables.

At sidings where loading and unloading of goods is carried out, the track switch must be provided with an earth blade. The object of the earth blade is to ensure that the overhead equipment is at the same potential as the rail when the switch is in the "open" position so that persons working in the siding do not receive a shock in the event of coming into contact with the overhead equipment.

Where a siding enters an area where flammable materials are handled or stored, a double switch should be provided. In such cases, the overheads as well as the rail are "switched off" to ensure that electric currents do not enter the siding via the rail. (The rail must be earthed in the area where the flammable materials are stored, as large stray currents could flow between the rail and earth if the rail were not isolated from the rest of the system).

Section Insulators

Section insulators are provided to segregate the various circuits on the traction system for load sharing purposes and to facilitate isolation and maintenance. Efforts are continuously being made to improve the design of section insulators, and it is likely that other types will be put into service from time to time. There are several types of section insulator commonly in use on OHTE systems. Refer to the relevant diagrams in the manual for further details.

Section insulators usually require a great deal of attention and should be inspected and adjusted regularly to ensure that they do not cause "hook-ups" with pantographs

and resultant damage to locomotives and overhead track equipment. When runners or arcing horns on section insulators are excessively worn, they should be replaced as soon as possible. The insulation must also be inspected for possible tracking. This inspection should be carried out on a ladder or trestle trolley in order to be able to detect fine tracks with the naked eye. If the section-insulator is excessively dirty it must be cleaned with al detergent and then inspected.

Insulation which exhibits signs of tracking must he replaced with new as soon as possible to prevent the section insulator from flashing over and burning off. In the case of the in-line type insulator (Siemens and ETSA), ensure that the copper runners protrude at least 2 mm below the insulation (over the full length) in order to ensure that the pantograph does not spark and damage the insulation.

Height Gauges

These must be installed at all level crossings on both sides of the track to ensure that vehicles with high loads do not come into contact with live overhead equipment. Refer to the relevant diagrams for further detail on the height and construction of the gauges.

c) Bonding and Earthing of the Electrification System

One of the most important aspects of the OHTE system that needs to be maintained is the bonding and earthing of the system; both from a safety and satisfactory operation of the network. Owing to the high voltages of the system (3 000 V) and the consequent danger or electric shock, it is essential to maintain the mast-to-earth potential at as low a value as possible. To obtain this, the masts are bonded to the rail at intervals not exceeding 350 metres and the rail is in turn connected to the substation negative busbar. In this way it is assured that the mast-to-earth potential cannot reach dangerous levels and should at all times be safe in case a person was to make contact with both mast and earth simultaneously.

It is therefore important that the bond connections to the rail and the mast must make proper contact and be maintained in a good condition at all times. The bond connected between the rail and the mast is term "mast-to-rail" bond.

As there are various methods of bonding to masts and rails, reference must be made to the Transnet manual on "Earthing and Bonding of 3 kV D.C. Electrification" CEE UOS9 for more details of the application of the different types of bonds, method of installation etc. Note that 96 mm2, PVC sheathed, galvanised steel wire is used for

mast-to-rail bonds in all cases except where negative feeders are installed. Mast-to-rail bonds must be installed at maximum intervals of 200 m (3 SPANS) if a steel earth wire is used or 350m if aluminium earth wire is used and also at stop blocks. Where block joints are installed in the traction rail a mast-to-rail bond must also be provided at the nearest masts on either side of the block joint. Double mast-to-rail bonds must be installed where there is no earth wire and a single mast-to-rail bond must be installed where an earth wire terminates to provide a second return path for fault currents in the event of an insulator flash-over.

Cross-bonds must be provided between all traction rails at both ends and in the centre of yards, or at intervals not exceeding 500 m, whichever is the shorter. Cross-bonds between adjacent tracks on main lines must be provided at intervals not exceeding 335 metres except where both rails in each track are available for traction currents, in which case such cross-bonds are not necessary. Equalising bonds are normally installed between the rails of such tracks if colour light signalling is used. In cases where valleys between tracks are covered by ballast, bonds must be laid on and stapled to scrap wooden sleepers which in turn are laid flush and end to end with track sleepers.

Earth wires are used to connect the overhead structures to rail so that the circuit is complete and the breaker in the substation will trip out in the event of a fault on live overhead equipment and a support structure. The structure is thus "earthed" to the rail, hence the name earth wire. Note that the earth wire itself is never connected to "earth" or directly to the rail. The earth wire only connects the structures together and the structures are then connected to rail by means of mast-to-rail bonds.

In addition to the above, an earth wire must also be run along the masts. This wire is electrically connected to each mast and its purpose is mainly to carry fault currents back to the substation (via the rail) in case of failure of the insulation between the overhead wires and the masts or steel, thereby making it possible .for the track breaker in the substation to switch the power off; thus making the line safe. As a safety measure each mast must have at least two return paths for the fault current. If an earth wire is connected to a mast from only one side, a mast-to-rail bond must be provided; or, if the mast is not connected to any earth wire at all, two mast-to-rail bonds must be provided. An earth wire also provides the following benefits:

- By situating the earth wire directly above the transmission line it serves as lightning protection thereof.

- Reduces return circuit resistance slightly.
- Increases current carrying capacity of the return system slightly.

All metal structures carrying 3 kV DC track switches must be double bonded directly to the rails with no spark gap in circuit, the bonds shall be a minimum of one metre apart. On sections where spark gaps are in general use, structures selected to carry switches must be fitted with mast base insulation. The track equipment "earth" wire must NOT be connected to such switch structures but is to be carried through on LT insulation or terminated on adjacent masts. The switch structure must be connected through a spark gap to an earth spike. This provision is necessary to ensure that failure, or partial failure of switch insulation does not bring the potential of the switch structure up to a value likely to cause shock to staff whilst operating switches.

On sections where mast base insulation is fitted, switches controlling the overhead circuits may be attached to any suitable electrification, provided that the structure is fitted with two rail to mast bonds structure. DC switches must not, under any circumstances, be attached to bridges, buildings, tunnels, structures on station platforms or any other structure not erected for the purpose of electrification. Switch rods, cables, lightning arrestors etc. must be bonded or earthed where installed. Siding switches must also be provided with a 50mm^2 copper bond between the earthing contact and the mast to ensure that the siding overhead equipment is properly earthed when the switch is in the open position.

Switches used for the control of AC transmission lines carried on track equipment structures, may be mounted directly on such structures, no special precautions being necessary with any type of track equipment construction. (Except where advised to the contrary; refer to clause 6.2.5 of the "3kV DC Earthing and Bonding " manual). Where switches used for the control of AC transmission lines are erected away from the track equipment structures; E.G. In signal cabins or in separate' switch houses, the metal frames of such switches must be connected to the track equipment "earth" wire or to the structures direct and not to earth or to water mains or similar earthed structures.

The connection must be made with insulated cable in order to prevent contact with earth or earthed structures. It must be appreciated that under these circumstances the AC switch frames will float at rail potential and will not be at the same potential as water pipes, power and telephone cable sheaths or building steelwork nor anything

attached thereto. It is necessary, therefore, for precautions to be taken to ensure that persons do not make accidental contact between AC switch frames and earth or earthed structures. Switches used for the control of lines directly connected to public systems without interposed transformer may not be mounted on overhead track structures. It must however be noted that on sections without mast base insulation a spark-gap must be installed between mast and rail instead of a direct mast to rail bond.

The traction rail return circuit must not be broken at any time whilst the overhead equipment is "alive", otherwise dangerous conditions can arise. Should it be necessary to break the track, the responsible Electrical Engineer or his deputy must be advised in advance before any work is started. The work may only be carried out by either direct supervision or after authorisation from a competent official of the Electrical Department.

Continuity bonds over rail joints must not be removed unless the joint is bridged out first by temporary jumper cables. The permanent bond can then be removed. If the piece of rail to be removed is not too long the jumper cable may be connected directly across the gap; otherwise two jumper cables must be used while use is being made of the new length of replacement rail.

The rail may only be cut after installation of the temporary jumper cables and must be either welded together or bonded out with a normal continuity bond before the temporary jumpers are removed again.

All structures supporting overhead track equipment must be protected in the event of failure of the insulation between the structure and the "live" equipment. Electrification support structures (cantilevers; booms; lattice bridges or tension bridges etc.) with mast base insulation must either be directly bonded to the rail or connected to rail via a common earth wire. Masts without mast base insulation may neither directly be connected to rail nor via an earth wire but must be connected to rail via a spark gap; either individually or via a common earth wire in which case every third mast must be connected to rail via a spark gap. All masts must have at least two return paths back to rail for safety.

Special conditions are applicable to bonding on sections where signalling systems are used. These systems make both rails of a track available for traction return currents instead of only one and certain aspects require special attention with regard to

bonding. Direct cross-bonds are not permitted between the two rails of any track on which these signalling systems are used. The Chief Signalling Engineer must be consulted for bonding on these sections in addition to reference being made to the Transnet "3kV DC Electrification" manuals.

All metallic structures within 3 metres from live overhead track equipment must be connected to rail via spark gaps in two separate places; except colour light signals and signalling equipment which must be earthed in accordance with the directions of the Chief Engineer (Signals and Telecommunications). Stake routes, fences, cattle guards and underground cables must be insulated from the traction rail or common return circuit. Long stake routes on metal poles must have the messenger wire insulated by means of egg-type insulators spaced not more than 800 m apart.

Structures such as bridges, goods sheds, etc. supporting the overhead track equipment may not be directly connected to the earth wire or rail but must be connected to rail via spark gaps at two separate positions. Furthermore the "dead" side of the 3 kV insulators must also be insulated from the structure either by means of an additional "bell" insulator or insulation pads, bushes or washers between the insulator support bracket and the fixing bolts. The insulator support brackets must then be connected to rail either directly or via a common earth wire. Where it is necessary to erect electrification masts at a distance of less than 3 m from a steel building (or shelter) the masts must be bonded to the building by means of a 96 mm galvanised steel, P.V.C. sheathed bond and to rail via a spark gap.

NOTE: These masts must neither be connected to rail directly nor through a common earth wire.

Water columns may not be erected adjacent to electrified tracks. Where the track serving a water column takes off from electrified lines, block joints must be installed in the former and the water column bonded thereto. The water main must also be provided with an insulated joint at the water column and an earth spike must be installed to earth that section of track. Pipes crossing underneath electrified tracks must be installed in accordance with SABS 0121 : "Code of Practice for Cathodic Protection of Buried and Submerged Structures".

At electrified sidings where hazardous commodities are handled or stored, two sets of block joints must be installed to separate the siding from electrified running lines. The first set of block joints must be installed where the siding takes off from the

running line and the second set immediately outside the fenced in the safety area. The distance between two block joints must, where practicable, be sufficient to clear the longest trains handled in the private siding in order to ensure that a train does not short circuit both sets of block joints. Where the siding is electrified, the section of track between block joints must be bonded for continuity. Where insulated joints (block joints) are used, all joints in sets of points that form part of the return circuit must also be bonded through using the correct copper bond. These bonds are installed either on the crown or the web of the rail, depending on the position thereof in the set of points. These provisions are designed to ensure that no difference of potential may exist between metal objects within the area and to limit traction leakage currents passing from the tracks into the earthed structures. The persons controlling the area within the siding are required to bond together all tracks, metallic buildings or structures, fences, pipes, etc. to each other and to earth spikes.

d) Electrolysis

Electrification masts were earlier planted directly into the ground or directly cast into the concrete foundations. Because the masts are to be connected to the rail a certain portion of the traction return current can be expected to leak into the ground via the masts thereby causing the masts to rust at an accelerated rate. Some of these leakage currents can also find its way into underground pipelines or other steel objects causing undesirable rusting thereof in the same way and steps must therefore be taken to prevent this. This type of rusting is generally referred to as electrolysis.

As a first solution to this problem, spark gaps are inserted in line with the mast-to-rail bonds. This prevents currents from leaking from the rail to the mast; but still affords the necessary protection by allowing the spark gap to "spark over" in the event of a fault arising that would raise the mast potential to a dangerous level. More recently "mast base insulation" has been used which makes the use of a spark gap unnecessary as the mast is insulated from its bolt group and thereby from the ground. The masts are insulated by using several layers of insulating tape between the concrete foundation and the mast base; a glass fibre insulating bush to insulate the base plates from the bolt group, and a glass fibre washers between the mast base and the steel holding down bolts and nuts.

Care must be taken during the erection of masts not to damage the glass fibre bushes or washers otherwise the mast base may be short circuited to the bolt group which

may lead to corrosion of the bolt group and subsequent cracking of the concrete foundations.

To reduce electrolysis to a minimum, the following precautions must be taken**:**

- The running rails must be kept clear of all conducting material, such as ash.
- All types of cables crossing under the tracks must be laid in insulated pipes.
- Fences and cattle guards must be kept clear from each other and from running rails.
- The bonding in the section must be kept in good order
- Insulating joints must be installed in all non- electrified tracks leading off the electrified tracks.
- The track equipment earth wire on mast base insulated sections must be kept clear of all earthed structures, such as bridges, roofs etc. Mast-to-rail bonds must be the insulated wire type.
- As a safety precaution all steel structures within 3 metres from live overhead track equipment is connected to rail via spark gaps.

e) General Precautions

This section is concerned with how the work should be done, when and what should be done. The general maintenance of overhead track equipment must be planned and carried out in an orderly fashion according to predetermined standards.

Maintenance personnel must obey the following basic rules without exception when carrying out maintenance duties to ensure the safety of personnel and equipment:

- Before maintenance personnel undertake any work, the overhead equipment must first be appraised from the ground to decide precisely how the particular task will be carried out.
- Determine precisely which part of the overhead is dead and which is "live" before commencing work under cover of a work permit.
- Do not work on "live" equipment in wet weather.
- Do not use equipment or tools that have not been approved for work on overhead traction equipment. Always use the correct tools for the type of work being carried out.
- No part of the overhead equipment may ever be "neutral". It must either be connected to the "live" part; or to "earth".
- All bolts, nuts and Crosby clips must be properly tightened when working on them.

- All contact surfaces must be thoroughly cleaned before any electrical connections are made.

f) Protection against Corrosion

Apart from the application of grease to electrical connections, it is also sound practice to coat all small galvanised fittings, such as bolts, Crosby clamps, clevis pins etc. with a layer of corrosion preventative grease. These fittings should be cleaned and inspected regularly during maintenance. They should be replaced if necessary, and re-coated with a layer of grease to protect them against corrosion. The contact wire is required to be greased approximately every 20 000 pantograph passes.(or as necessary due to rain washing) using a special graphite grease. In the case of copper electrical connections all contact surfaces should be kept free from grease and only screw threads and the outsides of clamps must be coated with grease.

Previously Painted Steelwork

All flaking paint, rust, etc. must first be removed by means of wire brushes, sandpaper, scrapers and chisels. Oil salt or powdered paint must be brushed off with a solution of 1% multi-purpose detergent in water. Thereafter the steelwork must be rinsed with water and allowed to dry. A red lead undercoat must be applied to all bare steel surfaces as soon as possible before the final coat of grey chlorinated rubber is applied after 48 hours.

Galvanised Steel

The above method must be used except where the galvanising is undamaged, in which case the undercoat is not necessary and the final coat may be applied as soon as all flaking paint has been removed and oil etc. has been rinsed off.

Small Galvanised Fittings

Fittings such steady arms, extension straps, push pull-off tubes, suspension clamps, insulators etc. must be inspected for rust regularly and painted as soon as possible if the galvanising is damaged. All flaking paint, rust etc. must first be removed by means of wire brushes, sandpaper, scrapers, etc. and all oil, salt, etc. must be brushed off with a solution of 1% multi-purpose detergent in water. Thereafter it should be rinsed with water and allowed to dry before the paint is applied. If the fittings are heavily coated in soot, grease, etc., it will more than likely be easier to replace them with new fittings and to place the old ones in a bath of "ARDROX " to

remove the dirt. Fittings that have been cleaned in this manner and repainted, may then be used as replacements at a later stage.

g) Numbering of Track Structures

The numbers on overhead structures must always be clearly visible. The accepted standard is that letters and numerals must be 75 mm high and painted in black on a white background at a height of between 2m and 3,3 m above rails. In yards the numbers are only applied on one side of the masts (preferably facing the zero kilometre mast). The numbers must start with the lowest kilometre distance and be consecutive. e.g. 0/1; 0/2 etc. A letter (A, B, etc.) must be added **to** masts situated between support structures. e.g. 119/lA. In large yards, letters must be applied in front of the number according to the function e.g. D = Departure yard; PS = Private siding etc. Refer to the Transnet "3kV DC Electrification" manual for more detail.

h) Clearances between Masts and Rail

The clearances between masts of overhead structures and the track must be checked regularly and must comply with the requirements as given in Appendix 17 of the Transnet "3kV DC Electrification" manual. As P.W.I. personnel may have repositioned tracks, it is necessary that the P.W.l. officials concerned be informed for correction should the recommended clearances have been compromised.

i) Micrometre Readings

In order to ensure that the contact wire is replaced before it wears to the stage where it might break; the thickness of the wire must be checked regularly with a micrometre. Special markers (micrometre clips) are installed on the contact wire at places where it wears rapidly such as pull-off points, knuckles, section-insulators and steady arms. The thickness is then measured each time next to the mark (on the side indicated by an arrow) after first cleaning the wire of all grease etc. Markers must also be installed at every third steady arm. Readings must be taken after 2 years (for new contact wire and every 4 years thereafter until the wire is approximately 10 mm thick. Thereafter readings should be taken every year. The wire must be replaced when it reaches a thickness of 9mm. The readings must be recorded and checked by Maintenance Managers so that the necessary arrangements to replace the wire can be instituted. If the wear is abnormally high, then the matter must be investigated so that the cause may be eliminated.

9.8.6 Preventive Maintenance

In order to prevent the overhead track equipment from failing and thereby causing train delays, it is necessary to maintain it in the best possible condition as would be the case with all other equipment or machines. Certain components however require more regular attention than others and it is therefore necessary that the work be carried out in accordance with pre-planned programs. These programs should specify when, and what work is to be carried out. The schedules are divided into four categories (A, B, C & D) as described below. Note that the services described merely contain a list of the various items of work to be carried out. More detail on the specific procedures, precautions of maintenance to be carried out are contained in the Transnet "3kV DC Electrification" manual. All paragraph references relate to the manual.

SERVICE "A" (Every 6 to 8 weeks)

- Section insulators: Inspect and clean; adjust or replace runners where necessary.
- Stagger at critical points e.g. curves etc.,) : Check and adjust if necessary.
- Micrometre readings: Check contact wire at critical spots. (Par.5.18
- Striking points: Check and adjust where necessary.
- Lightning arrestors (3 kV & 6.6/11 kV) : Replace if necessary
- Switch; Test operate old type (Magrini).
- Droppers: Replace where necessary.
- Arching horns: Check gap and repair where necessary.
- Swivel clips: Check bolts for tightness.
- Parallel arms: Check for burnt cheeks and replace where necessary.
- Steelwork: Note loose bolts and tighten where necessary.
- Insulators: Replace damaged insulators where necessary
- Grease contact wire (every +- 20 000 pantograph passes only). (95.14)
- Check for obstructions on the OHTE; e.g. tree branches fouling the OHTE.
- Check earth-wire and phase-wire clearances to OHTE.
- Check height gauges at level crossings.

SERVICE B (every 2 years in coastal areas, and every 8 years in inland areas)

Cleaning and greasing of all steelwork and fittings (and painting) is required. This work must be carried out every 2 years in coastal areas, and every 8 years in inland areas. This includes masts, booms; cantilevers; lattice bridges, tension bridges, verticals; brackets; etc.;

- Anchor straps and adapter plates
- Insulator caps and pins
- Steady arms hockey sticks (except if stainless steel)
- Push pull off tubes
- Suspension clamps
- Cross-span steady arm attachments
- Tower hooks, Turnbuckles
- Ending cones Crosby clips
- Link straps, clevis pins
- Cross-span fittings and pull-off fittings
- Stay-wire fittings
- Mast bases: Seal with "Denso" paste.
- Bolt groups : Seal nuts with "Denso" mastic.

SERVICE C (This work must be carried out every 2 years)

- Bridge cross-spans: Check tension and grease or paint steel parts.
- Tunnel fittings: Check and grease or paint steel parts;
- Track switches : Check contacts and connections.
- 6.6/11 kV switches : Check contacts and connections.
- Warning boards: Check and replace where necessary.
- Parallel clamps; feeder clamps; bi-metal spacers, F.C.C. lugs.
- Remove. clean and replace. Apply grease on outside.
- F.C.C.'s: Replace where necessary.
- Earth wire clamps (aluminium): Remove, clean and grease with "Penetrox" .
- Auto-tension weights: Check position against temperature charts and adjust where necessary.
- Grease pulleys and guide rods.
- 6.6/.11 kV pin insulators: Check for cracks and check binding wire.
- 6.6/11 kV phase-wires: Check for broken strands and repair.
- Spark gaps : Check and paint caps.

SERVICE D (This work must be carried out every 8 years)

- Check catenary and feeder sag and adjust where necessary.
- Check contact wire tension and adjust where necessary.
- Check overlaps and adjust where necessary.
- Check climbing angle heights and adjust where necessary.

- Check mast-to-rail clearances and report to supervisor.
- Check mast foundations for movement or cracks. Repair where necessary.

NOTE: In addition to the above the following inspections must also be carried out:

- Check bonding regularly and repair where necessary.
- Contact wire height and stagger must be checked annually from the inspection trolley as time will be saved by this method.
- Pantograph inspection from the cab of an electric locomotive whereby the interaction between the contact wire and pantograph can be observed.

NOTE: Coastal areas are defined as the areas within 20 km from the coast.

9.8.7 Appendices

2.10.15 Overhead Track Equipment (OHTE) Maintenance Task List

10 MECHANICAL ASSET MAINTENANCE

10.1 MODULE: LIFTING EQUIPMENT

10.1.1 Background

Lifting equipment refers to all power driven machines designed and constructed for raising or lowering a load, or moving in suspension, and includes a block and tackle, hoist, crane, lift truck, or jib-crane; (but excluding elevators, escalators goods hoists and builders hoists). Included under this broad definition is other lifting tackle such as chains slings, rope slings, rings, hooks, shackles, swivels, spreaders, or similar devices which are also used to raise or lower loads.

10.1.2 Special Requirements, Standards and Codes of Practice

- The regulations pertaining to Driven Machinery and the General Machinery regulations as contained in the Occupational Health and Safety Act;
- Safe Work Procedures for lifting equipment.
- Certification of Examiners, Operators and Supervisors (provision of COP 29)

10.1.3 Planning

In accordance with the provisions of Transnet Code of Practice No.29, all lifting equipment must be examined and tested at regular intervals. To ensure that the requirements of statues and other company policies are met, it is essential that accurate statistics of the volumes, types of lifting equipment, age maintenance frequencies and any other relevant physical properties be known in order for

maintenance task lists and examination schedules to be compiled. An integrated approach to planning of lifting equipment maintenance would thus include:-

- Compiling of maintenance task lists
- Compiling of maintenance schedules
- Annual budgeting
- Asset condition assessments
- Integration with SAP including feedback reports
- Evaluation of the number of faults/breakdowns

10.1.4 ASSESSMENT OF LIFTING EQUIPMENT

- Visual
- Testing program
- Fault s and breakdowns
- Asset condition reports (Age safety etc.)
- Age analysis
- Availability of spares
- Running hours

ASSET CONDITION ASSESSMENT

MECHANICAL PLANT	WEIGHT	CONDITION	VALUE	a	b	c	d	e
Lifting Equipment	4%							
Pressure Vessels	4%							
Driven Machinery	4%							
Fluid Control/Pump	4%							
Steelwork and Structures	4%							
	20%							

10.1.5 Execution

- Examine monthly (visual) / test & certify yearly
- Check lubrication and condition of brakes / wire rope / chains / pulleys / mounting bolts / hoist / slew / luffing / safety equipment or device / out riggers / wheels / controls / safety guards
- Check general appearance of equipment, asset numbering, safety signage etc.
- In accordance with NOSA recommendations, check colour coding of components

Steel Wire Ropes

Inspect the ropes for frayed or broken strands, kinks, corrosion or any other defects that could render them unsafe. Should there be any sign of damage, the ropes must be discarded and replaced in their entirety, by new ropes.

The new ropes must be manufactured of AISI grade 316 flexible, stranded, stainless steel in accordance with Specification No. CME 35 (rope detail as per table 39), with a factor of safety of not less than 10. Thimbles shall be secured by "Talurit" or equal approved compression splices, manufactured of copper and applied by means of a hydraulic tool.

10.1.6 Appendices

2.11.1 Cranes, cherry pickers, block and tackle, jib cranes, lift platforms

10.2 MODULE: PRESSURE VESSELS

10.2.1 Background

In general, pressure vessels refers to any vessel or container of which the interior or jacket is under pressure or in which a cushion of gas or vapour can form above the liquid in it which is at a pressure in excess of the general atmosphere. This general description does not cover all vessels that may be considered to be pressure vessels. E.g. It includes a diving bell, but not a boiler or hand held fire extinguisher; or several other types of vessels. In this regard the OHS act of 1993 is very specific on the description of what constitutes a pressure vessel, and how such equipment should be maintained and inspected. TNPA has several categories of pressure vessel equipment. This makes it imperative that competent personnel are available to carry out the required inspections etc. to ensure legal compliance and the safety of personnel.

10.2.2 Special Requirements, Standards and Codes of Practice

- OHS Act 85 of 1993 (incl. Construction Regulations)
- Transnet Code of Practice 7
- Transnet Code of Practice 29
- Transnet Compressor Instructions 5334
- SANS 0227

10.2.3 Planning

In accordance with the provisions of Transnet Code of Practice No.29 all pressure vessels must be examined and tested at regular intervals. To ensure that the

requirements of statues and other company policies are met, it is essential that accurate statistics of the volumes, types of pressure vessels, age maintenance frequencies and any other relevant physical properties be known in order for maintenance task lists and examination schedules to be compiled. An integrated approach to planning of pressure vessel maintenance would thus include:

- Compiling of maintenance task lists
- Compiling of maintenance schedules
- Annual budgeting
- Asset condition assessments
- Integration with SAP including feedback reports
- Evaluation of the number of faults/breakdowns

10.2.4 Execution

Types of Pressure Vessels:-

- Divers / Firefighting air bottles, Air separators / receivers – 50 Litres and bigger, Divers chamber, Gauges and safety valve
- Examine monthly (visual)
- Yearly test & certify
- Hydraulic – Test 3 Yearly
- Check gauges / safety valves / masks / pipes / fittings
- Check mounting bolts / base
- Check water traps / drains
- Check general appearance of equipment, asset numbering, safety signage etc.
- In accordance with NOSA recommendations, check colour coding of components

10.3 MODULE: DRIVEN MACHINERY

10.3.1 Background

The OHS Act of 1993 classifies all machinery that is electrically, hydraulically or mechanically driven for the purposes of doing "work" in its broadest sense, as driven machinery. Driven machines thus refers to all machinery designed for specific needs as laid down in the Driven Machinery Act of 1988; which act falls under the ambit of the of 1993. Equipment included under this description are bandsaws, lathes, guillotines, grinders, mechanical saws, conveyors, emergency standby plant etc. Driven machinery also includes lifting equipment. However, for the purposes of the maintenance manual, lifting equipment is dealt with separately in Section H.2.4.

10.3.2 Special Requirements, Standards and Codes of Practice

- OSH Act 85 of 1993
- Driven Machinery Act 1988
- Code of practice 29
- Construction Regulations

10.3.3 Planning

In accordance with the provisions of Transnet Code of Practice No.29, all driven machinery must be examined and tested at regular intervals. To ensure that the requirements of statues and other company policies are met, it is essential that accurate records of the various types of driven machinery, age, maintenance frequencies and any other relevant physical properties be known in order for maintenance task lists and examination schedules to be compiled. An integrated approach to planning of driven machinery maintenance would thus include:-

- Compiling of maintenance task lists
- Compiling of maintenance schedules
- Annual budgeting
- Asset condition assessments
- Integration with SAP including feedback reports
- Evaluation of the number of faults/breakdowns
- Inspection & test run – Monthly
- Service – 3 monthly / 250 Hrs / yearly

10.3.4 Execution

Bandsaws, lathes, guillotines, grinders, mechanical saws, conveyors etc.

- All driven machinery must be examined every 3 months and the applicable control document must be endorsed.
- Check integrity of safety guard and other safety mechanisms. For guillotines with automatic hand safety guards, check for correct operation ; including hydraulic and oil leaks;
- For grinders, check condition of stone for crack, grooves, foreign material, chipping etc. Check the distance and height of tool rest/guide. Maximum distance between stone and rest to be 3mm). Overall wear of stone to be within manufacturers tolerances (including speed of operation and correct application);
- Check for build-up of debris;
- Check guides and rollers; On conveyor belts, check condition of belt and belt

joint and adjust to required tension; as specified by manufacturer;

- Check condition of cutting blades
- Check operation and condition of sensors and other safety devices (where applicable); On conveyor systems check operation of whistle wire emergency stops;
- Check all moving components such as lathe turrets, cross travel, chuck (including key) lathe bed, cooling system;
- Check drive system (belts, chains) for tension, wear and tear;
- Check machine body, mounting bolts, wheels/axels etc.
- Check lock-out/electrical isolation and emergency stops (mechanical and electrical);
- Test run machine and check for smooth and noise free operation
- Check lubrication and grease points.
- Check general appearance of equipment, asset numbering, safety signage etc.
- In accordance with NOSA recommendations, check colour coding of components

Emergency standby plant (fixed and large mobile)

- In accordance with manufacturer's instructions
- In accordance with engineering instructions

Explosive Powered Tools

- As per Engineering Instructions and OHS act (Driven machinery and Construction regulations)

10.3.5 Appendices

2.3.9 Task List for Fixed Standby Diesel Plant

2.3.8 Task List for Workshop Machinery

2.3.10 Task List for Explosive Powered tools

2.3.11 Maintenance Plan

10.4 MODULE: FLUID CONTROL EQUIPMENT

10.4.1 Background

Fluid control equipment includes sewerage pumping installations, firefighting installations, or hydraulic systems which utilise a combination of pumps, valves and pneumatics etc. to control the movement of low or high pressure fluids to various installations employed by TNPA in the course of operating its ports.

10.4.2 Special Requirements, Standards and Codes of Practice

- OSH Act 85 of 1993
- Code of practice 29
- SANS Codes of Practice

10.4.3 Planning

In accordance with the provisions of Transnet Code of Practice No.29, all fluid control equipment must be examined and tested at regular intervals. To ensure that the requirements of statues and other company policies are met, it is essential that accurate records of the types of lifting equipment, age, maintenance frequencies and any other relevant physical properties be known in order for maintenance task lists and examination schedules to be compiled. An integrated approach to planning of lifting equipment maintenance would thus include:-

- Compiling of maintenance task lists
- Compiling of maintenance schedules
- Annual budgeting
- Asset condition assessments
- Integration with SAP including feedback reports
- Evaluation of the number of faults/breakdowns

10.4.4 Execution

Sewerage systems, High pressure pipes, Pumps and valves, Firefighting equipment, Hydraulic Installation

- Examine fire pumps weekly
- Check pressure / flow / leaks / vibration / cavitation
- Check mounting bolts / base / lubrication / driver
- Check controls / water in hydraulic oil / filters
- Check general appearance of equipment, asset numbering, safety signage etc.
- In accordance with NOSA recommendations, check colour coding of components

10.4.5 Appendices

2.3.12 Task List for Sewerage Stations

2.3.13 Task List for Fire Monitors

2.3.14 Task list for Centralised Foam Injection (CFI) systems

2.3.15 Maintenance plan

10.5 MODULE: STRUCTURES AND STEELWORK

10.5.1 Background

Structures and steelwork include Towers, Steel beams, Lattice structures, Railings, Catwalks, Ladders, Scaffolding, Light masts etc. Many of the items which fall within this category of equipment are required to either facilitate safe access to items of plant and equipment or buildings for maintenance purposes, are used to support other equipment (e.g. lighting), or are utilised during the construction of assets.

10.5.2 Special Requirements, Standards and Codes of Practice

- 85 of 1993 (incl. the Construction Regulations)
- Code of practice 29
- Engineering instructions

10.5.3 Planning

In accordance with the provisions of Transnet Code of Practice No.29 and the OH Act of 1993, all structures and support steelwork must be examined and tested at regular intervals to ensure that the requirements of statues and other company policies are being met. Accurate records of structures and steelwork, their function, age, maintenance frequencies etc. must be known in order for maintenance task lists and examination schedules to be compiled. An integrated approach to planning of lifting equipment maintenance would thus include:-

- Compiling of maintenance task lists
- Compiling of maintenance schedules
- Annual budgeting
- Asset condition assessments
- Integration with SAP including feedback reports
- Evaluation of the number of faults/breakdowns

a) Towers, Steel Beams, Lattice Structures, Railings, Cat Ladders, Ladders and Scaffolding, Light Masts

- Examine (a) 3 monthly – light mast
  (b) 6 monthly
- Check mounting bolts / rivets
- Check wheels / platforms / trap doors
- Check safety railings / chains / cables / ropes
- Check rungs / steps

- Check foot rubbers
- Check general appearance of equipment, asset numbering, safety signage etc.
- In accordance with NOSA recommendations, check colour coding of components

b) Masts and Towers, Foundations and Base Plates

- The surface of all concrete above ground shall be inspected for cracks, spalling or other visible signs of damage.
- Check the condition of grout under any plates. Look for cracks or any loose material.
- Inspect the soil around the foundation(s) for signs of movement or subsidence.
- Anchor assemblies, anchor bolts, plates, rods and embedded material shall be verified that they are sufficiently above grade to prevent excessive corrosion. If steel materials are not above grade, then a check of their corrosion protection should be made. This may involve verifying that coating systems such as galvanizing, painting, or special wrappings are in place.

c) Lighting Columns, Masts, Poles etc.

- Check perpendicularity of the column.
- Check the state of the access door, inspection chamber.
- Check that bolts and pins, as well as security connectors and "Crosby" clamps are secure.
- Check for paint deterioration and corrosion.
- Check for signs of snakes, rats, insects or birds nesting in the mast.

d) Portable Winches

- Remove any dirt or foreign matter that may have accumulated on the winch or wire ropes, by wiping with a clean cloth.
- Visually inspect the complete winch.
- Drain the oil.
- Remove cover plate and examine gearing while rotating gear wheels. If wear on gearing is excessive, the winch must be forwarded to a mechanical workshop for overhaul.
- Replace cover plate.
- Fill gearbox with new oil. (Stores item 9/919011, or 9/921606 or equivalent)
- Using the electric power tool, unwind the full length of wire ropes from the winch. Lay the wire ropes straight on to the ground for inspection. Ensure that the wire ropes do not kink or get damaged in the process.

- Inspect the ropes for frayed or broken strands, kinks, corrosion or any other defects that could render them unsafe. Should there be any sign of damage, the ropes must be discarded and replaced in their entirety, by new ropes. The new ropes shall be manufactured of AISI grade 316 flexible, stranded, stainless steel in accordance with Specification No. CME 35 (rope detail as per table 39), with a factor of safety of not less than 10. Thimbles should be secured by "Talurit" or equal approved compression splices, manufactured of copper and applied by means of a hydraulic tool.
- Inspect rope anchorage points on winch drums. Ensure that no undue wear is evident in the winch mechanism. Clean the wire ropes.
- Rewind wire ropes, ensuring that the rope coils correctly on to the winch drum.
- Store the winch in an upright position in a clean and dry place and cover with a canvas cover, if provided.
- Complete RMD 9, and where applicable RMD 66, log sheets.

e) Winch Electric Power Tools

- Visually inspect the complete unit, including the cable, for damage or defects.
- Remove and check the brushes for wear. Replace brushes if necessary.
- Check, without stripping the machine that the bearings, reversing switch and speed selection operate satisfactorily.
- Rectify all defects.
- Complete RMD 9 log sheet.

f) Hydraulic Power Tools

- Clean the pump unit.
- Visually inspect the complete unit for damages or leaks and replace if necessary.
- Check the hydraulic hoses and connectors for damage or leaks and replace if necessary.
- Examine seals for leaks.
- Check hydraulic oil level and top up if necessary (stores item 9/921101 or equivalent).
- Lightly lubricate all external bearing points.
- Rectify all defects.
- Complete RMD 9 log sheet.

10.5.4 Appendices

2.3.16 Task List for Structures and Steelwork

2.3.17 Maintenance plan

10.6 MODULE: LIFTS AND ESCALATORS

Maintenance of lifts and escalators is excluded from the provisions of the maintenance manual, as this maintenance is outsourced to specialist service providers in the private industry who have the necessary expertise. However, the responsibility of ensuring that the requirements of the OHS act of 1993 with respect to Lifts and Escalator maintenance and safety is being met, remains with the owner/user of the asset. It is further required that independent audits are carried out on lift and escalator installations at least every 2 years to determine that the installations are being maintained in accordance with safety legislation. Port Engineers must ensure that this requirement is being met.

Basic guidelines that have been recommended for consideration are the following:

- Monthly OEM inspections
- Annual recording of load test results
- Mandatory display of service provider's contact numbers for emergency purposes.

Expansion and practical considerations of the above guidelines will be covered during the next review of the manual.

10.7 MODULE: AIR CONDITIONING

10.7.1 Background

Air-conditioning and ventilation plant and equipment is primarily provided in administrative, commercial and domestic facilities for the purposes of comfort cooling of the occupants. In addition, specialised electronic installations and computer equipment for local area networks invariably require air-conditioning to ensure operational reliability. Finally, refrigeration equipment such as domestic refrigerators, freezers and water coolers are a necessary requirement to ensure preservation of perishable foodstuffs for health purposes and the general well-being of humans. The important factors involved in a complete air-conditioning system include; temperature control, humidity control, air movement and circulation, and air filtering. Complete air-conditioning provides automatic control of these factors for all weather conditions and all seasons.

The purpose of air-conditioning and refrigeration maintenance is to determine the effectiveness of maintenance planning and actual execution of day to day

maintenance, the magnitude of expenditure incurred, and the extent to which maintenance is being carried out in accordance with maintenance schedules. Regular visual inspection coupled with specific feedback mechanisms and measurement data to evaluate the condition of air-conditioning and refrigeration systems should be integral to the monitoring/feedback process. Provision must also be made for allow for long term refurbishment of air-conditioning and refrigeration systems. Air-conditioning maintenance covers the inspection, routine servicing and major servicing of air-conditioning and refrigeration plant in buildings and on floating craft. Air-conditioning and refrigeration can be divided into the following broad categories:

- Central chillers
- Air and Water Cooled Package Systems
- Unit type air conditioners (Window and Console type units)
- Split Systems (Console, Cassette, Mid-wall etc.)
- Refrigeration equipment

10.7.2 General Legal Requirements, Policy and Standards

- In addition to complying with the provisions of the Infrastructure Maintenance Policy and Procedures documents (Parts 1 and 2), all electrical maintenance activities associated with air-conditioning maintenance must be carried out in accordance with the provisions of the Electrical Policy and Procedures document (Part 1 and 2); where applicable.
- Existing Electrical Engineering Instructions as distributed by the former Chief Electrical Engineer with the aim of ensuring a standard approach in the selection, procurement, maintenance and operation of certain categories of air-conditioning equipment should be used as a guide. Although many of the instructions may have become redundant due to advances in technology and/or maintenance methods, it is nevertheless desirable that the contents of the engineering instructions continue to serve as reference works during the process of such documents being amended/rationalised to suit current maintenance practice within TNPA.
- In accordance with TNPA's Safety, Health and Environments policies, it is desirable that Standard Work Procedures be compiled for maintenance tasks on air-conditioning plant and equipment in order to minimise the risks to which personnel and TNPA assets are exposed. Due regard must be taken of the provisions of engineering instructions or other reference works such as SABS

publications when carrying out maintenance or major refurbishment, and/or when compiling work procedures.

- The appointed competent person for each port must ensure that compliance with the Occupational Health and Safety Act No.85 of 1993 is achieved. The execution of maintenance work must be strictly in accordance with the Construction Regulations in addition to the Electrical Installation Regulations.
- Due cognisance must be taken of applicable international protocols and agreements with respect to the use, control, re-cycling and disposal of CFC's. In this regard, both engineering and maintenance personnel involved with air-conditioning and refrigeration should appraise themselves with the contents of documents such as the Montreal Protocol and any National environmental requirements contained in the Environmental Act.
- SANS Codes of Practice pertaining to Air-conditioning design, ducting, the safe handling of refrigerants etc.

10.7.3 Planning

a) Types of Maintenance Services

Visual Inspection (daily/weekly):

In the case of important installations (e.g. air-conditioning installations serving computer rooms or other expensive or critical processes) where failure of air-conditioning plant to maintain design conditions can have expensive and far reaching implications, a daily or weekly audible and visual inspection of the air-conditioning plant shall be carried out.

The responsible person shall determine the importance of individual air-conditioning plant under their control in consultation with user departments and shall lay down the frequency of inspections. Any unusual or abnormal conditions found during inspection (e.g. noisy bearings, vibration, water leaks, faulty electrical or pneumatic controls) shall be rectified immediately.

Routine Servicing (monthly/quarterly):

Routine servicing requirements are set out in Appendix 2.11.6. The frequency of routine servicing can be varied between four to six weeks. It is regarded as more important that a thorough service fully in accordance with the schedule of requirements be performed every six weeks than to increase the frequency of servicing to four weekly intervals but at the expense of thoroughness.

Local circumstances (e.g. extreme dust) may necessitate more frequent routine servicing on certain items such as filters or cooling towers. Technical Superintendents in charge of air-conditioning plant shall issue clear guidelines and instructions to maintenance staff regarding items that require more frequent attention.

Major Servicing (6 monthly/annually):

Major servicing requirements are set out in Appendix 2.11.6. The aims in performing an annual major service should be to take all necessary steps to prevent long term deterioration of the air-conditioning plant and to reinstate design conditions. These aims should always be borne in mind and serve as guidelines in determining the exact nature of work to be performed in a particular installation.

b) Asset Condition Assessment

The table below pertains to air-conditioning assets. It shows typical minimum asset condition that would be attained given the feedback data entered under columns (a) to (e). This data would be based on the weighting criteria and five assessment criteria (availability, safety, faults, age, maintenance planning).

CONDITION ASSESSMENT TABLE

AIRCONDITIONING	WEIGHT	CONDITION	VALUE	a	b	c	d	e
Central chillers	5							
Ducted package systems	4							
Split systems	3							
Individual units	2							
Appliances	1							
	15							

For air-conditioning and refrigeration assets, the age and criteria applicable is shown in the table below.

AGE ASSESSMENT TABLE

Domestic Appliances	Air-conditioning & Refrigeration		
	Central	Package	Units
< 5 yrs.= 5	< 10 yrs = 5	< 5 yrs = 5	< 3 yrs.= 5
6 yrs. = 4	11-15 yrs =4	6-10 yrs =4	3 yrs. = 4
7 yrs. = 3	16-20 yrs. = 3	11-15 yrs. = 3	4 yrs. = 3
8 -10 yrs. = 2	21-25 yrs = 2	16-20 yrs = 2	5 yrs. = 2

> 10 yrs. = 1	>25 yrs = 1	>20 yrs = 1	> 5 yrs.= 1

10.7.4 Execution

Port Engineer's electrical departments are responsible for air-conditioning equipment installation and maintenance. To prevent split responsibility, and for more efficient utilisation of maintenance personnel, artisans with an electrical background carry out both mechanical and electrical maintenance activities on air-conditioning plant. Major mechanical repairs are however performed by mechanical maintenance personnel only, or outsourced to suitably qualified contractors. Checking and servicing instructions contained in manufacturers plant maintenance manuals supplied by particular installation contractors shall be studied in conjunction with the requirements of this manual. Should there be conflict with instructions contained in this manual, the manufacturers' guidelines and instructions must be followed.

10.7.5 Routine Servicing Requirements (Daily/Weekly, Monthly)

As a general guideline, the following routine servicing tasks should be carried out on air-conditioning installations. The actual intervals may vary according to the type of plant or its strategic importance to the business. The responsible person in each port should determine the frequency of inspections.

- Carry out an audible and visual inspection of the entire plant
- Investigate and rectify any unusual noises or excessive vibrations.
- Rectify water leaks
- Ensure that all overflows and drains are free from blockages.
- Clean out all debris from plant room and cooler tower areas. Do not allow water to accumulate on plant room floors. Clean and remove dust and dirt from all equipment.
- Inspect all fresh air intakes and exhaust air discharges for blockages.
- Inspect air distribution system and ensure that all dampers are in the "normal" position and all access doors are properly sealed.
- Perform all the specific inspections and tasks listed in the remainder of the maintenance schedule as applicable to the particular installation.
- Verify that satisfactory conditions are being maintained in all air-conditioned areas. React to all valid complaints and take corrective action.

In addition, specific categories of air-conditioning plant have other additional routine servicing requirements. These are detailed hereunder:-

Central Chiller and Ducted Package Installations

Additional Inspection and checks (as applicable to the particular plant configuration):

- Visually inspect for leaks and rectify.
- Audibly check for unusual noises.
- Check compressor oil level.
- Check for proper refrigerant charge to ensure optimum performance.
- Check crankcase and body (low pressure side) for excessive condensation.
- Check crankcase and body (high pressure side) for excessive temperature.
- Check drive belt wear and tension.
- Cycle operating controls and check un-loaders.
- Check compressor crankcase heater operation.
- Check purge operation of centrifugal machines. Drain non-condensibles from purge drum.
- Note all temperature, pressure and electrical readings and compare with reference readings. Change over the "lead-lag" compressor arrangement or switch to standby machine (as applicable).
- Check chilled and condenser water pump shaft glands for excessive or insufficient leakage, or check mechanical seals for leakage.
- Check chilled and condenser water pump bearing lubricant reservoir levels. Check bearings for excessive temperature or wear. Check for undue noise or excessive vibration. Clean drip trays and discharge lines. Note pressure readings and compare with reference values.

Cooling Towers/Evaporative Condenser Inspection

- Inspect fan operation.
- Remove dirt or debris from fans and air inlet screens.
- Check belt wear and tension.
- Check bearings and bearing lubricant levels.
- Drain, clean and flush sumps.
- Clean strainers.
- Check and adjust (if required) sump water level and bleed-off rate.
- Inspect operation of spray nozzles and general operation of the units for effectiveness. Take remedial action as required.

- Check and clean drains.

Water Cooled Condenser Inspection

- Inspect for leaks.
- Note condenser water temperature and pressure readings and compare with reference readings.

Air Cooled Condenser Inspection

- Inspect fan operation (observe that different stages of cooling are operational, as applicable).
- Remove all air flow obstructions from coils and fins.
- Check belt wear and tension.
- Check bearings and bearing lubricant levels.
- Check for pipe connection leaks.

Water Treatment Plant Inspection

- Take water sample and arrange to submit to officers responsible for chemical analysis.
- Add chemicals, as required. (Details the chemical treatment required will be advised by officers responsible for water analysis who will also be responsible for supply of the necessary chemicals.)
- Check for correct bleed-off rate.
- Verify correct operation of the water treatment plant.

Air Distribution Fans/Air Handling Units Inspection

- Inspect fan operation.
- Check belt wear and tension.
- Check bearings and bearing lubricant levels.
- Inspect coil and fins. Remove obstructions/clean as required. Check for refrigerant/water leaks and rectify.
- Check and clean condensate drains.
- Check filters visually or check manometer readings/filter condition indication lights. Clean or replace filters as required.
- Ensure that all filter media is securely fitted into frames and that unfiltered air leakage does not take place past filter frames. In the case of roll filters, check and lubricate/adjust filter advancing mechanisms.
- Check that all air handling unit access doors are secure, and I sealed effectively.

Delivery/Return Air Ducting and delivery diffusers

- Check quality of duct lagging/insulation. For ducts lined on the inside, it is necessary to determine whether the insulation is still adequately secured to the inner walls of ducts and that air flow has caused damage to the insulation. This will result in poor temperature control, sweating of ducts and discharge of insulation membrane/fluff (glass fibre) into the air-conditioned spaces. The latter causes significant distress to occupants.
- Should the presence of fluff be detected, steps must immediately be taken to determine the concentrations in the air through the services of an accredited air quality specialist, and the necessary remedial action taken.
- Periodic cleaning of air delivery ducts and diffusers should be undertaken at intervals not exceeding 5 and 2 years respectively to remove the build-up of deposits on the interior of ducts and around the louvers/blades of diffusers.

Pipework Systems Inspection

- Visually inspect for leaks.
- Check and clean strainer elements in chilled water, condenser water, hot water, steam and condensate lines.
- Check water levels of make-up and expansion tanks and adjust float valves if required.
- Verify that all temperature and pressure gauges are operational and reflect normal operating conditions.

Air Compressor (Pneumatic Control) Inspection

- Check air compressor oil level.
- Check air compressor drive belt wear and tension.
- Drain air receiver and condensate traps.
- Check condition of chemical dryer or refrigerated air dryer elements, clean condenser, etc., as required.
- Check air intake filter.
- Verify correct air pressure regulation.
- Check for air leaks.

Electrical Control Panels, Switchboards (including Heaters) inspection

- Maintenance of electric panels and other electricity distribution associated with air-conditioning installations must conform to the requirements detailed under Sections H.14 and H.16. (Maintenance of Low Voltage Switchboards;

Maintenance of Building Distribution and Lighting respectively).

In addition, the following items should receive the necessary attention during routine inspections:

- Visually inspect for any abnormal conditions.
- Verify that all pilot lights and instruments are operational and reflect normal plant running conditions.
- Check all switches for correct settings.
- Verify correct heater operation by taking ammeter readings.

Humidifier inspection (where applicable)

- Check sump and strainer for contamination. Clean as required.
- Check and adjust (as required) float valve and water level.
- Check for and rectify leaks and excessive corrosion or contamination.
- Verify correct operation of atomiser, heating elements, automatic drain and refill cycle, low level limit switch and unit as a whole.

Energy Controllers Inspection

- Wet bulb control: Ensure that wet bulb wick is properly soaked, If not, clean or replace. Check sump water level and if necessary, drain and clean sump.
- Wet bulb, enthalpy or dry bulb control: Verify that all dampers are in the correct position in accordance with design and climatic conditions.
- Check all damper linkages and grease if required.

10.7.6 Major Servicing Requirements

Central Chiller/refrigeration Machines:

Perform a thorough and complete check and service fully in accordance with maker's "annual service" instructions, inclusive of the following :

- Take an oil sample and arrange chemical analysis; change oil if required or if laid down in maker's instructions;
- Replace all oil and refrigerant filters and dryers
- Change system to the correct refrigerant level for optimal performance;
- Test for refrigerant leaks with a leak detector;
- Lubricate linkages and lubrication points;
- Check alignment and wear on drive systems;

- Check all auxiliary equipment for correct operation; e.g. heaters, unloaders, purge pumps, etc. (as applicable);
- Test all electrical/pneumatic control systems and calibrate as required;
- Test the operation of and recalibrate all safety controls;
- Check and recalibrate all indicating instruments and gauges;
- Clean electrical panels, inspect all relays and contactors, check tightness of all connections;
- Clean all external surfaces and restore damaged insulation or paintwork (repaint if required).
- Run the machine and check all operating conditions and performance against design/commissioning data;
- Log all temperatures, pressures and electrical operating conditions as reference for future in-service checking.

Package Systems

Perform a thorough and complete check and service fully in accordance with maker's "annual service" instructions, inclusive of the following :

- Take an oil sample and arrange chemical analysis; change oil if required or if laid down in maker's instructions;
- Replace all oil and refrigerant filters and dryers
- Change system to the correct refrigerant level for optimum performance;
- Test for refrigerant leaks with a leak detector;
- Lubricate linkages and lubrication points;
- Check alignment and wear on drive systems;
- Check all auxiliary equipment for correct operation, viz. heaters, un1oaders, purge pumps, etc. (as applicable);
- Test all electrical/pneumatic control systems and calibrate as required
- Test the operation of and recalibrate all safety controls;
- Check and recalibrate all indicating instruments and gauges;
- Clean electrical panels, inspect all relays and contactors, check tightness of all connections;
- Clean all external surfaces and restore damaged insulation or paintwork (repaint if required).
- Run the machine and check all operating conditions and performance against design/commissioning data.

- Log all temperatures, pressures and electrical operating conditions as reference for future in-service checking.

Chilled and Condenser Water Pumps:

Inspect fan and motor bearings for wear.

- Lubricate fan and motor bearings as per manufacturer's recommendations;
- Visually check pump alignment.
- Inspect coupling for excessive wear.
- Inspect motor mountings and vibration pads. Replace and adjust as required.
- Tighten all nuts and bolts.
- Check and clean strainers.
- Operate and check hand valves.
- Inspect and replace pump shaft seals or packing, as required.
- Inspect electrical connections and contactors.
- Check motor operating conditions.
- Verify gauges for accuracy and recalibrate as required.
- Log suction and discharge pressures.
- Clean, treat against corrosion and repaint all corroded or damaged external surfaces.

Cooling Towers and Evaporative Condensers:

Remove all bolted panels and inspect units thoroughly internally and externally;

- Clean thoroughly all strainers, spray nozzles, sumps, air screens, panels, spray eliminators, fans and all other parts;
- Clean float valve assembly and check for proper operation
- Check and re-adjust damper and tower by-pass operation.
- Check and lubricate fan and motor bearings as per manufacturer's recommendations;
- Suitably treat and repaint all corroded surfaces; Replace parts as required;
- Recalibrate instruments and gauges;
- Operate all hand valves and inspect for correct operation;
- Check and rectify any undue noise or vibration.

Water Cooled Condensers

- Check and recalibrate all thermometers and gauges;
- Test for refrigerant leaks with a leak detector;

- Check relief valve and fusible plugs;
- Determine level of condenser tube fouling and mechanically I brush-clean tubes if required;
- Clean external surfaces and restore damaged paintwork.

Air Cooled Condensers

Lubricate fan and motor bearings as per manufacturer's recommendations;

- Check belts, pulleys, sheaves for wear and alignment; replace and adjust as required;
- Clean and straighten fins;
- Check and clean fan blades; inspect fan mounting;
- Inspect motor mountings;
- Check motor operating condition;
- Check all electrical connections, contactors, relays; clean electrical panels;
- Test the operation of operating and safety controls;
- Remove all corrosion, treat with a suitable corrosion inhibitor and repaint.

Air Distribution Fans/Air Handling Units

- Clean and carefully inspect fan assembly and fan blades.
- Check that all pulleys and sheaves are securely fastened to their shafts.
- Check alignment, tension and wear of belt drive systems;
- Inspect fan shaft for straightness.
- Check fan and motor bearings and lubricate in accordance with manufacturer's recommendations;
- Check motor mountings and vibration pads. Replace and adjust as required;
- Check motor operating conditions, electrical connections and contactors;
- Carefully inspect cooling or heating coils, remove all dirt and obstructions, straighten damaged fins, remove all corrosion and suitably treat corroded areas against further deterioration;
- Inspect all coil connections for leaks;
- Clean, lubricate and adjust all dampers and linkages.
- Clean outside air intake screens.
- Clean, remove corrosion and suitably treat and paint drain pans and drain pipes.
- Check and clean strainers/steam traps;
- Operate and check hand valves;

- Check operation of diverting and mixing valves;
- Verify gauges for accuracy and recalibrate as required.
- Inspect filter frames or roll filter mechanisms and reinstate all damaged seals, fasteners, operating mechanisms;
- Re-adjust manometer liquid level "zero" (or) verify correct operation of filter condition indication lights;
- Clean and repaint all damaged external panels;

Pipework Systems, Insulation and Lagging

Remove and treat all corrosion on pipework and Supports. Repaint as required.

- Seal all leaks.
- Repair and repaint all damaged insulation.
- Check and recalibrate all pressure and temperature gauges and log various readings for reference purposes.

Air Compressor and Associated Pneumatic Equipment

Perform a thorough and complete check and service on the air compressor, fully in accordance with the manufacturers "annual service" instructions, inclusive of the following:

- Change oil and check oil pressure (Note: use manufacturers recommended oil and additives only);
- Drain tank and check traps
- Check belt and sheaves and change, as required;
- Change large suction filter, as required
- Check unloader operation and settings;
- Inspect, clean, overhaul or replace air check valve;
- Check high pressure safety valve;
- Record individual compressor running times;
- Clean and repaint as required.
- Check and service refrigerated air dryer in accordance with Manufacturer's instructions.
- Clean condenser and cover grilles;
- Check and replace chemical dryer elements, as required.
- Filter and pressure reducing station :
- Check and change particle filters as required;
- Change oil filter;

- Check pressure reducing valve settings;
- Check low pressure safety valve.

Pneumatic Control Systems

- Perform a comprehensive check and re-calibration service on the entire automatic control system (pneumatic or electronic) inclusive of all pneumatic or electronic/
  electrical/mechanical interfaces and the mechanical systems under control (i.e. air/water/refrigerant flow control devices\chiller and boiler controls and auxiliary control devices).
- Repair all air leaks.
- Replace all faulty controls.
- Clean and adjust as required and lubricate all damper control linkages and operating mechanisms.

Electric Heating Elements

Inspect and clean all electric heater elements in the air flow system. Particularly attend to the following:-

- Tightness of electrical connections;
- Soundness of electrical insulation;
- Mechanical rigidity;
- Effectiveness of thermal insulation;
- Safe operation of all overheat stats, no-air-flow switches and interlocks and other safety aspects.

Air Distribution System and Controls

- Verify that main air distribution duct and individual zone duct static air pressures are in accordance with design and commissioning data. Re-commission as required.
- Verify correct air temperatures and take corrective action as required.
- Check soundness of insulation and effect repairs as required.
- Check for air leaks and ensure that all access panels are properly sealed and secured;
- Check and reset all room air control thermostats.
- Check and readjust for correct air flow rates and operation of unit air flow controls.

- Replace all faulty controls.

Log Books and Maintenance Records

- Plant log books shall be kept in all air-conditioning plant rooms.
- The following information (as applicable) shall be entered in log books –
- Date and time of arrival and departure against name(s) of maintenance, supervisory or engineering staff responsible for the installation ;
- Type of maintenance service performed;
- Reason for call-out;
- Details of defects/failures/repairs/replacements;
- Remarks by supervisory, inspecting or engineering staff;
- Special notes (e.g. compressor No 2 not to be started; sump heater failed);
- Signature of all maintenance staff, signifying that inspection, routine servicing or major servicing (as applicable) has been performed;
- Supervisory staff must keep record sheets whereon maintenance programs for all air-conditioning plant are clearly set out.
- Maintenance programs shall reflect types of maintenance services, frequency of the respective services and scheduled dates for performing the services.
- Where scheduled servicing dates cannot be adhered to, the reasons and suitable amendments in scheduled dates must be reflected in maintenance records.
- Maintenance records, as set out above, shall serve as both a clear future maintenance plan and a past history of plant maintenance.

10.7.7 Maintenance by Contract

- Where maintenance staff cannot adhere to the frequency and quality of air-conditioning plant maintenance as laid down in this manual, maintenance contracts may be concluded with suitably qualified air-conditioning contractors.
- Maintenance contracts in the air-conditioning field are difficult to administer and should not be resorted to unless all reasonable steps have been taken to strengthen system maintenance organizations to the point where the work load can be adequately handled.

10.7.8 Water Treatment

- The importance of maintaining the correct chemical treatment at all times to prevent scale formation on heat exchange surfaces and corrosion of piping, condenser and faceplates, cannot be overstressed. Without properly applied

water treatment the heat exchange efficiency of plant and the effective lifespan of water systems are dramatically reduced, leading to costly cleaning operations, replacements and increased power consumption.

- Water samples from open cooling water systems shall be taken on a regular monthly basis for chemical analysis and the prescribed chemical treatment with controlled bleed-off shall be applied at all times.
- Water samples shall normally be submitted for analysis to water laboratories (usually accredited external service providers).
- Cooling tower sumps shall be drained and thoroughly cleaned out on a regular basis to prevent the accumulation of sludge. Accumulated sludge in cooling tower sumps is pumped by the recirculating water pump into the cooling system where it settles out in low flow areas. Such mud or silt deposits cause a reduction of heat transfer and can be the cause of corrosion starting on metal surfaces.

10.7.9 Fire Defence Systems

- Fire defence systems in buildings are normally integrated with air-conditioning systems in a number of ways; E.G. In the event of fire, all air delivery fans must stop and fire dampers in air-conditioning ducts must close. CO2 extraction fans must run to clear CO2 after a fire has been extinguished.
- The regular checking and maintenance of fire defence systems is the responsibility of TNPA Fire Department. However, assistance or supervision by air-conditioning staff is required where access to ducts is required for the purpose of servicing fire damper mechanisms, where fans have to be restarted and for other duties as may be applicable. Air-conditioning maintenance staff should therefore respond to all requests for assistance by Fire Officers and should also immediately draw the attention of Fire Officers to any defects that may be detected in fire defence systems in the process of maintaining air-conditioning systems.
- It is recommended that fire defence systems and fire stats be checked at least quarterly to determine their correct operation.

10.7.10 Energy Saving

- Various energy saving modes of operation should be incorporated in the design of large air-conditioning installations. Such equipment should compare the heat content of return air and outside air in order that during the cooling mode, for example, outside air can be brought into the building and return air released to

atmosphere when the outside air has a lower heat content than the return air. Comparisons in heat content are based on either dry bulb or wet bulb temperature readings or enthalpy (total heat content) measurements.

- If the sensors, control systems and damper actuating mechanisms are not correctly serviced, checked and adjusted on a regular basis, potential energy saving is lost where energy management controllers are employed. Wastage of energy is a strong possibility when, for example, in the cooling mode outside air is called for at a stage when its total heat content is higher than that of the return air.
- Maintenance and Engineering personnel must take an active interest in energy saving modes of operation incorporated in air-conditioning systems under their control as the functioning of these systems is often complex. Energy management systems must be checked by taking wet and dry bulb temperature readings and establishing the enthalpy of the air from psychometric charts.

10.7.11 Maintenance of Unit and Split Unit Type Air-conditioning

Unit and split type air-conditioned servicing requirements are less extensive compared to central plant. The frequency of servicing is 3 monthly, 6 monthly and annually. The list of tasks are as follows:

3 Month Basic Service (optional)

This includes a visual examination, general operation of the unit in situ to determine whether the plant is operating efficiently and quietly; and filter cleaning. Where a large number of unit/split type equipment is in operation, this service may be extended to 6 months maximum; due cognisance being taken of the operating environment (I.E. Units in very dusty environments may need filter and condenser fin cleaning at shorter intervals than 3 months.

6 Monthly Service Requirements. As for 3 month service, but include:-

- Brush down unit and wash out the condenser coil;
- Check gas charge and top up if necessary;
- Wire brush rust spots and paint;
- Paint compressor, fan motor and capacitors;
- Check wiring for loose connections;
- Clean out drip tray and condensate drain line

Annual Service Requirement. As for 6 month service, but include:-

- Wash down evaporator section and evaporator coil, delivery fan;
- Replace filters if required;
- Lubricate plant;
- Check and record liquid and suction pressures, evaporator, condenser and temperatures, and operating voltage and amperage;
- When checking /cleaning drain pan and drain pipe, also check the efficiency of the drainage system;
- Check general deterioration of components;
- Check for refrigerant leaks;
- Check thermostat operation/accuracy;
- Thoroughly treat all signs of corrosion, paint and finish with rust protective solution such as "Tectyl";
- Check unit electrical supply point condition, including any timers and contactors which may form part of the installation;
- For split type systems, check condition of refrigerant line insulation, saddles, support frames/brackets and repair as required;

10.7.12 Appendices

2.4.1 Air-conditioning Maintenance Task List (Large Plant)

2.4.2 Air-conditioning Maintenance Task List (Small Plant)

2.4.3 Maintenance Program

APPENDIX 2.1: LEGISLATION, POLICIES AND REGULATIONS

The main Acts that influence the execution of Maintenance include:

- Environment Conservation Act 1989
- Marine Pollution (Control and Civil Liability) Act 1981
- National Environmental Management Acts 2004
- National Building Regulations and Building Standards Act 1977
- Occupational Health and Safety Act, 1993
- Construction Industry Development Board Act, 2000
- Explosives Act, 2003
- National Land Transport Act, 2009
- National Railway Safety Regulator Act, 2002
- National Road Traffic Act, 1996
- Water Services Act, 1997

Transnet policies that must be adhered to include:

- Occupational Health Management Policy
- SHE Policy Statement

The latest versions of applicable Transnet and TNPA policies, procedures and standards should be sourced from the intranet.

The Regulations within the OHS Act have the biggest impact on maintenance activities. The next table lists some of the legislative requirements that apply to civil, electrical and mechanical assets. This table may not be comprehensive; the Acts should be reviewed by the maintenance manager on a regular basis.

Asset Group	Legislation/Standard	Reference Document	Type of Asset	Frequency
Civil				
Asbestos work	Asbestos Regulations, 2001 Section 3 – Notification of asbestos work	OHS Act	All installations containing asbestos products	Demolition – notify provincial director in writing prior to commencement of work Maintenance – standardized TNPA SOP to be developed and implemented
Construction regulations; • Construction work • Demolition work • Excavation work	Construction Regulations, 2003	OHS Act		Notification to Department of Labour in terms of Construction Regulation 3
Construction regulations; • Erection of scaffolding • Explosive powered tools • Vehicles and mobile plant	Construction Regulations, 2003	OHS Act Transnet Fleet Management Policy		Quote OSH act Daily task
Inspection of structures by competent person	Construction Regulations, 2003 Section 9 – Structures; clause 4	OHS Act	Any structure as defined in the OSH Act	All structures to be inspected by a competent person as follows; • New structures at least once every 6 months until the structure is 2 years old, thereafter annually • Existing structures, annual inspection
Lifts and escalators	Lifts, Escalators and Passengers Conveyer Regulations	OHS Act	Lifts and escalators	Monthly inspection by certified lift technician
National Building Regulations	SANS 10400	SANS Code	Structures, amongst others; • Buildings • Workshops • Sheds • Etc.	Must be applied to; • Design of new structures etc. • Alterations/refurbishment of existing structures etc.
Roads	SADC Road Traffic Signs Manual			
Diving				
Diving Operations	Diving Regulations 2009	OHS Act Transnet Standard		

	Diving Operations Manual August 2010			
Diving Cylinder Maintenance	Portable metal container for compressed gasses Use and maintenance of underwater diving equipment	SABS -19 – 1985 SABS 0127 - 1976		Annual hydrostatic testing Air quality testing Compressor/filter maintenance
Safe operation of machinery, and equipment –instructions regarding examining, testing and logging procedures	Code of Practice no.29			
Decompression Chamber				
Diving Medicals				Annually
Perway				
Standards for Perway Maintenance (TFR)	Manual for Track Maintenance - 2012		Perway assets	Daily – as per workload budget
Specifications For Track Welding	Manual SSS 1 to SSS 14		Perway assets	Daily – as per workload budget
Trains Working Rules	Occupations and protection of track		Perway assets – operational	Daily – monthly plan ahead for occupations
Green book for Civil Engineering (Track manual)	Design and construction of perway		Perway assets; - construction of new asset or - - modification of existing asset	As and when required
Construction Regulation	E7 & E10			As and when required
Electrification - Overhead Track Equipment	Specification no. CEE.0041.98		Perway assets	As per maintenance schedule – 6 monthly inspection
SANS 3000-1:2009	Railway Safety Management		Perway assets	Rail Safety Regulator (RSR); - Submit report – quarterly - Submit improvement plan – annually - Audit/inspection – annually TNPA to conduct internal audits/inspection; - Determine workload budget - annually

				- Network operator – 6 monthly - RME – monthly - Interface meetings – quarterly
SANS 3000 – 2-2-1:2012	Level Crossings		Perway assets	Inspections - quarterly
SANS 3000 – 4 : 2011	Human Factors			Audit - annually
Code of Practice no 29	Act 85 of 1993		Lifting Equipment	Own equipment, ss per COD 29 – see mechanical section RME (Contractor) included in safety file
Permits	Hot permit – Welding/gas cutting		Perway assets	As and when required
Rail track maintenance – removal of scrap metal, refuse and used soil from yard	ISO 14001	SHE standards	Perway assets	As and when required
Electrical				
Electrical Installations • Installations • Municipal By-Laws – Electrical Instructions • Commencement and permission to connect installation work • Approved inspections Authorities for electrical installations • Electrical control gear	Installation Regulations SANS 10142-1 wiring code As per each Municipality Electrical Installation Regulations Electrical Installation Regulations Electrical Machinery Regulation – section 6	OHS Act SANS Codes By-Laws OHS Act OHS Act OHS Act	All electrical installations	Certificates of Compliance (COC), issued in terms of installation regulations Each Port to ensure compliance to local municipality by-laws As required As required As required
Specialized Electrical Installations; • SANS 0108 – hazardous locations	Installation Regulations SANS 10142-1 wiring code	OHS Act SANS Codes	Battery Rooms for Substations Grain Elevator, Sewerage pits, Confined spaces	Appendix 2.2.18 Certificate of Compliance (COC) plus 2 yearly inspection/assessment by

• SANS 086 – explosive at atmospheres • SANS 089 – petroleum industry • SANS 051 – medical facilities • SANS 0147 – air conditioning			Chemical berths Tanker berths and/or any installation where petroleum products are stored or handled Not applicable	competent person – applicable for all specialized electrical installations
Substations and networks; • Work and Test permits • Authorization of Personnel	SANS 10142-2 MV installations High Voltage Regulations Electrical Machinery Regulation – section 5	SANS Code Transnet Standard – Safety Instructions OHS Act	MV Electrical Networks	As required 2 yearly refresher training for all authorized personnel
Substation equipment	Electrical Machinery Regulation – section 5	OHS Act	HV switchboards MV switchboards Batteries/chargers Substation control Gear/protection,	Monthly, 2 years and 3 Monthly (Appendix 2.2.8)
	Electrical Machinery Regulation – section 5	OHS Act	Transformers	
Mast Lighting	COP 29 Engineering Instructions P27	Transnet Standard	High Mast Lighting	2 year (Appendix 2.2.13)
Mast Lighting	COP 29 Engineering Instructions P27	Transnet Standard	Medium Mast Lighting	3 Months (Appendix 2.2.14)
Mast Lighting	COP 29 Engineering Instructions P27	Transnet Standard	Street Mast Lighting	3 Months (Appendix 2.2.15)
Building Distribution	COP 29	Transnet Standard	Distribution Boards	1 year (Appendix 2.2.16)

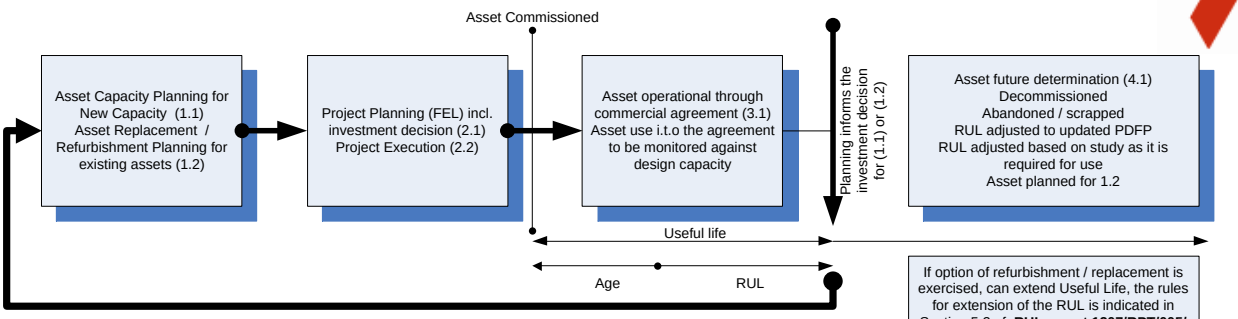
	Engineering Instructions P27			
Lighting	COP 29 Engineering Instructions P27	Transnet Standard Transnet Standard	For definition of medium and high mast lighting – see engineering instruction P27 page 3	• Each medium and high mast lighting structure must have its own RMD 9 logsheet • Ancillary equipment associated with medium and high mast lighting must each have RMD 9 or 66 logsheet • Testing of lifting equipment to be carried out in terms of Code of Practice (COP) 29 • All maintenance, repairs and load tests to be carried out in terms of engineering instruction P27 • All personnel required to work on medium and/or high mast lighting are required to attend a certified training course
Mechanical				
Vessels under pressure;	Vessels under pressure	OHS Act	Amongst others; Boilers Compressors (3 Monthly) Gauges (Annual) Pressurized systems Fire extinguishers Portable gas containers	All vessels under pressure must be inspected, tested and certificated if; • Any repairs or modification are made • In service by certified service provider every 36 months Appendix 2.3.5
Lifting equipment – Part 3 COP 29	Code of Practice 29 (COP 29)	Transnet Standard	All lifting equipment owned by TNPA Mobile Cranes (monthly) Slings (3 Monthly) Shackles(3 Monthly) Chains(3 Monthly) Lifting beams (Annual) Overhead Cranes (Monthly)	1. Examination and testing of lifting equipment – to be carried in terms of part 3 of COP 29 2. Per Cost Centre/Department a functional location to be created for; • Monthly examinations as per RMD logsheets • Three monthly examinations as per RMD logsheets

				• Six monthly examinations as per RMD logsheets (Spencer to assist with naming convention of functioning locations to ensure standardization) Appendix 2.3.1 Appendix 2.3.2 Appendix 2.3.3
Plant and Driven Machinery	Driven Machinery Regulations	OHS Act	Standby Generators/Alternators(Annual) Grinders(3 Monthly) Conveyors(3 Monthly)	Monthly inspections Appendix 2.3.9
Oxy Acetylene Equipment		Transnet Standard	Oxy Acetylene sets	Gauges – to be tested in terms of COP 29 Flashback arresters – to be replaced annually Hoses and clips – to be checked monthly
General – applicable to all				
Drivers Licenses Lifting equipment operators • Forklift • Cranes	National Road Traffic Act and Regulations Code of Practice 30	 Transnet Standard	Fleet Management	Fleet Manager to ensure that all personnel authorized to drive company vehicles have valid licenses to do so
PDP Licenses	National Road Traffic Act and Regulations		Fleet Management	Fleet Manager to ensure that all personnel have valid PDP where required in terms of road ordinance act
Confined space entry - permits	General Safety Regulations	OHS Act	Sewerage pump stations/tanks, tunnels, service ducts, pipes or any area where hazardous gases with an oxygen content of >20% exist	All work must be carried out as follows; • Under permit conditions • Air quality must be tested by a competent person

				• Air quality meter must be approved, calibrated and in date • Suitable PPE to be worn
Medical surveillance	Occupational Health	OHS Act	SHE Department	

APPENDIX 2.2: ASSET MANAGEMENT FRAMEWORK

TNPA Proposed Asset Management Framework (Class 41 Assets only)



If option of refurbishment / replacement is exercised, can extend Useful Life, the rules for extension of the RUL is indicated in Section 5.2 of **RUL report 1207/RPT/005/ Rev G.**

DSL (Design Service Life) Categories (1 to 6), reference RUL report 1207/RPT/005/Rev G

- DSL 1: 80 -120 years
- DSL 2: 65 – 100 years
- DSL 3: 50 – 80 years
- DSL 4: 25 – 50 years
- DSL 5: 10 – 50 years
- DSL 6: 12 – 50 years

DSL 1 are major Port Assets and need to be functionally suitable at all times. For all intents and purposes the life could be considered infinite as any operational damage or degradation can be relatively easily repaired without compromising the design life of the asset. The approach here is to employ an annual conditional and functional suitability confirmation. Based on the condition assessment, the necessary repair can be effected as both planned and unplanned events. The functional suitability requires a long term approach in accordance with the PDFP as per 4.1 above. The forecasting technique shall be as per the RUL report 1207/RPT/005/ Rev G. Capacity and Utilization need to be studied in light of the latest developments. Long term impacts such as climate changes can forecast the future capacity and utilization requirements

DSL 2 are assets that have a more finite life and the mentioned DSL mentioned should be reviewed based on current TNPA data. Hence the annual condition and functional suitability needs to be done in additional to annual capacity and utilization. These structures may last a long time but need to be assessed on their fit for use. A study is needed every 5 years on the cost of maintenance and efficiency of use in relation to its functional purpose. This can be studied in conjunction with the location of the asset in accordance with the PDFP. This will give insight into 4.1.

DSL 3 same as DSL 2

DSL 4,5 and 6. These assets require a multi-condition assessment as per section 2.2.5 of RUL report 1207/RPT/005/Rev G. Decisions are based normally around cost and efficiency, technology changes, safety and compliance etc. Multi-condition needs to be done annually

DSL 1
- Dredged Channels and Basins
- Breakwaters

DSL 2
- Quaywalls, Jetties and Wharfs

DSL 3
- Slipways
- Wave Walls

DSL 4
- Floating Docks
- Ship Lifts
- Sand traps

DSL 5
- Moorings

DSL 6
- Quay furniture

Maintenance Strategies to be developed.

- Long life assets which demand high reliability and high condition factors such as DSL 1
- Medium life assets with a limited life and cannot have the useful life extended easily DSL2 and DSL 3 through maintenance and refurbishment
- Assets that have limited useful life and cannot extend the useful life or it is not wise to extend based on reliability, safety and compliance
- Assets that may not achieve the useful life due to high wear, accident

It Is recommended that 4 strategies to suit the above, are developed which prescribe the levels of condition and functional suitability; capacity and utilization; cost and efficiency; safety and compliance and location. Each strategy will have varying definitions of these and effort required to determine the quantum of maintenance work required as well the operational requirements i.t.o the agreements.

APPENDIX 2.3: DETERMINATION OF REMAINING USEFUL LIFE

1. Background

The TNPA has developed Asset Maintenance Procedures (AMP) for the maintenance of TNPA assets. These procedures were approved by the TNPA EXCO in February 2010 and have been rolled out to all the ports. The primary purpose of the AMP is to ensure that the assets of TNPA are maintained at optimum levels of condition and at minimum cost. In this context, the determination of optimum levels of condition shall take into account the required serviceability (functionality), reliability & availability, legal requirements, appearance and expected future life of assets.

The last mentioned aspect of expected future life of assets is vital for TNPA since the inherent value is lodged in its asset base which comprises mainly of Infrastructure, Marine, Dredging and Lighthouse assets.

The determination of the Remaining Useful Life (RUL) of assets is not only important for planning of operational utilization (capacity planning), the prediction of future operational/ capital spending but also for determination of depreciation.

In April 2008 TNPA appointed ZLH Projects and Naval Architects to undertake a study relating to the optimum determination of RUL's for financial reporting for class 41 assets (Wet assets). This culminated in a report titled:

Wet Asset (Class 41) Revaluation Project (2007/2008)
Remaining Useful Life Study
Final Report P&NA 1207/RPT/005 REV G dated 19 December 2008

2. Output from ZLH report

(The notes and comments in this section have been extracted from the above-mentioned report)

This RUL study was very comprehensive and included a review of international best practice for the determination of RUL for use in financial reporting. This report also recommended that the determination of RUL is based on carefully structured Infrastructure Management Systems that include regular condition surveys.

The review of the RUL of assets should be done on a regular basis and should consider a multi-condition test of factors including the following:

- *Future economic benefits,*
- *Changes in anticipated cargo flows (consumption),*
- *Functional condition suitability,*
- *Capacity and utilization,*
- *Cost and efficiency,*
- *Safety and implementation,*

- *Location (port planning).*

It should be noted that the condition of the assets is not the sole determinant in estimating remaining life. Condition is an engineering assessment and not an accounting one. The carrying value of an asset is the financial representation of the actual condition as assessed by the engineer.
Detailed recommendations were also given regarding the RUL for various asset groups (12 to 120 years) as well as the calculations of depreciated optimized replacement costs of assets.

3. TNPA Engineering Analysis of the Content of the ZLH Report

Whilst the primary purpose of this study was for financial aspects, it is clear that there is a direct link to infrastructure asset maintenance and the proposed Asset Management Framework (AMF) (ZLH referred to this as "a structured Infrastructure Management System").
This AMF covers the entire life cycle of the asset and is represented in the attached diagram (Figure 1). From this diagram the following can be seen:

- This requires a multi-disciplinary approach,
- The asset life cycle is from concept to decommissioning,
- There should be no artificial disconnect between the various phases in the life cycle of the asset,
- Different assets types have different design lives and need to be managed in different ways,
- This approach requires regular condition assessment as well as in-depth analysis of all the factors mentioned in section 2 above.

Currently, there is no systematic approach to the following:

- Life cycle management,
- Determination of the RUL taking into account all relevant factors,
- Determination of port capacity with respect to RUL of assets,
- The consideration of RUL in the determination of future capacity and CAPEX requirements,
- Maintenance strategy for RUL of assets.

The report makes recommendations for the Design Service Life (DSL) of the various asset groups. These DSLs need to be reassessed based on TNPA's knowledge and asset history.

4. Recommendations

The following recommendations are to be considered:

- The ZLH report is to be used as the basis for the determination of the RUL for TNPA Wet Assets (class 41)

- The Design Service Life for the various assets types as proposed by ZLH must be reassessed by TNPA
- Maintenance strategies for the various assets types must be developed
- An Asset Management Framework (AMF) must be developed and implemented
- Commence with detailed inspections and prepare estimates for RUL for port infrastructure class 41 assets
- That recommendations are supported/approved for implementation.

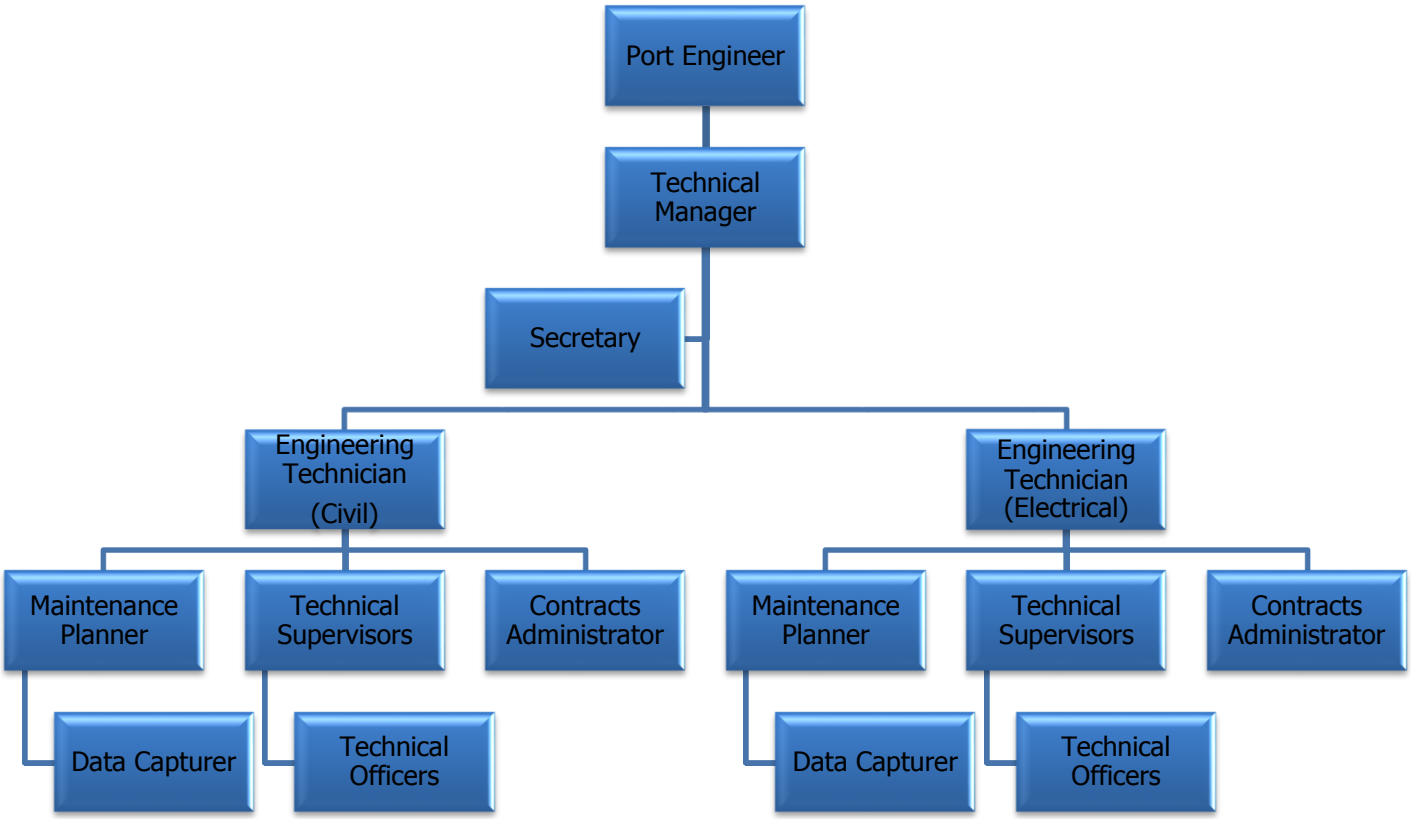
APPENDIX 2.4: KEY PERFORMANCE INDICATORS

To be implemented in phases as shown in the table below.

Key Performance Indicators	Frequency	Feedback source
Phase 1		
Maintenance Plan Schedule Compliance	Monthly	IW39, IP19
% Maintenance Orders that are backlogged	Monthly	IW39
% Planned vs Unplanned Maintenance Orders	Monthly	IW39
Safety incidents	Monthly	
Downtime for all key assets	Monthly	IW29
Maintenance Cost of Breakdown Repairs	Monthly	IW29
Phase 2; include		
Statutory Maintenance Schedule Compliance	Monthly	IW39
Phase 3; include		
Staff Utilisation	Monthly	IW47

APPENDIX 2.5: IDEAL ORGANOGRAM

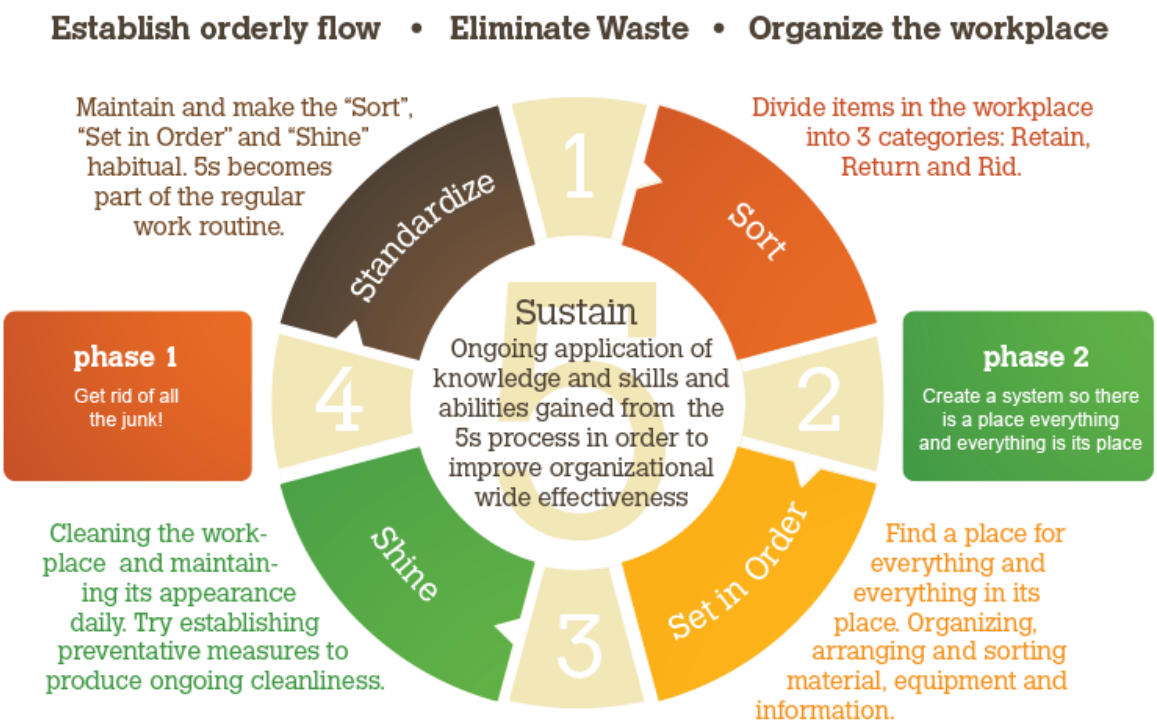
The organogram below should be tailored to suit the needs of the port.



APPENDIX 2.6: ROLES AND RESPONSIBILITIES

Role	Duty
Artisan & Trade Hand	• Return all completed shop papers and inspection/service sheets within 24 hours of completion. • Ensure all tasks are carried out as per task list. • Ensure all information is correctly filled in on all shop papers/inspection/service sheets • Assist in identifying root cause of equipment failures. Document all damage and cause information on inspection/service sheets.
Equipment Examiners	• Ensure that all inspections are carried out as per task lists/inspection sheets. • Ensure that equipment have valid test certificates – report all outstanding cases to MP for scheduling.
Technical Supervisor	• Forward Artisan/Trade Hand availability for next week to Maintenance Planner. • Ensure 100% schedule completion rate. • Ensure that 5 - Why's are done on all equipment breakdowns. • Technically complete work orders on SAP.
Maintenance Planner	• Update action list • Create work orders for notifications to be included in schedules currently being planned. • Re-schedule orders from previous week. • Reserve spares and run material availability checks. • Communicate outstanding PO's to the Buyers. • Inform Store Manager of material shortages. • Provide stores with a pick list for the following week's schedules. • Prepare following weeks schedule (equipment, dates,) • Communicate schedule to relevant role players. • Print work orders, pick lists and confirmation slips. • Update weekly KPI's • Ensure all failure information is captured correctly on all notifications. • Review RCA results and update maintenance plans accordingly
Maintenance Managers	• Review past 24 hours equipment/asset downtime. Ensure that monthly audits are being carried out on the compliance to the maintenance program. • Review maintenance costs per work order type and put in place plans to rectify high cost maintenance. • Ensure that maintenance KPI targets are achieved. • Ensure that weekly maintenance trends are displayed and understood by all staff. • Trend the processing time of work orders.
Port Engineers/Harbour Master/BUM's	• Ensure SAP optimal usage and reporting. • Develop maintenance KPI's and set control limits. • Track maintenance KPI's and report to Port EXCO.

APPENDIX 2.7: JAPANESE 5S SYSTEM



APPENDIX 2.8: ASSET CONDITION SUMMARY RATING

ASSET CONDITION SUMMARY RATING								
ASSET TYPE AND ELEMENT			TARGET CONDITION	ACTUAL ASSESSED CONDITION RATING (%)	WEIGHT	WEIGHTED ACTUAL CONDITION RATING	FACTOR (ACTUAL RATING/ TARGET RATING)	COMMENTS
1. CIVIL		**80%**						
1.1.	**Breakwaters**	**15%**						
		Armour Outer	85%	100	55%	**6.600**	1.18	
		Armour inner	85%	100	10%	**1.200**	1.18	
		Toe - outer	85%	100	10%	**1.200**	1.18	
		Toe - inner	85%	100	5%	**0.600**	1.18	
		Splash Wall	85%	100	5%	**0.600**	1.18	
		Top structure	70%	100	10%	**1.200**	1.43	
		Services	70%	100	5%	**0.600**	1.43	
1.2	**Seawalls**	**10%**						
		Armour protection	80%	100	45%	**3.600**	1.25	
		Toe	80%	100	20%	**1.600**	1.25	
		Backup area	80%	100	15%	**1.200**	1.25	
		Services	80%	100	10%	**0.800**	1.25	
		Splash wall	85%	100	10%	**0.800**	1.18	
1.3	**Navigable Areas**	**15%**						
		Entrance Channel/s	95%	100	25%	**3.000**	1.05	
		Sandtrap/s	**65%**	100	5%	**0.600**	1.54	
		Channels	95%	100	20%	**2.400**	1.05	
		Basins	95%	100	25%	**3.000**	1.05	
		Berths	95%	100	25%	**3.000**	1.05	
1.4	**Quays & Other Berthing Structures**	**15%**						
1.4.1	Quay walls	45%						
		Walls, piles	80%	100	30%	**1.620**	1.25	
		Cope, deck	80%	100	20%	**1.080**	1.25	
		Toe, scour protection	80%	100	15%	**0.810**	1.25	
		Bollards	80%	100	8%	**0.432**	1.25	
		Fenders and chains	80%	100	10%	**0.540**	1.25	
		Ladders	80%	100	2%	**0.108**	1.25	
		Services tunnel	80%	100	10%	**0.540**	1.25	
		Services	80%	100	5%	**0.270**	1.25	
1.4.2	Jetties	25%						
		Deck	90%	100	25%	**0.750**	1.11	
		Pile structure	90%	100	25%	**0.750**	1.11	
		Scour protection	90%	100	15%	**0.450**	1.11	
		Hand rails	90%	100	10%	**0.300**	1.11	
		Bollards	90%	100	8%	**0.240**	1.11	
		Fenders and chains	90%	100	10%	**0.300**	1.11	
		Ladders	90%	100	2%	**0.060**	1.11	
		Services	90%	100	5%	**0.150**	1.11	
1.4.3	Dolphins	25%						
		Deck, caisson, blockwork	80%	100	15%	**0.450**	1.25	
		Pile structure	80%	100	15%	**0.450**	1.25	
		Scour protection	80%	100	10%	**0.300**	1.25	
		Hand rails	80%	100	10%	**0.300**	1.25	
		Bollards	80%	100	10%	**0.300**	1.25	
		Fenders and chains	80%	100	10%	**0.300**	1.25	
		Ladders	80%	100	5%	**0.150**	1.25	
		Services	80%	100	5%	**0.150**	1.25	
		Approach bridge	80%	100	10%	**0.300**	1.25	
		Catwalk	80%	100	10%	**0.300**	1.25	
1.4.4	Offshore buoy moorings	5%	100%	100	100%	**0.600**	1.00	
1.5	**Other Structures & Utilities**	**10%**						
1.5.1	Drydocks	20%						
		Walls	90%	100	15%	**0.240**	1.11	
		Gates	90%	100	15%	**0.240**	1.11	
		Grooves	90%	100	10%	**0.160**	1.11	
		Steps, landings, ledges	90%	100	10%	**0.160**	1.11	
		Tunnels, conduits	90%	100	5%	**0.080**	1.11	
		Fenders	90%	100	5%	**0.080**	1.11	
		Crane rails	90%	100	10%	**0.160**	1.11	
		Hydrants	90%	100	5%	**0.080**	1.11	
		Markings	90%	100	5%	**0.080**	1.11	
		Hatches, manholes, craneboxes	90%	100	5%	**0.080**	1.11	
		Handrails, escape-ladders	90%	100	10%	**0.160**	1.11	
		Flood & emergency valves	90%	100	5%	**0.080**	1.11	
1.5.2	Slipways	10%						
		Rails	85%	100	25%	**0.200**	1.18	
		Rail-beams and piles	85%	100	25%	**0.200**	1.18	
		Bollards	85%	100	0%	**0.000**	1.18	
		Fenders	85%	100	0%	**0.000**	1.18	
		Leading Jetty	85%	100	10%	**0.080**	1.18	
		Cradle	85%	100	30%	**0.240**	1.18	
		Floors and walls	85%	100	10%	**0.080**	1.18	
1.5.3	Syncrolift	15%						
		Leading Jetty	85%	100	10%	**0.120**	1.18	
		Cradle/Lift	85%	100	20%	**0.240**	1.18	
		Traverser/Pit	85%	100	20%	**0.240**	1.18	
		Capstons	85%	100	10%	**0.120**	1.18	
		Fenders	85%	100	5%	**0.060**	1.18	
		Rails	85%	100	10%	**0.120**	1.18	
		Rail beam and Piles	85%	100	10%	**0.120**	1.18	
		Hydrants	90%	100	5%	**0.060**	1.11	
		Drainage	85%	100	5%	**0.060**	1.18	
		Winch Motor (Incl. cables)	90%	100	5%	**0.060**	1.11	
1.5.4	Underground services	10%						
		Portable water system	80%	100	35%	**0.280**	1.25	
		Sewer pipes	80%	100	35%	**0.280**	1.25	
		Storm water system	80%	100	30%	**0.240**	1.25	

1.5.5	Fencing	5%						
		Posts	80%	100	20%	**0.080**	1.25	
		Interim uprights	80%	100	15%	**0.060**	1.25	
		Straining wires/horizontal members	80%	100	10%	**0.040**	1.25	
		Panels or mesh	80%	100	20%	**0.080**	1.25	
		Foundations & plinths	80%	100	20%	**0.080**	1.25	
		Top wire	80%	100	10%	**0.040**	1.25	
		Fixings	80%	100	5%	**0.020**	1.25	
1.5.6	Bridges and culverts	20%						
		Abutments	85%	100	20%	**0.320**	1.18	
		Abutment foundations	85%	100	15%	**0.240**	1.18	
		Wing walls	85%	100	5%	**0.080**	1.18	
		Parapets & handrails	85%	100	5%	**0.080**	1.18	
		Deck slab	85%	100	25%	**0.400**	1.18	
		Expansion joints	85%	100	10%	**0.160**	1.18	
		Surfacing	85%	100	10%	**0.160**	1.18	
		General drainage	85%	100	5%	**0.080**	1.18	
		Kerbing & sidewalks	85%	100	5%	**0.080**	1.18	
1.5.7	Tunnels	10%	85%	100	100%	**0.800**	1.18	
1.5.8	Retaining Walls	10%	**85%**	100	100%	**0.800**	1.18	
1.6	**Roads & Paving**	**10%**						
		Kerbing	65%	100	10%	**0.800**	1.54	
		Surface	80%	100	60%	**4.800**	1.25	
		Road markings	95%	100	15%	**1.200**	1.05	
		Traffic signs	100%	100	15%	**1.200**	1.00	
1.7	**Perway Infrastructure**	**15%**						
		Shunting lines - Rails	85%	100	10%	**1.200**	1.18	
		Running lines - Rails	85%	100	15%	**1.800**	1.18	
		Complete Sets	85%	100	20%	**2.400**	1.18	
		Ballast / concrete	85%	100	10%	**1.200**	1.18	
		Sleepers	85%	100	10%	**1.200**	1.18	
		Rail fastenings	85%	100	5%	**0.600**	1.18	
		Warning signs	85%	100	5%	**0.600**	1.18	
		Surfacing	85%	100	5%	**0.600**	1.18	
		Tumbler	85%	100	5%	**0.600**	1.18	
		Cover plate &box	85%	100	5%	**0.600**	1.18	
		Welding joint	85%	100	5%	**0.600**	1.18	
		Stop blocks	85%	100	5%	**0.600**	1.18	
1.8	**Buildings & Sheds**	**10%**						
1.8.1	Office Buildings	40%						
		Floors, stairways, carpets	85%	100	10%	**0.320**	1.18	
		Doors, windows	85%	100	10%	**0.320**	1.18	
		Tiled walls	85%	100	10%	**0.320**	1.18	
		Roof, gutters, facias, etc	85%	100	15%	**0.480**	1.18	
		Walls interior	85%	100	10%	**0.320**	1.18	
		Walls exterior	85%	100	15%	**0.480**	1.18	
		Sanitary ware, plumbing	85%	100	10%	**0.320**	1.18	
		Blinds, etc	85%	100	5%	**0.160**	1.18	
		Ceilings	85%	100	5%	**0.160**	1.18	
		Signage	85%	100	10%	**0.320**	1.18	
1.8.2	Workshops and sheds	40%						
		Floors	75%	100	15%	**0.480**	1.33	
		Doors & windows	75%	100	15%	**0.480**	1.33	
		Sprinkler system	75%	100	10%	**0.320**	1.33	
		Roof, gutters, Fascias, etc	75%	100	20%	**0.640**	1.33	
		Walls interior	75%	100	15%	**0.480**	1.33	
		Walls exterior	75%	100	15%	**0.480**	1.33	
		Plumbing	75%	100	10%	**0.320**	1.33	
1.8.3	Electrical sub-stations	20%						
		Floors	90%	100	20%	**0.320**	1.11	
		Doors, windows	90%	100	15%	**0.240**	1.11	
		Roof, gutters, fascias, etc	90%	100	25%	**0.400**	1.11	
		Walls interior	90%	100	20%	**0.320**	1.11	
		Walls exterior	90%	100	20%	**0.320**	1.11	
2. ELECTRICAL & MECHANICAL		**20%**						
2.1.	**Network**	**25%**						
		Cables/OH line	100%	100	20%	**1.000**	1.00	
		Transformers	100%	100	20%	**1.000**	1.00	
		HV Switchboards	100%	100	20%	**1.000**	1.00	
		LV Switchboards	85%	100	20%	**1.000**	1.18	
		Batteries/Chargers	100%	100	20%	**1.000**	1.00	
2.2.	**Airconditioning**	**20%**						
		Central Plant	100%	100	33%	**1.333**	1.00	
		Ducted Package	85%	100	27%	**1.067**	1.18	
		Split Systems	80%	100	20%	**0.800**	1.25	
		Individual Units	80%	100	13%	**0.533**	1.25	
		Appliances/Coolers	80%	100	7%	**0.267**	1.25	
2.3.	**E L & P**	**20%**						
		LV cables/Sboards	85%	100	25%	**1.000**	1.18	
		Area/Hi Mast lights	85%	100	20%	**0.800**	1.18	
		Tools/Appliances	80%	100	10%	**0.400**	1.25	
		Plant & Equipment	85%	100	20%	**0.800**	1.18	
		Building Distribution	90%	100	25%	**1.000**	1.11	
2.4.	**OHTE**	**10%**						
		Foundations	80%	100	10%	**0.200**	1.25	
		Steelwork	80%	100	20%	**0.400**	1.25	
		Contact/Catenary	85%	100	20%	**0.400**	1.18	
		Earthing/Bonding	100%	100	25%	**0.500**	1.00	
		Switches/Insulators	100%	100	25%	**0.500**	1.00	
2.5.	**Mechanical**	**25%**						
		CFI/Fire Monitors	100%	100	20%	**1.000**	1.00	
		Sewer Stations	80%	100	15%	**0.750**	1.25	
		Standby Diesel Alt.	85%	100	20%	**1.000**	1.18	
		Breakwater Crane	85%	100	15%	**0.750**	1.18	
		Tools & Equipment	80%	100	10%	**0.500**	1.25	
		Lifts	100%	100	20%	**1.000**	1.00	
					FINAL PORT ASSETS RATING (%)	**100.000**	1.18	

Reviewed by: _____ Technical/ Maintenance Manager _____ Date

Approved by: _____ Port Engineer _____ Date

APPENDIX 2.9: INSPECTION SHEETS FOR CIVIL ASSETS

APPENDIX 2.9.1: NAVIGABLE AREAS (DREDGING)

NAVIGABLE AREAS (DREDGING) INSPECTION SHEET

Asset No.
NPA Port Of:
Type of Inspection: Statutory
Frequency: Monthly
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: Competent Person

BERTH	BOLLARD NUMBERS	DESIGN DEPTH	REQUIRED DEPTH	MAXIMUM DEPTH AVAILABLE	MAX. PERM. DRAFT	DATE SOUNDED	SOUND SHT NO

BERTH	Design depth less Max dapth		BERTH	Design depth less Max dapth	

Down to depth	
0 < D <= 0.3	
0.3 < D <= 0.6	
0.6 < D <= 0.9	
D > 0.9	
Check >	

Inspected by: _____ (Name) _____ (Job Title) _____ (Inspection Date)

Reviewed by: _____ (Technical/ Maintenance Manager) _____ (Signature) _____ (Date Reviewed)

APPENDIX 2.9.2: BREAKWATERS

BREAKWATER INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Station no.	Armour		Splash walls	Top Structure	Services	Toe		General Notes
	Outer	Inner				Outer	Inner	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
Average Condition								
Weight	55%	10%	5%	10%	5%	10%	5%	
Weighted Average Condition								
Asset Condition (sum of weighted average condition)								

Condition

Poor	<40%	Not safe for use	Major upgrades required	Decision required on future of asset
Satisfactory	40-59%	Safe	Some urgent work required	Use of current and planned budget
Good	60-79%	Safe	Moderate ongoing maintenance required	Plan for next cycle
Very good	80-89%	Safe	Minor maintenance required	Plan for next cycle
Excellent	90-100%	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by:

Name	Job Title	Inspection Date

Reviewed by:

Technical/ Maintenance Manager	Signature	Date Reviewed

APPENDIX 2.9.3: SEAWALLS

SEAWALL INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Section no.	Armour		Backup Area (levels, stability)	Toe	Splash Wall	Services	General Notes
	Open str	Closed str					
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
Average Condition							
Weight	45%	45%	15%	20%	10%	10%	
Weighted Average Condition							
Asset Condition (sum of weighted average condition)							

Condition

Poor	<40%	Not safe for use	Major upgrades required	Decision required on future of asset
Satisfactory	40-59%	Safe	Some urgent work required	Use of current and planned budget
Good	60-79%	Safe	Moderate ongoing maintenance requ	Plan for next cycle
Very good	80-89%	Safe	Minor maintenance required	Plan for next cycle
Excellent	90-100%	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by:

Name	Job Title	Inspection Date

Reviewed by:

Technical/ Maintenance Manager	Signature	Date Reviewed

APPENDIX 2.9.4: RETAINING WALLS

RETAINING WALLS INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Bridge Name	Abutment	Abutment Foundation	Wing Walls	Parapet/ Handrail	Deck Slab	Expansion Joint	Surfacing	General Drainage	Kerbing/ Sidewalks	General Notes
Average Condition										
Weight	20	15	5	5	25	10	10	5	5	
Weighted Average Condition										
Asset Condition (sum of weighted average condition)										

Condition

u/s	1	Not safe for use	Replace	Budget to replace
Very poor to u/s	2	Not safe for use	Major upgrades required	Consider replacement
Very poor	3	Safe	Overall urgent work required	Decision required on future of asset
Poor	4	Safe	Some urgent work required	Plan for next cycle
Fair to poor	5	Safe	Maintenance required	Plan for next cycle
Fair	6	Safe	Moderate ongoing maintenance required	Repair within 12 month period
Good to fair	7	Safe	Minor maintenance required	Repair within 18 month period
Good	8	Safe	Minor maintenance required	Monitor
Perfect to good	9	Safe	No maintenance required	No budget needed
Excellent	10	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by: _____ Name _____ Job Title _____ Inspection Date

Reviewed by: _____ Technical/ Maintenance Manager _____ Signature _____ Date Reviewed

APPENDIX 2.9.5: QUAY STRUCTURES

INSPECTION SHEETS FOR QUAYS, JETTIES, SHEET PILE WALLS

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: Competent Person

Berth Number	Main Structure		Fenders and Chains	Bollards	Berth Furniture e.g. ladders	Services	Weighted Average Condition	General Notes
	Wall/Cope	Piles						
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
Average Condition								
Weight	**60**		**10**	**10**	**10**	**10**		
Weighted Average Condition								**Asset condition (sum of weighte average condition) =**

Poor	<40%	Not safe for use	Major upgrades required	Decision required on the future of drydock
Satisfactory	40-59%	Safe	Some urgent work required	Use of current and planned budget
Good	60-79%	Safe	Moderate ongoing maintenance required	Plan for next cycle
Very good	80-89%	Safe	Minor maintenance required	Plan for next cycle
Excellent	90-100%	Safe	No maintenance required	No budget

Inspected by: _____ Name _____ Job Title _____ Inspection Date

Reviewed by: _____ Technical/ Maintenance Manager _____ Signature _____ Date Reviewed

APPENDIX 2.9.6: FENDERS

								Date:	
Caisson No	Fender Number	Side L / S	Fender Plates	Pens	Head Chain	Visual part of mat	Mat Chain	Condition of tyres	General Notes
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

Poor	Satisfactory	Good	Very Good	Excellent
<40%	40-59%	60-79%	80-89%	90-100%
Not safe for use	Safe	Safe	Safe	Safe
major upgrades	some urgent work required	moderate ongoing maintenance required	minor maintenance	no maintenance required
Decision required on the future of drydock	use of current and planned budget	Plan for next cycle	Plan for next cycle	no budget

APPENDIX 2.9.7: ROADS AND PAVING

ROADS AND SURFACING INSPECTION SHEET

Asset No.
Type of Inspection: Normal (as per Asset Maintenance Principles & Procedures)
Frequency: Annual
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Road Description	Surface Area	Road Markings	Traffic Signs	Kerbing	Comments
Average Condition					
Weight	60	15	15	10	
Weighted Average Condition					
Asset Condition (sum of weighted average condition)					
O/H Rating					

Condition

Poor	1	Replacement required
Bad	2	Urgent rapairs
Fair	3	Need repairs
Good	4	Minor damage
Perfect	5	As good as new

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by: _____ (Name) _____ (Job Title) _____ (Inspection Date)

Reviewed by: _____ (Technical/ Maintenance Manager) _____ (Signature) _____ (Date Reviewed)

APPENDIX 2.9.8: PERWAY

PERWAY INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Monthly
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: Competent Person

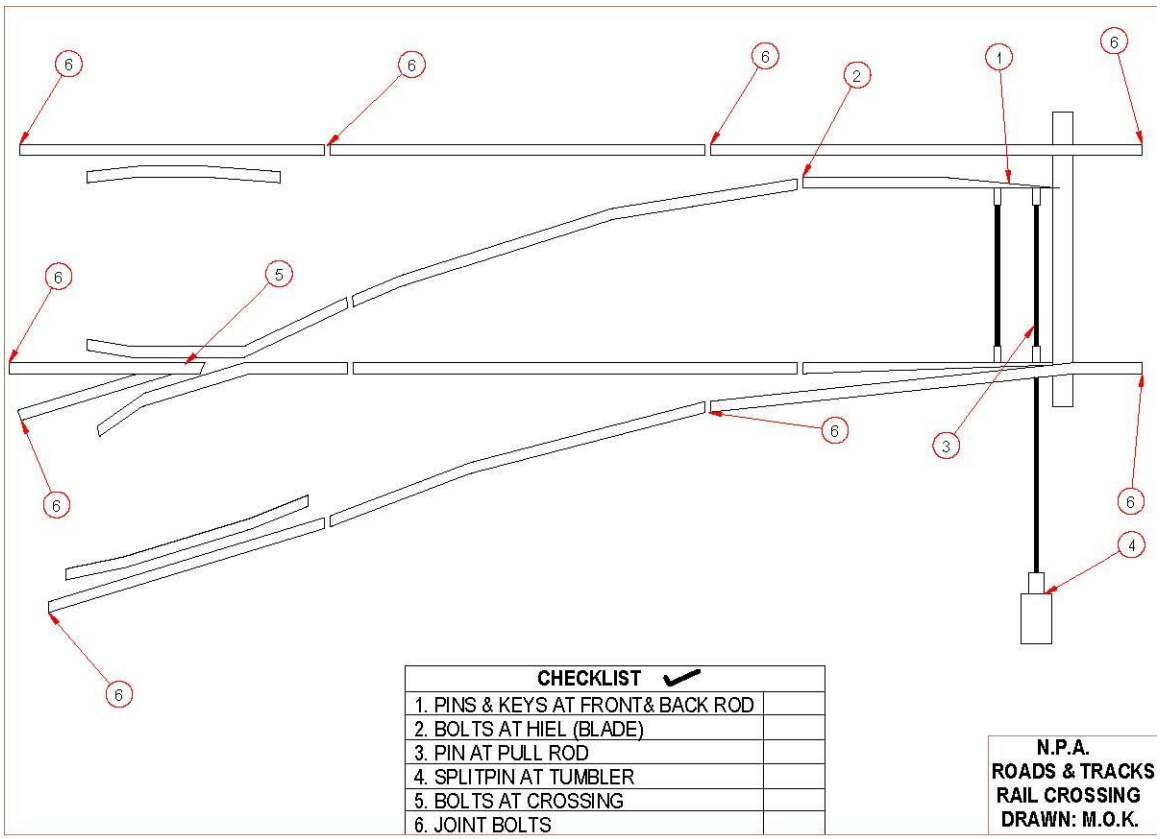
TURNOUTS INSPECTION SHEET													
TURNOUTS	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Remarks
T1													
T2													
T3													
T4													
T5													
T6													
T7													
T8													
T9													
T10													
Sign:													

STOPBLOCKS INSPECTION SHEET													
STOPBLOCKS	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Remarks
S1													
S2													
S3													
S4													
S5													
S6													
S7													
S8													
S9													
S10													
Sign:													

LINE INSPECTION SHEET													
LINE INSPECTION	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Remarks
S1													
S2													
S3													
S4													
S5													
S6													
S7													
S8													
S9													
S10													
Sign:													

Inspected by: _____ _____ _____
Name Job Title Inspection Date

Reviewed by: _____ _____ _____
Technical/ Maintenance Manager Signature Date Reviewed



CHECKLIST ✔	
1. PINS & KEYS AT FRONT& BACK ROD	
2. BOLTS AT HIEL (BLADE)	
3. PIN AT PULL ROD	
4. SPLITPIN AT TUMBLER	
5. BOLTS AT CROSSING	
6. JOINT BOLTS	

N.P.A.
ROADS & TRACKS
RAIL CROSSING
DRAWN: M.O.K.

APPENDIX 2.9.9: BUILDINGS

WORKSHOP/ SHED INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Workshop/ Shed Name	Floors	Doors & Windows	Sprinkler System	Roof, gutters,	Walls exterior	Walls interior	Plumbing
Average Condition							
Weight	15	15	10	20	15	15	10
Weighted Average Condition							
Asset Condition (sum of weighted average condition)							

Condition

Poor	<40%	Not safe for use	Major upgrades required	Decision required on future of asset
Satisfactory	40-59%	Safe	Some urgent work required	Use of current and planned budget
Good	60-79%	Safe	Moderate ongoing maintenance require	Plan for next cycle
Very good	80-89%	Safe	Minor maintenance required	Plan for next cycle
Excellent	90-100%	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by:

Name	Job Title	Inspection Date

Reviewed by:

Technical/ Maintenance Manager	Signature	Date Reviewed

APPENDIX 2.9.10: SHEDS

WORKSHOP/ SHED INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Workshop/ Shed Name	Floors	Doors & Windows	Sprinkler System	Roof, gutters,	Walls exterior	Walls interior	Plumbing
Average Condition							
Weight	15	15	10	20	15	15	10
Weighted Average Condition							
Asset Condition (sum of weighted average condition)							

Condition

Poor	<40%	Not safe for use	Major upgrades required	Decision required on future of asset
Satisfactory	40-59%	Safe	Some urgent work required	Use of current and planned budget
Good	60-79%	Safe	Moderate ongoing maintenance require	Plan for next cycle
Very good	80-89%	Safe	Minor maintenance required	Plan for next cycle
Excellent	90-100%	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by: _____ (Name) _____ (Job Title) _____ (Inspection Date)

Reviewed by: _____ (Technical/ Maintenance Manager) _____ (Signature) _____ (Date Reviewed)

APPENDIX 2.9.11: BRIDGES

BRIDGE INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Bridge Name	Abutment	Abutment Foundation	Wing Walls	Parapet/ Handrail	Deck Slab	Expansion Joint	Surfacing	General Drainage	Kerbing/ Sidewalks	General Notes
Average Condition										
Weight	20	15	5	5	25	10	10	5	5	
Weighted Average Condition										
Asset Condition (sum of weighted average condition)										

Condition

u/s	1	Not safe for use	Replace	Budget to replace
Very poor to u/s	2	Not safe for use	Major upgrades required	Consider replacement
Very poor	3	Safe	Overall urgent work required	Decision required on future of asset
Poor	4	Safe	Some urgent work required	Plan for next cycle
Fair to poor	5	Safe	Maintenance required	Plan for next cycle
Fair	6	Safe	Moderate ongoing maintenance required	Repair within 12 month period
Good to fair	7	Safe	Minor maintenance required	Repair within 18 month period
Good	8	Safe	Minor maintenance required	Monitor
Perfect to good	9	Safe	No maintenance required	No budget needed
Excellent	10	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by: _____ Name _____ Job Title _____ Inspection Date

Reviewed by: _____ Technical/ Maintenance Manager _____ Signature _____ Date Reviewed

APPENDIX 2.9.12: DRY DOCKS

DRYDOCK INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Item	Weight	Rating	Weighted Average	General Notes
Walls	15			
Gates	15			
Steps, landings, ledges	10			
Tunnels, conduits	5			
Fenders	5			
Crane-rails	10			
Hydrants	5			
Markings	5			
Hatches, manholes, crane-boxes	5			
Handrails, escape ladders	10			
Keel and side blocks				
Flood and emergency valves	5			
Caisson doors				
O/H Rating				

Condition

Poor	<40%	Not safe for use	Major upgrades required	Decision required on future of asset
Satisfactory	40-59%	Safe	Some urgent work required	Use of current and planned budget
Good	60-79%	Safe	Moderate ongoing maintenance req	Plan for next cycle
Very good	80-89%	Safe	Minor maintenance required	Plan for next cycle
Excellent	90-100%	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by: _____ Name _____ Job Title _____ Inspection Date

Reviewed by: _____ Technical/ Maintenance Manager _____ Signature _____ Date Reviewed

APPENDIX 2.9.13: SLIPWAYS

SLIPWAY INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Item	Weight	Rating	Weighted Average	General Notes
Walls	15			
Gates	15			
Steps, landings, ledges	10			
Tunnels, conduits	5			
Fenders	5			
Crane-rails	10			
Hydrants	5			
Markings	5			
Hatches, manholes, crane-boxes	5			
Handrails, escape ladders	10			
Keel and side blocks				
Flood and emergency valves	5			
Caisson doors				
O/H Rating				

Condition

Poor	<40%	Not safe for use	Major upgrades required	Decision required on future of asset
Satisfactory	40-59%	Safe	Some urgent work required	Use of current and planned budget
Good	60-79%	Safe	Moderate ongoing maintenance req	Plan for next cycle
Very good	80-89%	Safe	Minor maintenance required	Plan for next cycle
Excellent	90-100%	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by: _____ Name _____ Job Title _____ Inspection Date

Reviewed by: _____ Technical/ Maintenance Manager _____ Signature _____ Date Reviewed

APPENDIX 2.9.14: SYNCHROLIFTS

SYNCHROLIFT INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Item	Weight	Rating	Weighted Average	General Notes
Walls	15			
Gates	15			
Steps, landings, ledges	10			
Tunnels, conduits	5			
Fenders	5			
Crane-rails	10			
Hydrants	5			
Markings	5			
Hatches, manholes, crane-boxes	5			
Handrails, escape ladders	10			
Keel and side blocks				
Flood and emergency valves	5			
Caisson doors				
O/H Rating				

Condition

Poor	<40%	Not safe for use	Major upgrades required	Decision required on future of asset
Satisfactory	40-59%	Safe	Some urgent work required	Use of current and planned budget
Good	60-79%	Safe	Moderate ongoing maintenance req	Plan for next cycle
Very good	80-89%	Safe	Minor maintenance required	Plan for next cycle
Excellent	90-100%	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by: _____ (Name) _____ (Job Title) _____ (Inspection Date)

Reviewed by: _____ (Technical/ Maintenance Manager) _____ (Signature) _____ (Date Reviewed)

APPENDIX 2.9.15: FENCING AND GATES

FENCING AND GATE INSPECTION SHEET

Asset No.
Type of Inspection: Normal (as per Asset Maintenance Principles & Procedures)
Frequency: Annual
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Fences	Corner post	Interim Uprights	Straining Wire	Fencing Wire	arbed/ Top Wir	undations/ Plint	Fixings	Asset Conditio	Comments
Average Condition									
Weight	20	15	10	10	20	20	5		
Weighted Average Condition									
Palisade Fence	Corner Posts	Uprights	Bolts	Sheets	Concrete plinth				
Average Condition									
Weight	30	30	10	20	10				
Weighted Average Condition									
Gates	Corner Posts	Straining Wire	Fencing Wire	Mesh	Hinges	Locks			
Average Condition									
Weight	30	30	10	20	15	5			
Weighted Average Condition									
O/H Rating									

Condition

Poor	1	Replacement required
Bad	2	Urgent rapairs
Fair	3	Need repairs
Good	4	Minor damage
Perfect	5	As good as new

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by: _____ Name _____ Job Title _____ Inspection Date

Reviewed by: _____ Technical/ Maintenance Manager _____ Signature _____ Date Reviewed

APPENDIX 2.9.16: UNDERGROUND SERVICES

UNDERGROUND SERVICES INSPECTION SHEET

Asset No.
Type of Inspection: Normal (as per Asset Maintenance Principles & Procedures)
Frequency: Annual
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Item	Weight	Rating	Weighted Average	General Notes
Walls	15			
Gates	15			
Steps, landings, ledges	10			
Tunnels, conduits	5			
Fenders	5			
Crane-rails	10			
Hydrants	5			
Markings	5			
Hatches, manholes, crane-boxes	5			
Handrails, escape ladders	10			
Keel and side blocks				
Flood and emergency valves	5			
Caisson doors				
O/H Rating				

Condition

Poor	<40%	Not safe for use	Major upgrades required	Decision required on future of asset
Satisfactory	40-59%	Safe	Some urgent work required	Use of current and planned budget
Good	60-79%	Safe	Moderate ongoing maintenance req	Plan for next cycle
Very good	80-89%	Safe	Minor maintenance required	Plan for next cycle
Excellent	90-100%	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by: _____ (Name) _____ (Job Title) _____ (Inspection Date)

Reviewed by: _____ (Technical/ Maintenance Manager) _____ (Signature) _____ (Date Reviewed)

APPENDIX 2.9.17: TUNNELS

TUNNEL INSPECTION SHEET

Asset No.
Type of Inspection: Statutory
Frequency: Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation: Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by: *Competent Person

Bridge Name	Abutment	Abutment Foundation	Wing Walls	Parapet/ Handrail	Deck Slab	Expansion Joint	Surfacing	General Drainage	Kerbing/ Sidewalks	General Notes
Average Condition										
Weight	20	15	5	5	25	10	10	5	5	
Weighted Average Condition										
Asset Condition (sum of weighted average condition)										

Condition

u/s	1	Not safe for use	Replace	Budget to replace
Very poor to u/s	2	Not safe for use	Major upgrades required	Consider replacement
Very poor	3	Safe	Overall urgent work required	Decision required on future of asset
Poor	4	Safe	Some urgent work required	Plan for next cycle
Fair to poor	5	Safe	Maintenance required	Plan for next cycle
Fair	6	Safe	Moderate ongoing maintenance required	Repair within 12 month period
Good to fair	7	Safe	Minor maintenance required	Repair within 18 month period
Good	8	Safe	Minor maintenance required	Monitor
Perfect to good	9	Safe	No maintenance required	No budget needed
Excellent	10	Safe	No maintenance required	No budget needed

*Competent Person
means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training;

Inspected by: _____ Name _____ Job Title _____ Inspection Date

Reviewed by: _____ Technical/ Maintenance Manager _____ Signature _____ Date Reviewed

APPENDIX 2.10: INSPECTION SHEETS FOR ELECTRICAL ASSETS

APPENDIX 2.10.1: COMMISSIONING TESTS FOR HV EQUIPMENT

Appendix 12 a.

Typical Commissioning Tests

Commissioning Tests for Transformers	Yes	No	Details	Comments
1. Ratio Test on all Taps				
2. % Impedance Test				
3. Vector Group Test				
4. Phase Resistance Test				
5. Insulation test (Megger Test)				
6. Pressure Relief test				
7. Oil Temperature relay (Alarm and trip)				
8. Winding Temperature relay (Alarm and trip)				
9. CT ratio tests / Magnitising saturation test				
10. Secondary Injection Tests on relays Magnitising saturation test				

Commissioning Tests H.V. Circuit Breaker	Yes	No	Details	Comments
1. Manual Controls: Trip & Close Test				
2. Remote Controls:Trip & CloseTest (if applicable)				
3. Change of state indication verification Remote Change of state indication verification (if applicable)				
4. Open/Close status verification Remote Change Open/Close status verification (if applicable)				
5. Earth state verification Remote Earth state verification (if applicable)				
6. Trip circuit healthy Test Remote trip Circuit state verification (if applicable)				
7. Solkor Relay secondary injection Solkor Relay indication on primary protection meter (if applicable)				
8. Overcurrent and Earth fault secondary injection indication on primary protection meter (if applicable)				
9. Primary injection tests				
10. CT ratio tests Magnising saturation test				
11. Auto-reclose (where applicable)				
12.Remote alarms/indications verify (if applicable)				

Solkor Relay Tests	Yes	No	Details	Comments
1. Check connections				
2. Secondary wiring insulation resistance test				
3. CT ratio and polarity test				
4. Pilot cable insulation and continuity tests				
5. Overall fault setting tests (primary injection)				
6. Circuit breaker tripping tests				
7. Stability tests				

Other Metering checks	Yes	No	Details	Comments
1. Kilowatt-hour meter connections/polarity				
2. C.T.ratio				
3. Panel Volt meters; scale, operation				
4. Panel Ammeters; correct ratios, scale, operation				
5. Kilowatt-hour meter accuracy				
6.				

APPENDIX 2.10.2: TEST SHEET FOR FEEDER PANEL

Appendix 12 b.

Substation Electrical Test and Calibration Sheet (Feeder panel)

Substation A:_____ **Ref. No:**_____

Substation B:_____ **OCB. No.** **Sub. A:**_____ **Sub B:**_____

Solkor Relay Tested at Substation A

Current Transformer Data

	Make	Ratio	VA	Class	Serial number
Protection					
Metering					

CT Ratio's : Protection Rph_____ Yph_____ Bph_____

Metering Rph_____ Yph_____ Bph_____

Magnetising Curve Characteristics

Solkor					Metering			
V	I_r	I_y	I_b		V	I_r	I_y	I_b

Solkor Relay Serial no.:_____

(a) Check that Starpoints of CT's connected on the same side of CT in local & remote substation I.E. CT's are opposing on through faults:- **Yes / No**

(b) Are Pilot cores connected to the same terminals in both substations: **Yes / No**

Pilot Cable

Insulation resistance core 1:_____M ohms

Insulation resistance core 2:_____M ohms

Insulation resistance core 1 to core 2:_____M ohms

Loop resistance Lp:_____ohms

Add padding resistance in each relay so that R relay = 0,5 (1000 – Rp) ohms

Overall Fault Settings

Connect DC milliammeter across open relay test link. Connect AC milliammeter in series with pilot cable.

Fault	Secondary A	DC mA sub A	DC mA sub B	Pilot mA	Operating %	Expected %
R-E						
Y-E						
B-E						
R-Y						
R-B						
Y-B						

Operating coil current should be approximately 11mA in local relay and 5,5 mA in remote relay. If incorrectly connected both relay currents will be approximately equal.

Stability Test

Inject through fault single phase primary current between R-E & R-B from sub A

Fault	CT connections on relays	Primary Amps	Pilot mA	Operating coil Amps Sub A	Operating coils Amps sub B	Relay Operation Sub. A	Relay Op. Sub. B
R-E						Yes / No	Yes / No
R-B						Yes / No	Yes / No
R-E						Yes / No	Yes / No
R-B						Yes / No	Yes / No

Check remote tripping:_____ Ammeter:_____

Tested by :_____ Date:_____

APPENDIX 2.10.3: TEST SHEET FOR TRANSFORMER PANEL

Appendix 12 c

Electrical Test Laboratory : Test Sheet (Transformer panel)

Substation:_____ **Ref. No:**_____

Designation:_____ **OCB. No.:**_____ **Panel no:**_____

Main transformer data

Transformer make		Breather	
Year of Manufacture		Cooling type	
Serial number		Bucholtz relay	
kVA		Oil temperature	Alarm Trip
% Impedance		Winding temperature	Alarm Trip
Vector symbols		Tap change position	
Oil quantity		Total Mass	

Current Transformer Data

	Make	Ratio	VA	Class	Serial number
Protection					
Metering					

CT Ratio's : Protection Rph_____ Yph_____ Bph_____

Metering Rph_____ Yph_____ Bph_____

Magnetising Curve Characteristics

Solkor					Metering			
V	I_r	I_y	I_b		V	I_r	I_y	I_b

Relay type:_____ Serial no.:_____ Rating (I_r):_____Amps
Overload PMS:_____ TMS:_____ Relay calibrated:2 x I_r =___Amps
Earth Fault PMS:_____ TMS:_____ Operating time:_____seconds

Multiple of PS	Overload Rph Amps	Overload Rph mSec	Overload Yph Amps	Overload Yph mSec	Overload Bph Amps	Overload Bph mSec	Earth Fault Amps	Earth Fault Sec
2								
4								
6								
8								
10								

Check Operation of:- Directional element : _____ Ammeter:_____ Flag operation:_____
Intertripping of secondary with primary breakers:_____

Instantaneous relay:- Type:_____ Set at _____amps for test

	Rph	Yph	Bph	Earth Fault
Setting				
Pick-up				

Sensitive earth fault relay:- Type:_____ Current Setting: _____% = _____Amps

Pickup:_____Amps Time Delay:_____Sec

Transformer
Bucholtz trips OCB when: _____ Glass _____C.C. of air is injected.
Oil temp Indicator set Alarm_____°C; Trip to trip at _____°C which corresponds to 90°C

Tested by :_____ Date:_____

APPENDIX 2.10.4: HIGH VOLTAGE REPORT

HIGH VOLTAGE NETWORK WEEKLY REPORT | Week ending :

APPENDIX 12 D

NOTE: IF UNIT ON AUTO AND "OFF", SET TO MANUAL & RECORD STATUS

POWER FACTOR CORRECTION EQUIPMENT STATUS

		STANGER STREET				SAR DURBAN				PIER NO.2 MAIN				ALAN DALTON			
MVAR METER READING																	
		L01		L02		L03		L04		L07		L08		L05		L06	
CAPACITOR BANK		No.1		No.2		No.1		No.2		No.1		No.2		No.1		No.2	
Capguard readings	I^{sc}		%		%		%		%		%		%		%		%
	I^{ef}		%		%		%		%		%		%		%		%
	I^{ub}		%		%		%		%		%		%		%		%
	I^{h}		%		%		%		%		%		%		%		%
AMMETER READINGS	Red					Red				Red				Red			
	White					White				White				White			
	Blue					Blue				Blue				Blue			
CAPACITOR FAIL INDICATION	ON					ON				ON				ON			
	OFF					OFF				OFF				OFF			
CAPACITOR OFF & DISCHARGED	ON					ON				ON				ON			
	OFF					OFF				OFF				OFF			
COUNTER READING																	
CAPACITOR CONTROL SWITCH	AUTO					AUTO				AUTO				AUTO			
	MAN					MAN				MAN				MAN			
	OFF					OFF				OFF				OFF			
PANEL HEATER SWITCH	ON					ON				ON				ON			
	OFF					OFF				OFF				OFF			
LAMP TEST	OK					OK				OK				OK			
	FAULT					FAULT				FAULT				FAULT			

Additional Remarks : POINT

Additional Remarks : FYNNLAND

HIGH VOLTAGE SUPPLY AVAILABILITY

POINT/T.JETTY/M.WHARF SUBSTATIONS	DATE	DESCRIPTION OF FAULT AND EQUIPMENT AFFECTED	DURATION

Additional Remarks

FYNNLAND/PIER No. 1 SUBSTATIONS	DATE	DESCRIPTION OF FAULT AND EQUIPMENT AFFECTED	DURATION

APPENDIX 2.10.5: SUBSTATION TASK LIST

SUBSTATION MAINTENANCE SCHEDULE

SUBSTATION : APPENDIX 12 E

DATE:

	SERVICE ITEM	TYPE OF SERVICE	DATE	BATTERY CELL DATA N0.	V	S.G.
1	HT & LT PANEL VISUAL CHECK			1		
2	TRANSFORMER VISUAL CHECK (LEAKS, SILICA GEL)			2		
3	CHECK BATTERY CHARGER			3		
4	BATTERY CHECK (visual & spot check cell S.G's)			4		
5	POWER FACTOR EQUIPMENT CHECK			5		
6	CHECK OCB OPERATING TOOLS	"A"		6		
7	CHECK SUBSTATION MAIN L.V.PANEL			8		
8	CHECK SCHEMATIC DIAGRAM/S			9		
9	C.T. 's AND PT.'s CHECK			10		
10	CHECK SAFETY SIGNS & WARNINGS ERECTED			11		
11	CLEAN OUTDOOR YARD			12		
12	CLEAN/SWEEP SUBSTATION			13		
13	BUSHINGS VISUAL CHECK (where applicable)			14		
14	VISUAL CHECK ALL MAIN EARTH CONNECTIONS			15		
15	CHECK BUILDING DISTRIBUTION & LIGHTING			16		
16	CHECK FIRE EXTINGUISERS & INSPECTION DATE			17		
17	LIGHTNING ARRESTORS CHECK (where applicable)			18		
				19		
18	SPRAY FOR WEEDS	"B"		20		
19	CHECK EMERGENCY TELEPHONE LIST			21		
20	OIL SUBSTATION DOORS AND GATE HINGES			22		
				23		
21	ALL PANEL WIRING/CUBICLES; CHECK & CLEAN			24		
22	OCB OPERATING MECHANISMS/TEST TRIP CB'S			25		
23	BATTERY CHECK & LOAD TEST; S.G.CHECK	"C"		26		
24	CLEAN TRANSFORMERS			27		
				28		
25	PROTECTION RELAYS CALIBRATION AND TESTING			29		
26	SUBSTATION EARTHING TESTING			30		
27	LOW VOLTAGE INSTALLATION TESTING			31		
28	EARTH MAT TEST/CHECK	"D"		32		
29	TRANSFORMER OIL SAMPLES			33		
30	OCB OIL CHANGE **(or after 3 trips)**			34		
31	INFRA-RED SCAN AND/OR BUSBAR MAINTENANCE			35		
				36		
	METERING EQUIPMENT & PROTECTION RELAYS: VISUAL			37		
1	BUCHOLTZ			38		
2	TEMPERATURE			39		
3	POWER FACTOR RELAY & PLC			40		
4	EARTH FAULT RELAY	"A"		41		
5	OVERCURRENT			42		
6	SOLKOR/TRANSLAY			43		
7	FRAME LEAKAGE			44		
8	KILOWATT-HOUR			45		
				46		
	TYPE OF SERVICE			47		
	"A" MONTHLY "C" ANNUALLY			48		
	"B" QUARTERLY "D " 2 YEARLY			49		
				50		
	REMARKS			51		
				52		
				53		
				54		
				55		

BATTERY REPLACED

SIGNATURE: _____ **DATE:** _____

APPENDIX 2.10.6: SUBSTATION INSPECTION SHEET

SUB-STATION INSPECTION SHEET

Asset No.	
Type of Inspection:	Statutory
Frequency:	Bi-annual for structures less than 2 years old; annual for structures older than 2 years
Regulation:	Construction Regulations, 2003; Section 9 - Structures (clause 4)
Inspection to be done by:	*Competent Person

Workshop/ Shed Name	Floors	Doors & Windows	Roof, gutters,	Walls exterior	Walls interior
Average Condition					
Weight	20	15	25	20	20
Weighted Average Condition					
Asset Condition (sum of weighted average condition)					

Condition				
Poor	<40%	Not safe for use	Major upgrades required	Decision required on future of asset
Satisfactory	40-59%	Safe	Some urgent work required	Use of current and planned budget
Good	60-79%	Safe	Moderate ongoing maintenance require	Plan for next cycle
Very good	80-89%	Safe	Minor maintenance required	Plan for next cycle
Excellent	90-100%	Safe	No maintenance required	No budget needed

*Competent Person

Inspected by:

Name Job Title

Reviewed by:

Technical/ Maintenance Manager Signature

APPENDIX 2.10.7: SUBSTATION MAINTENANCE PROGRAMME

SCHEDULE OF PLANNED vs ACTUAL SUBSTATION MAINTENANCE : FYNNLAND SECTION

		APRIL					MAY					JUNE					JULY					AUG					SEPT					OCT					NOV					DEC					JAN					FEB					MARCH					YR.	YR.
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	TOT	%
SOUTH PIER	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
COAL TERMINAL	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
FYNNLAND	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
FYNNLAND ELEC DEP	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
TANK WASHOUT	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
ALLAN DALTON 6,6KV	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
ALLAN DALTON 33KV	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
KINGS REST	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
BERTH 100	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
B & M DEPOT	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
REPAIR QUAY	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
FLOATING DOCK	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
FLOAT. DOCK NO.3	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
SHOT BLAST	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
GRAVING DOCK	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
PUMP STATION	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
CRANE SUPPLY MINI	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
CONVERTER MINI	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
CAPSTON MINI	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
INNER CAISSON MINI	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
PIER 2 MAIN 33 KV	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
PIER 2 MAIN 11 KV	PLANNED	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	1	1	20	100
	ACTUAL																																																										0	0
	PLAN MTH	22	0	0	0	0	22	0	0	0	0	22	22	0	0	0	22	0	0	0	0	22	0	0	0	0	22	22	22	0	0	22	0	0	0	0	22	0	0	0	0	22	22	0	0	0	22	0	0	0	0	22	22	22	22	22	440	100
	ACT MONTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	%MONTH	0					0					0					0					0					0					0					0					0					0					0					0	
	%TO DATE	0					0					0					0					0					0					0					0					0					0					0						

APPENDIX 2.10.8: FLOOR MOUNTED LV SUBSTATION

3 MONTHLY INSPECTION OF LOW VOLTAGE ELECTRICAL SWITCHBOARDS

CHECKLIST

APPENDIX 14 a

- ☐ **1.** Open lock and door. Check hinges and lock that they are rust free and oil if necessary.
- ☐ **2.** Check that all information, danger and warning signs are mounted to outside of doors.
- ☐ **3.** Check earth leakage unit and perform trip test.
- ☐ **4.** Check lighting contactors by switching by-pass switch on and checking to see that photo-cells operate correctly.
- ☐ **5.** Isolate kiosk, remove cover and check operation/condition of circuit breakers - alternatively test with a meter.
- ☐ **6.** Check tightness of all connections.
- ☐ **7.** Using a brush remove all dust, spider webs from components, etc.
- ☐ **8.** Check all insulation for damage due to heat, etc.
- ☐ **9.** Ensure all cables are secured to cable trays and that all cable glands are secured.
- ☐ **10.** Check that all circuits are labelled.
- ☐ **11.** Replace all covers and energise kiosk again.
- ☐ **12.** If meters are present, check that meters are operating correctly, check for tightness of connections, etc.
- ☐ **13.** Check earth spike and connections.
- ☐ **14.** Close doors and lock kiosk.
- ☐ **15.** Record all defects.

REMARKS

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DETAILS OF RESPONSIBLE PERSONS

NAME : _____
SIGNATURE : _____
DATE TESTED : _____
NEXT TEST DATE : _____

_____

SUPERVISOR : _____
SIGNATURE : _____
DATE : _____

APPENDIX 2.10.9: FLOOR MOUNTED LV SWITCHBOARDS

3 MONTHLY INSPECTION OF LOW VOLTAGE ELECTRICAL KIOSKS

CHECKLIST APPENDIX 14 b

- ☐ **1.** Open lock and door. Check hinges and lock that they are rust free and oil if necessary.
- ☐ **2.** Check that all information, danger and warning signs are mounted to outside of doors.
- ☐ **3.** Check earth leakage unit and perform trip test.
- ☐ **4.** Check contactor by switching by-pass switch on; Check that photo-cells operate correctly.
- ☐ **5.** Isolate kiosk, remove cover and check operation/condition of circuit breakers - alternatively test with a meter.
- ☐ **6.** Check tightness of all connections.
- ☐ **7.** Using a brush remove all dust, spider webs from components, etc.
- ☐ **8.** Check all insulation for damage due to heat, etc.
- ☐ **9.** Ensure all cables are secured to cable trays and that all cable glands are secured.
- ☐ **10.** Check that all circuits are labelled.
- ☐ **11.** Replace all covers and energise kiosk again.
- ☐ **12.** If meters are present, check that meters are operating correctly, check for tightness of connections, etc.
- ☐ **13.** Check earth spike and connections.
- ☐ **14.** Close doors and lock kiosk.
- ☐ **15.** Record all defects.

REMARKS

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DETAILS OF RESPONSIBLE PERSONS

NAME : _____
SIGNATURE : _____
DATE TESTED : _____

_____

SUPERVISOR : _____
SIGNATURE : _____
DATE : _____

APPENDIX 2.10.10: HIGH MAST LIGHTING

2 YEARLY CHECK SHEET HIGH MAST ASSET NO. _____

HIGH MAST LIGHTING MAINTENANCE SCHEDULE

APPENDIX 15 a

- ☐ 1. Check condition of bolts and pins, as well as security connectors and "Crosby" clamps
  N.B. Ensure that saddle portion of "Crosby" clamp is installed against the wire rope under tension
- ☐ 2. Inspect anchorage point of wire ropes at compensating pulley (if fitted).
- ☐ 3. Inspect wire rope terminal ends, anchor blocks, locating plates and pins (if fitted)
- ☐ 4. Check, without ascending mast, for paint deterioration and corrosion.
- ☐ 5. Check for signs of vermin, insects or birds nesting in the mast.
- ☐ 6. Check for ground or ballast covering the foundation bolts and arrange removal if evident.
- ☐ 7. Check for corrosion on the foundation bolts and arrange for cleaning and anti-corrosive treatment
- ☐ 8. Check and where necessary, tighten all foundation bolts.
- ☐ 9. Check earthing of feeder cables to mast and earthing of mast.
- ☐ 10. Check spark gap and bond for repair by traction personnel, if required.
- ☐ 11. Check general condition of distribution board and test operation of earth leakage relay.
- ☐ 12. Lower the luminaire carriage of each mast.(N.B. Luminaire carrige must be undocked manually)
- ☐ 13. Check that the winch runs smoothly and that the wire ropes are undamaged. ("fixed winch type only)
- ☐ 14. Inspect rope anchorage points on winch drums (fixed winch type only).
- ☐ 15. Check that a minimum number of five turns of rope remain on the winch drums.
- ☐ 16. Inspect S/S wire rope connections to luminaire carriage for wear, deterioration, corrosion
- ☐ 17. Inspect luminaire carriage and associated items for paint deterioration, corrosion, cracks or other damage
- ☐ 18. Check all nuts and bolts and tighten if necessary.
- ☐ 19. Inspect guide rollers (if fitted), or soft rubbing surfaces.
- ☐ 20. Inspect electrical cables, junction boxes and "Conmax" type electrical contacts (if fitted).
- ☐ 21. Check that the luminaire glasses, clips, etc., are secure and undamaged and for moisture ingress
- ☐ 22. Clean luminaire glasses and replace lamps (Take care to not disturb aiming angles of floodlights)
- ☐ 23. Inspect the stainless steel wire ropes visually from the ground. Steel wire ropes to be inspected for frayed or broken strands, kinks, corrosion or any other defects which could render them unsafe. Should there be any sign of damage, the ropes must be discarded and replaced in their entirety, by new ropes.
- ☐ 24. Clean the wire ropes for a distance of two metres above the luminaire carriage. Examine the ropes for strand distortion or flattening of outer strand wires due to their being in constant stress over the top pulleys.
- ☐ 25. Complete RMD 9 logsheets.

LOAD TEST ON RAISING AND LOWERING SYSTEM OF HIGH MAST

1. The test to consist of hoisting a test load, equal either to 1,25 times the mass of the luminaire carriage complete with all luminaires, or to 1,5 times the (mass of the maintenance cage + 180 kg), whichever is the greater, through the full height of the mast, holding in the uppermost position and lowering again. The results shall be recorded on RMD 9 log sheets.

N.B. The aforementioned tests shall be carried out using masses assized by an approved authority.

2 YEARLY REPLACEMENTS

			COSTS		
	2004	2006	2008	2010	2012
Number of lamps					
Number of ballasts					
Number of ignitors					

REMARKS _____

NAME : .....
SIGNATURE : .....
DATE TESTED : .....

SUPERVISOR : _____
SIGNATURE : _____
DATE : _____

APPENDIX 2.10.11: MEDIUM MAST LIGHTING

3 MONTHLY INSPECTION OF MEDIUM MAST LIGHTING (Hinged type)

CHECKLIST

APPENDIX 15 b

- ☐ **1.** Open any inspection covers; General visual check of interior/exterior condition of mast
- ☐ **2.** Clean circuit breaker with brush to remove all dust and dirt.
- ☐ **3.** Check for loose connections.
- ☐ **4.** Switch on bypass switch at kiosk and check for operation of all luminaires.
- ☐ **5.** Connect hand operated winch to pole, apply the brake and remove retaining bolt from pole.
- ☐ **6.** Switch off circuit breaker in base of pole.
- ☐ **7.** Release brake and lower pole.
- ☐ **8.** Open inspection cover on control gear housing and check components for damage or loose connections.
- ☐ **9.** Replace inspection cover and proceed to remove the glass cover from the luminaire.
- ☐ **10.** Clean glass and reflector and replace lamp with new.
- ☐ **11.** Replace glass cover and ensure all holding down bolts are tight.
- ☐ **12.** Raise pole back into position, apply brake and secure retaining bolt and nut into position.
- ☐ **13.** Switch circuit breaker back on and ensure all lights are operational.
- ☐ **14.** Check earth connections.
- ☐ **15.** Record conditions of pole and equipment on record sheet.

REMARKS

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DETAILS OF RESPONSIBLE PERSONS

NAME : _____

_____

SIGNATURE : _____

DATE TESTED : _____

NEXT TEST DATE : _____

SUPERVISOR : _____

_____

SIGNATURE : _____

DATE : _____

APPENDIX 2.10.12: STREET MAST LIGHTING

3 MONTHLY INSPECTION OF STREET/AREA LIGHTING

APPENDIX 15 c

CHECKLIST

- ☐ **1.** Open inspection cover.
- ☐ **2.** Clean circuit breaker with brush to remove all dust and dirt.
- ☐ **3.** Check for loose connections.
- ☐ **4.** Switch on bypass switch at kiosk and check for operation of all luminaires.
- ☐ 5 Switch of circuit breaker in base of pole.
- ☐ **6.** Using a skyjack or ladder proceed to the top of the pole.
- ☐ **7.** Open inspection cover on control gear housing and check components for damage or loose connections.
- ☐ **8.** Replace inspection cover and proceed to remove the glass cover from the luminaire.
- ☐ **9.** Clean glass and reflector and replace lamp with new.
- ☐ **10.** Replace glass cover and ensure all holding down bolts are tight.
- ☐ **11.** Descend pole.
- ☐ **12.** Switch circuit breaker back on and ensure all lights are operational.
- ☐ **13.** Check earth impedance.
- ☐ **15.** Record conditions of pole and equipment on record sheet.
- ☐ **16.** Close inspection cover.

REMARKS

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DETAILS OF RESPONSIBLE PERSONS

NAME : _____

SIGNATURE : _____

DATE TESTED : _____

SUPERVISOR : _____

SIGNATURE : _____

DATE : _____

APPENDIX 2.10.13: BUILDING DISTRIBUTION AND LIGHTING

ANNUAL BUILDING DISTRIBUTION AND LIGHTING INSPECTION SCHEDULE

APPENDIX 16 a

CLIENT_____ LOCATION _____BUILDING NO. _____

DISTRIBUTION BOARD		ADDITIONAL COMMENTS
Distribution. Board	Single or Three phase	
Distribution Board Type	Flush in wall/ surface on wall / floor standing	
Distribution Board Appearance and Cleanliness	Good / fair / poor	
Distribution Board Age		
Labeling in terms SABS-0142	Good / fair / poor	
Distribution. Board Wiring i.t.o. SANS 10142	Yes / No	
Earthing/Earth bar connections secure	Yes / No	
Neutral Bar Connections Secure	Yes / No	
Labelling of Circuits and Safety Notices	Yes / No	

CIRCUIT BREAKERS and ISOLATORS		ADDITIONAL COMMENTS
General Condition and Ratings i.t.o.SANS 101142	Yes / No	
Operating Levers	Normal / sticky / faulty	
All Units Securely Mounted	Yes / No	

SWITCH SOCKET OUTLETS		ADDITIONAL COMMENTS
Physical Condition of Outlets	Good / fair / poor	
Circuit Protection i.t.o. SANS 10142	Yes / No	
Socket Outlet Provided at Distribution Board	Yes / No	

EARTH LEAKAGE PROTECTION UNITS		ADDITIONAL COMMENTS
Earth Leakage Device Provided	Yes / No	
Test Button Trip Test O.K.	Yes / No	
Earth Leakage trip test level (mA)		
Earth Leakage Unit Correct Rating	Yes / No	

EARTHING AND BONDING		ADDITIONAL COMMENTS
Earth Spike Provided	Yes / No	
Earth Resistance Test Reading		
Condition of Earth Spike Connection	Good / fair / poor	
Earth Loop Impedance Test Reading		
Building Bonding Condition	Good / fair / poor	

LIGHTING/SWITCHES/CONTROL UNITS		ADDITIONAL COMMENTS
Type of Luminaires and Quantities of Each		
Physical Condition of Lighting	Good / fair / poor	
All Lamps Operational	Yes / No	
Switches Operational	Yes / No	
Control Units/Time Switches Checked	Yes / No	

GEYSER		ADDITIONAL COMMENTS
Geyser Type	Low / High Pressure	
Geyser	Single / Three phase	
Thermostat Operation	Yes / No	
Check Thermostat setting at 65 ºC check		
Isolator Provided at Geyser	Yes / No	
Geyser capacity and kW rating		
Water Pipe Condition	Good / fair / leaking water	

FIXED APPLIANCES	General Operation and Wiring	ADDITIONAL COMMENTS
Stoves/Fry-top Grillers	Good / fair / poor	
Hydro-boils/Urns	Good / fair / poor	
Cooker hoods	Good / fair / poor	

WIRING/CONDUITS/POWER SKIRTING		ADDITIONAL COMMENTS
General Condition of Building Wiring	Good / fair / poor	
General Condition of Building Conduits	Good / fair / poor	
General Condition of Power Skirting	Good / fair / poor	

KILOWATT-HOUR METER		ADDITIONAL COMMENTS
Type of kWh meter	Single or Three phase	
Analogue/Digital	Yes/ No Number:	

Certificate of Comp. Issued/Available Yes / No

Remarks .....
.....
.....

Electrician Name/Signature ..... **Technical Supervisor**.....

NOTE: The inspecting electrician must inform the occupier/s of the building, that it is their duty to test trip the earth leakage unit monthly by pressing the button and record this operation in the NOSA reports.

APPENDIX 2.10.14: SPECIALISED ELECTRICAL INSTALLATIONS

SPECIALISED ELECTRICAL INSTALLATION CHECKLIST

ANNEXURE 17a

BUSINESS UNIT		DEPOT	
BUILDING ADDRESS / AREA		BUILDING No.	
ZONE CLASSIFICATION		DRAWING No.	
NEW C.O.C.		C.O.C. No.	
EXISTING C.O.C.		C.O.C. No.	
TYPE OF INSTALLATION			

OIL STORE		BATTERY ROOMS (SUBSTATION BATTERY UNITS	
PAINT STORE		FUEL BOWSER	
GAS STORE		CHEMICAL STORAGE	
PETROL STORE (EQUIPMENT FUEL)		SEWERAGE STATION PITS	
BUNKER TUNNEL		SUGAR TERMINALS	
PETROLEUM STORAGE TERMINAL AREA		CHEMICAL / FUEL DISCHARGE POINTS	
GRAIN ELEVATOR / SILO		OTHER	
GRAIN ELEVATOR CONVEYER BELTS			

DESCRIPTION OF EQUIPMENT INSTALLED

EQUIPMENT	No.	SERIAL No.	CONDITION	CERTIFICATE No.

DATE OF INSPECTION	Jan-04	Jul-04	Jan-05	Jul-05	Jan-06	Jul-06	Jan-07	Jul-07	Jan-08	Jul-08	

INSPECTED BY			
NAME			
REMARKS			

SIGNATURE		DATE	

APPENDIX 2.10.15: OHTE

3KV DC OVERHEAD TRACK EQUIPMENT MAINTENANCE SCHEDULE

APPENDIX 19a

SECTION/YARD:			
	SERVICE ITEM	TYPE OF SERVICE	REMARKS
1	Inspect section insulators, clean; adjust or replace runners if required		
2	Check stagger at critical points and adjust if necessary		
3	Take micrometer readings;of contact wire at critical spots		
4	Check striking points and adjust where necessary.		
5	Check lightning arrestors (3 kV & 6.6/11 kV) and replace if necessary		
6	Switch Test operate old type (Magrini).	"A"	
7	Check droppers and replace where necessary.		
8	Check arching horns including "gap" and repair where necessary.		
9	Check swivel clips: Check bolts for tightness.		
10	Parallel c] ,11':1>3 : Check for burnt cheecks & replace where necessarv		
11	Steelwork: Note loose bolts and tighten where necessary.		
12	Insulators: Replace damaged insulators where necessary.		
13	Check for obstructions on the OHTE.	"B"	
14	Grease contact wire (+- every 20 000 pantograph passes only)		
15	Check for tree branches fouling the OHTE.		
16	Check earth-wire and phase-wire clearances to OHTE		
17	Check height gauges at level crossings		
18	Clean and grease anchor straps and adapter plates		
19	Clean and grease Insulator caps and pins		
20	Clean and grease Steady arms hockey sticks (except if stainless steel)		
21	Clean and grease Push pull off tubes	"C"	
22	Clean and grease Suspension clamps		
23	Clean and grease Cross-span steady arm attachments		
24	Clean and grease Tower hooks, Turnbuckles		
25	Clean and grease Ending cones, Crosby clips		
26	Clean and grease Link straps, clevis pins		
27	Clean and grease Cross-span fittings and pull-off fittings		
28	Clean and grease Stay-wire fittings		
29	Mast bases: Seal with "Denso" paste.		
30	Clean and grease Bolt groups : Seal nuts with "Denso" mastis.		
31	Paint all steelwork including all support structures		
32	Bridge cross-spans; Check tension & grease or paint steel parts		
33	Track switches : Check contacts and connections		
34	6.6/11 kV switches : Check contacts and connections.		
35	Warning boards: Check and replace where necessary.		
36	Parallel clamps; feeder clamps; bi-metal spacers, F.C.C. lugs.		
37	Remove. clean and replace. Apply grease on outside		
38	F.C.C.'s: Replace where necessary		
39	Earth wire clamps (aluminium): Remove, clean, grease with "Penetrox"		
40	6.6/.11 kV pin insulators: Check for cracks and check binding wire		
41	6.6/11 kV phase-wires: Check for broken strands and repair.		
42	Spark gaps : Check and paint caps.		
43	Check catenary and feeder sag and adjust if required		
44	Check contact wire tension and adjust where necessary		
45	Check overlaps and adjust where necessary.		
46	Check climbing angle heights & adjust where necessary	"D"	
47	Check mast-to-rail clearances and report to supervisor		
48	Check mast foundations for movement/cracks & repair		
49	Check bonding and repair where necessary.		
50	Contact wire height and stagger check		

		TYPE OF SERVICE			
		"A"	QUARTERLY	"C"	ANNUAL
SIGNATURE	SUPERVISOR	"B"	6 MONTHLY	"D "	2 YEARLY

APPENDIX 2.11: INSPECTION SHEETS FOR MECHANICAL ASSETS

APPENDIX 2.11.1: CRANES, CHERRY PICKERS ETC.

BREAKWATER CRANE MAINTENANCE SCHEDULE

APPENDIX 21 A

Bogies, Drive gears and Structure in General	Service	
Grease bogie wheel pin nipples -32 ea	B	
Grease primary drive long travel nipples -4 ea	B	
Grease storm jacks nipple pins - 4 ea	B	
Grease/dress long travel primary drive teeth (NGLI 3) - 4 ea	B	
Grease / dress bogie wheel teeth (NGLI 3) - 4 ea	B	
Oil cover hinges on the primary drive enclosure-4ea	B	
Ensure all hydraulic couplings are denso taped	B	
Inspect hydraulic piping and joints / tees for leaks	B	
Inspect hydraulic long travel hoses for damage/cuts	B	
Inspect condition of structure overall for corrosion	C	
Inspect condition of machine house for corrosion	C	
Slew/Pedestal Area	**Service**	
Grease slew gear- top nipples - 6 ea	B	
Grease slew gear- bottom nipples - 6 ea	B	
Grease / dress slew ring gear teeth (NGLI 3)	B	
Grease / dress slew pinion drive gear teeth (NGLI 3) -2 ea	B	
Grease slew pinion drive gear nipples - 2 ea	B	
Grease rotor hydraulic transfer post system - 1ea	B	
Lightly oil slew brake hydraulic cylinder hinge pins	B	
Inspect hydraulic all piping and joints / tees for leaks	B	
Ensure all hydraulic couplings are denso taped	B	
Driver's Cabin and Boom	**Service**	
Oil drivers seat linkages/ hinges / cabin door latches	B	
Clean window rails and lightly grease	B	
General clean of cabin, windows etc.	B	
Inspect condition of mesh guards	B	
Inspect-internal-condition of corrosion of boom, cabin	B	
Inspect-external-condition of corrosion of boom, cabin	B	
Inspect hydraulic piping and joints / tees for leaks	B	
Ensure all hydraulic couplings are denso taped	B	
Inspect anti-pigeon mesh in place and secure	B	
Oil passage door hinges and latches	B	
Crab/Trolley and 5/30 ton Hook Assembly	**Service**	
Inspect trolley wire tensions	B	
Oil / grease pinion points/sheaves	B	
Grease/Oil sheeve pins of 5/30 ton hook assembly	B	
Grease/Oil 5/30 ton cross head end assembly	B	
Testing	**Service**	
Test run - long travel	A	
Test run - slew	A	
Test run - crab/trolley	A	
Test run - main hoist and auxiliary hoist	A	
Crane performance test	C	
5/30 ton hook test	C	

Diesel Engine
Check oil level
Check fuel lines and injectors for leaks
Check injection pump assembly
Check V-belts (3) condition & tension
Check V-belt tension springs and alarm
Check 12V terminals, circuits are clean, secure
Clean/ grease 12V terminals secure
Check batteries (3) electrolyte level
Check cooling blower blade -clean
Check cylinder cooling fins are clean
Check oil cooler fins are clean
Check air intake for tightness
Check exhaust manifolds for tightness
Check operation cyl head temp. sensor
Clean fuel precleaner
Major service and oil sample test
Change oil (Dependant on oil analysis)
Change fuel filter
Change air intake filter
Lubricate linkages and hinges
Machine House Hydraulics
Check /Top up hydraulic reservoir main tank
Inspect hydraulic piping, joints, tees for leaks
Inspect accumulator bladder assembly
Inspect pressure gauges for correct operation
R/R pressure guages for calibration
Inspect Main brake adjustment settings
Inspect Main brake lining tolerances
Inspect Auxallary brake adjustment settings
Inspect Auxllary brake lining tolerances
Inspect trolley brake adjustment settings
Inspect trolley brake lining tolerances
Grease/dress-Main/Aux/Trolley rope wires
Check pressures and operating temperatures
Hydraulic oil sample test
Electrical Controls and Equipment
Check battery electrolyte level/charge rate
General clean of control panels
Check terminals, relay connections, junction boxes etc.
Inspect and test panel heater
Inspect electrical panel & equipment for corrosion
Check PLC equipment
Check all connections to control valves
Inspect socket outlets,cables,wiring,gland condition
Service and clean main drivers controller
Check and test all indicator lamps
Check operation of all other crane lighting
Check and test all limits and proximity devices

Remarks

NAME:

Millwright

Service Legend

APPENDIX 2.11.2: SEWERAGE STATIONS

SEWER STATION MAINTENANCE SCHEDULE

1
2
3
4

APPENDIX 24 a

SEWERAGE STATION:

DATE:

	SERVICE ITEM	TYPE OF SERVICE	DOUBLE HORIZONTAL CENTRIFUGAL PUMPS	DOUBLE ELECTRICAL EJECTOR STATION	SUBMERSIBLE ROBOT PUMPS	REMARKS:
1	ENDORSE SEWER STATION LOGBOOK	A	X	X		
2	SWITCH ON BLOWER FAN FRESH AIR INTAKE		X	X		
3	PURGE RESERVOIR TANK		X	X		
4	RECORD METER READINGS AMPERAGE/ VOLTAGE		X			
5	TEST RUN MOTORS (MANUAL & AUTOMATIC)		X			
6	CHECK DRIVE SHAFT/BELTS GUARDS		X	X		
7	VISUAL INSPECTION OF MECHANICAL EQUIP.		X	X		
8	CHECK GLAND PACKINGS FOR LEAKS & ADJUST		X	X		
9	VISUAL INSPECTION OF ELECTRICAL EQUIP.		X	X		
10	DRAIN CONDENSATE FROM AIR RECEIVERS		X	X		
11	DRAIN CONDENSATE FROM AUXILIARY RECEIVERS		X	X		
12	CHECK BLOW DOWN TIME SOLENIOD VALVES 20 SEC.		X	X		
13				X		
14				X		
15				X		
16	CHECK FOR SEEPAGE	B	X	X		
17	CHECK CONDITION OF PRESSURE VESSELS			X		
18	VISUAL INSPECTION OF ELECTRICAL EQUIPMENT				X	
19	VISUAL INSPECTION OF MECHANICAL EQUIPMENT				X	
20	VISUAL CHECK OF PUMP CHAINS,HOSES & CLAMPS				X	
21	CHECK MANUAL OPERATION OF BOTH PUMPS				X	
22	CHECK AMP METERS & PRESSURE GAUGES				X	
23	CHECK OPERATION OF FLOAT SWITCHES & SONIC EYES				X	
24	CHECK FIRE EXTINGUISHER (SEAL)			X	X	
25	CHECK GATE VALVES				X	
26	CLEAN SONIC SENSOR				X	
27	GENERAL CLEANING OF FLOORS,WINDOWS & EQUIP.				X	
28	CLEAN SURFACE OF ELECTRICAL EQUIPMENT	C	X	X	X	
29	OPEN SEWER TANK COVERS		X	X	X	
30	WASH DOWN PUMPS,CHAINS, STEPS, CLAMPS & FLOAT				X	
	SWITCHES WITH ODASAN				X	
31	SPRAY OF WITH HIGH PRESSURE HOSE				X	
32	CHECK FOR WASTE & PLASTIC BAGS				X	
33	CHECK ON LIGHTING (BUILDINGS ONLY)				X	
34					X	
35					X	
36					X	
37	SWEEP FLOORS CLEAN WINDOWS	D	X	X		
38	CHECK MANUAL HAND PUMP		X	X		
39	GREASE ALL NIPPLES		X	X		
40	CHECK FOR NOISY PUMPS		X	X		
41	CHECK EQUIPMENT FOR CORROSION AND TREAT		X	X		
42	TOUCH UP PAINTWORK ON EQUIPMENT		X	X		
43	CHECK FAN BELT TENSION & COMPRESSOR OIL		X	X		
44	OPERATE GATE VALVES TO PREVENT SEIZING		X	X		
45	CHECK UNIVERSAL ON DRIVE SHAFT FOR WEAR&TARE		X	X		
46	CHECK VALVE SPINDLE & GREASE		X	X		
47	CHECK TANK FOR SAND & RUBBLE BUILD UP (REMOVE)		X	X		
48	CHECK RECEIVER PRESSURE & ADJUST (200 KPA)		X			
49	OIL WINDOW & DOOR HINGES & LOCKS		X			
50	PAINT PUMP STATION FLOORS	E	X	X		
51	PAINT ELECTRICAL MOTORS MECH. EQUIP.			X		
52	DE SCALING OF EJECTOR VESSEL			X		

A ---- FORTNIGHTLY
B ----MONTHLY
C ---- QUARTERLY
D ---- ANNUALLY
E ---- 2 YEARLY

SIGNATURE:_____ GRADE:_____

APPENDIX 2.11.3: FIRE MONITORS

FIRE MONITORS MAINTENANCE SCHEDULE

LOCATION :

APPENDIX 24 b

DATE:

	SERVICE ITEM	TYPE OF SERVICE	BERTH 2		BERTH 4		BERTH 5		BERTH 6			BERTH 7		BERTH 8	
			1	2	1	2	1	2	1	2	3	1	2	1	2
1	OVERALL VISUAL INSPECTION OF MECH. ELEMENTS	"A"													
2	OVERALL VISUAL INSPECTION OF ELECT. ELEMENTS														
3	RESET/CLEAR LOGGED FAULTS (WHERE APPLICABLE)														
4	CHECK FOR OIL LEAKS														
5	CLEAN IN-LINE STRAINER														
6	CHECK FOR WATER LEAKS THROUGH DELUGE VALVE														
7	OPERATE MANUALLY & OBSERVE FOR LEAKS, NOISE														
8	OPERATE ELECTRICAL TRAVERSE AND ELEVATION														
9	OPERATE BLABBER-MOUTH & CHECK LINKAGES														
10	CHECK ROADSIDE VALVE ISOLATES WATER SUPPLY														
11	WASH MONITOR WITH FRESH WATER														
12	OBSERVE PLANT GENERAL OPERATION, NOISE, LEAKS														
13	CHECK/SET OVER RIDE VALVES														
26	CHECK PLC OPERATION (Where appl;icable)														
27	GREASE ALL POINTS	"B"													
28															
29															
32															
33	REMOVE AND CLEAN PILOT (CONTROL) VALVE	"C"													
34															
35															
38															
39	REMOVE RUST, TREAT AREA AND TOUCH UP/PAINT	"D"													
40															
41															
42															
43															
44	REPLACE OR CLEAN SUCTION FILTER	"E"													
45	CHANGE HYDRAULIC OIL, CLEAN TANK/FLUSH SYSTEM														
46	REMOVE & REPLACE MOTOR-HYDRAULIC UNITS														
47	DERUST & PAINT HYDRAULIC FITTINGS														
48	REMOVE & REPLACE DELUGE-VALVE AS PER SPEC														

REMARKS

TYPE OF SERVICE	
2 WEEKLY	A
MONTHLY	B
6 MONTHLY	C
ANNUAL	D
2 YEARLY	E

SIGNATURE: **DATE:**

APPENDIX 2.11.4: CFI

CENTRAL FOAM INJECTION/SECURITY INSTALLATION MAINTENANCE SCHEDULE

	MECHANICAL MAINTENANCE	DAILY	EACH WEEK	FORT NIGHT	EACH MNTH	6 MNTH	12 MNTH	2 YRS
	ACTIVITY							
PUMP	Check BERMAD valve operation (incl. pilot valves)							
STA.	Check guages							
	Check for pipe leaks, corrosion							
	Test guages							
	Check pump glands and bearings							
	Check accumulators							
	Paint piping, floor							
	Sweep and dust station							
	Check safety signage							
	Oil doors, locks etc.							
	Check fire extinguishers							
	Performance test pumps							
	Check automatic pressure selection controls							
FOAM	Check BERMAD valves, incl. pilot valves.							
STA.	Diesels check							
	Check operation of foam pumps ,inpect							
	Check piping for leaks, corrosion							
	Diesels run, inspect							
	Check guages.							
	Paint piping, floor							
	Sweep and dust station							
	Check safety signage							
	Oil doors, locks etc.							
	Check fire extinguishers							
	Performance test pumps							
POWER	Check jockey pumps, log water use, hours-run, visual							
STA.	Check for piping leaks,remove corrosion.							
	Diesels run and inspect							
	Diesels lubricate,service,clean.							
	Check guages,fuel tanks and pipelines.							
CUTLER	Emergency diesel run and inspect,clean.							
	Check operation,lubricate, service							
	Check drop gates and examine ladders and platforms							
	Operate drop gates							

	ELECTRICAL MAINTENANCE	DAILY	EACH WEEK	FORT NIGHT	EACH MNTH	6 MNTH	12 MNTH	2 YRS
	ACTIVITY							
PUMP	Run and inspect 6,6kV motor and lubricate, adjust							
STA.	Inspect,relamp,repair of minor faults.							
	Check heaters, pilot valves, limit switches							
	Check earthing							
	Check building distribution and lighting							
	Electrical controls/starters check							
POWER	Check alternator, connections, lubricate, blow out							
STA.	Check transformers,replace silica gel							
	General check, trips, chargers etc; visual O.K.							
	Transformer oil tests							
	Run/operate,inspect/check,adjust.							
	Check PLC operation							
	Check protection, starter controls							
	Paint piping, floor							
	Sweep and dust station							
	Check safety signage							
	Oil doors, locks etc.							
	Check fire extinguishers							
	Performance test alternators							
	Boost charge, check connections, electrolyte (10 sets)							
	Check volt drop on start-up with chargers "OFF"							
	Check and clean battery chargers							
	Building lighting, ventilation check							
FOAM	Check motor run,inspect, adjust.							
STA.	Building lighting, ventilation etc.							
	Paint piping, floor							
	Sweep and dust station							
	Check safety signage							
	Oil doors, locks etc.							
	Boost charge, check connections, electrolyte (8 sets)							
	Check volt drop on start-up with chargers "OFF"							
	Check and clean battery chargers							
	Check fire extinguishers							
CUTLER	Inspect security lighting ,lamping,ignitors,clean.							
	Check mini substations, lubricate,clean,							
	Standby plant run,blow out,clean,check,adjust controls							
	Check earthing systems							
	Check bldg. dist. boards, earth leakages, tunnel lighting							
	Step up transformer check							
	Check,replace silica gel							
	Building relamping							
	Evening lighting patrol							
	Main L.V. distribution board check/adjust							
	Soil potential, cathodic protection tests							
	Oil tests							
	Boost charge, check connections, electrolyte levels							
	Check volt drop on start-up with chargers "OFF"							
	Check and clean battery chargers							

FUEL DELIVERIES **APPEN**

MAIN DIESELS	
FOAM DIESELS	
CUTLER DIESEL	

TEST RUN MAIN DIESEL ALT

	RUN	WEEKLY	HOUR MET
MAIN GEN. 1			
MAIN GEN. 2			
MAIN GEN. 3			

TEST RUN SALT WA

	RUN	WEEKLY	HOUR MET
PUMP NO.1			
PUMP NO.2			
PUMP NO.3			
FILLER PUMP			
CHARGE PUMP			

TEST RUN FOAM DI

	RUN	WEEKLY	HOUR MET
FOAM NO.1			
FOAM NO.2			

TEST CUTLER & POWER STATION STANDBY

	RUN	WEEKLY	HOUR MET
CUTLER			
POWER STA.			

THREE MONTHLY PIPE TO SOIL POTENT

TEST	HYDRANT	LOCATIO
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

CATHODIC PROTECTION TEST

UNIT	LOCATION	VOLTAGE
1	SUMATRA ROAD	
2	WHARFSIDE ROAD	
3	WHARFSIDE ROAD	
4	VENEZUELA ROAD	
5	WHARFSIDE ROAD	
6	WHARFSIDE ROAD	

APPENDIX 2.11.5: MILLENIUM TOWER

MILLENIUM TOWER MAINTENANCE SCHEDULE

DATE:

APPENDIX 25 A

	SERVICE ITEM	TYPE OF SERVICE	CAROUSEL	TIDAL INDIC.	COWL
1	OBSERVE ALL MOVING ELEMENT OPERATION, NOISE, VIBRATION				
2	RESET/CLEAR LOGGED FAULTS ON SCADA/COMUTER SYSTEM				
3	CHECK BRAKES OPERATION, HYDRAULIC SYSTEM				
4	CHECK TIDAL INDICATOR SHEAVES/PULLEYS; GREASE & ADJUST				
5	CHECK CAROUSEL DRIVE UNIT/GEARBOX & MOUNTINGS				
6	CHECK SAFETY NOTICES, LABELLING, EMERGENCY NUMBERS				
7	CHECK OPERATION AND/OR ADJUST BRAKE CONTROL VALVES				
8	CHECK AUDIBLE ALARM SYSTEMS OPERATION	"A"			
9	CHECK CAROUSEL DRIVE UNIT/MOTOR OPERATION (INCL. FAN)	2 WEEKLY			
10	CHECK BRAKE OPERATING RAMS, HINGE PINS, BRAKE OPERATION				
11	CHECK CAROUSEL ROLLERS FOR WEAR & REPAIR/ADJUST				
12	CHECK CAROUSEL BRAKE HYDRAULIC PUMP OPERATION				
13	CHECK OPERATION OF WINCH INCLUDING ELECTRICAL SUPPLY				
14	CHECK TIDAL INDICATOR OPERATION AND LIMIT SWITCHES				
15	CHECK CONDITION/OPERATION OF ANEMOMETERS				
16	CHECK STROBE LIGHTING OPERATION				
17	CHECK COWL LED LIGHTS AND FLOODLIGHTS				
19	CHECK TOWER BASE LIGHTS				
20	CHECK PINION AND RING GEAR FOR WEAR AND LUBRICATE				
21	GENERAL LUBRICATION AND GREASE OF MOVING ELEMENTS				
22	CHECK TIDAL INDICATOR ROPE, ANCHOR POINTS, PINS, LOCKNUTS	"B"			
23	CHECK OPERATION OF WINCH; OIL LEVEL CHECK/TOP UP	3 MONTH			
24	INSPECT ALL LADDERS, PLATFORMS, RAILING				
25	CHECK MAST INTERIOR LIGHTING				
26	CHECK SPIRE, SKIRT AND TAIL LIGHTING				
27	INSPECT MAST INTERNAL LADDER AND PLATFORMS				
28	INSPECT ALL CAROUSEL BOLTS AND NUTS FOR CORROSION				
29	GENERAL INSPECTION OF COWL STRUTS, BOLTS, NUTS, PANELS	"C"			
30	CHECK EMERGENCY STOP OPERATION	6 MONTH			
31	CHECK SPIRE BASE ANCHOR BOLTS				
32	CHECK OPERATION OF DRIVES AND STARTERS				
33					
34					
35	CHECK CONDITION/OPERATION OF ALL PROXIMITY DEVICES	"D"			
36	CHECK OPERATION /CONDITION OF TRAILING CABLE SYSTEM	ANNUAL			
37	CHECK ALL ROOF L.V.DISTRIBUTION EQUIPMENT AND WIRING				
38	GENERAL INSPECTION FOR CORROSION, TREAT & TOUCH UP				
39	CAROUSEL INSPECTION AND CERTIFICATION				
40	COWL INSPECTION AND CERTIFICATION				
41	LOAD TEST TIDAL INDICATOR HOIST SYSTEM				
42					
43		"E"			
44		2 YEAR			
45					

REMARKS

SIGNATURE:

DATE;

APPENDIX 2.11.6: AIR-CONDITIONING

AIRCONDITIONING MAINTENANCE SCHEDULE

APPENDIX 27A

LOCATION :

DATE:

SERVICE ITEM	TYPE OF SERVICE
OBSERVE PLANT GENERAL OPERATION, NOISE, VIBRATION ETC.	"A"
RESET/CLEAR LOGGED FAULTS (WHERE APPLICABLE)	
CHECK FOR WATER LEAKS	
CHECK FOR REFRIGERANT AND OIL LEAKS	
CHECK AND RECORD DELIVERY AIR TEMPERATURES	
CHECK AND RECORD CHILLED WATER TEMPERATURE (WHERE APPLICABLE)	
CHECK AND RECORD CONDENSER WATER TEMPERATURE (WHERE APPL;ICABLE)	
CHECK AIR COMPRESSOR OPERATION AND PNEUMATICS (WHERE APPLICABLE)	
CHECK AIR COMPRESSOR OIL LEVEL, DRAIN RECEIVER (WHERE APPLICABLE)	
CHECK COOLING TOWER SUMP LEVEL/BALL VALVE	
CHECK CHILLED AND CONDENSER WATER PUMPS FOR OPERATION , LEAKS ETC.	
CHECK READINGS OF CHILLED & CONDENSER WATER PRESSURE GUAGES	
CLEAN PLANTROOM AND REMOVE EXCESS WATER	
CHECK ELECTRICAL INSTRUMENTATION OPERATION	
CHECK PLANT ROOM LIGHTING	
CHECK OPERATION OF COOLING TOWER CAPACITY CONTROLS (IFAPPLICABLE)	"B"
BACKWASH AND CLEAN SAND FILTER (WHERE APPLICABLE)	
SWAP CHILLED/CONDENSER WATER PUMP OPERATION (IF APPLICABLE)	
CHECK FRESH AIR MAKE-UP OPERATION	
CLEAN ALL DRIP TRAYS	
CLEAN ALL FILTERS	"C"
CHECK COOLING TOWER SUMP LEVEL/BALL VALVE & WATER SPRAY DISTRIBUTION	
CHECK AIR HANDLER AIRFLOW, FAN BELT TENSION	
CHECK ALL PULLEYS, GREASE AND ADJUST WHERE NECESSARY	
CHECK MOUNTINGS, VIBRATION RUBBERS, SECURING SCREWS/HANGERS ETC.	
SWAP CHILLER OPERATION (WHERE APPLICABLE)	
CHECK ALL CONDENSATE AND PLANTROOM DRAINS AND CLEAN	
TEST CHILLED , AND CONDENSER WATER CONTROL VALVES (IF APPLICABLE)	
CHECK EARTHING OF PLANT	"D"
CHECK OPERATION OF ALL ELECTRICAL SWITCHES AND CABLE CONNECTIONS	
CHECK SAFETY NOTICES, LABELLING, EMERGENCY NUMBERS	
CHECK COOLING TOWER MOTOR OPERATION	
CHECK COOLING TOWER FAN BLADE MECHANICAL CONDITION	
DRAIN AND CLEAN COOLING TOWER SUMP	
CHECK EXPANSION TANK WATER LEVEL AND BALL VALVE (IF APPLICABLE)	
CHECK ALL TIME CLOCKS (IF APPLICABLE	
CHECK THERMOSTAT OPERATION	
CHECK CONTROL DAMPER OPERATION	
CHECK AND RECORD REFRIGERANT PRESSURES	
CHECK AND CLEAN ICE PROBES (IF APPLICABLE)	
CHECK AND RECORD GLYCOL S.G. READINGS (IF APPLICABLE)	
CHECK, ADJUST AND GREASE ALL BEARINGS, COUPLINGS ETC.	
CHECK OPERATIONAL EFFICIENCY OF ALL PUMPS	"E"
DE-SLUDGE/CLEAN ALL AHU COILS	
REMOVE AND CLEAN STRAINERS (CHILLED & CONDENSER WATER SYSTEMS)	
CHECK FLOW SWITCH OPERATION	
CLEAN, CHECK AND ADJUST CONTROL VALVES	
ACID CLEAN/ROD CONDENSER	
CHECK AND BLEED CHILLED WATER SYSTEM OF AIR	
CHECK ALARM SYSTEMS/FIRE CONTROLS (IF APPLICABLE)	
CHECK CONDITION OF PIPE AND CHILLER LAGGING/INSULATION	
INSPECT COOLING TOWER ELIMINATORS FOR SCALE AND CLEAN	
REMOVE RUST, TREAT AREA AND TOUCH UP/PAINT	
CLEAN ICE TANKS (INCLUDING LID/TOP) AND PAINT	"F"
PAINT PLANTROOM, FLOOR, PIPING AND BARRIER LINES	
CLEAN DUCTING INTERIOR	

WEEKLY TEMPERATURE RECORDINGS

WEEK	CHILLED WATER IN	CHILLED WATER OUT	CONDENSER WATER IN	CONDENSER WATER OUT	SUPPLY AIR TEMP.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
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41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					

6 MONTHLY RECORDINGS

REFRIGERANT PRESSURES				GLYCOL
DATE	LOW	DATE	HIGH	S.G.'s

REMARKS

TYPE OF SERVICE

"A"	WEEKLY	"D"	6 MONTHLY
"B"	MONTHLY	"E"	ANNUAL
"C"	QUARTERLY	"F"	2 YEARLY

SIGNATURE: **DATE**