Eskom	Standard	Technology

Title: **MAINTENANCE, OPERATION AND FAULT FINDING ON HVAC EQUIPMENT – PACKAGE PLANT**

Unique Identifier:	**TOPAC-004**
Alternative Reference Number:	**<n/a>**
Area of Applicability:	**Maintenance**
Documentation Type:	**Standard**
Revision:	**0.2**
Total Pages:	**12**
Next Review Date:	**May 2029**
Disclosure Classification:	**Controlled Disclosure**

Compiled by	Approved by	Authorized by
Ronald Niranjan	**Johan Badenhorst**	**Abram Motaung**
PTM HVAC&R Witbank Section Manager	**Technical Support Manager**	**PTM Manager**
Date: 12/04/2024	Date:	Date:

Supported by SCOT/SC

N/A

SCOT/SC Chairperson

Date:

PCM Reference: **240-93932323**

SCOT Study Committee Number/Name: **PTM Maintenance Manual for Eskom Generation**

Content

1. Introduction

This standard is compiled to assist staff in performing maintenance, operation and fault finding on HVAC & R Package Plant in an identical way and consistent manner.

2. Supporting Clauses

2.1 Scope

To formalize the required tests to be done, as well as methods, precautions and check sheets to be adhered to when performing maintenance, operation and fault finding on HVAC & R Package Plant.

2.1.1 Purpose

The purpose of this document is to capture general guidelines and rules to be adhered to when performing work activities on Packaged HVAC systems used in almost all classes of commercial buildings. They function in harsh outdoor environments, and often with no on-site staff responsible for their operation, so that they get no attention until they break down.

The main purpose of regular maintenance is to keep equipment in good working order. It also keeps it running at optimal efficiency, though realistically this is often considered a secondary benefit.

2.1.2 Applicability

This standard is applicable where PTM (including contractors in PTM service or under PTM supervision) is rendering a service to a client with regards to the maintenance, operation and fault finding on HVAC & R Package Plant.

2.2 Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems

[2] TOPAC-001, Maintenance of HVAC Equipment – Window / Console / Split Units

2.2.2 Informative

[1] None

2.2.3 General

Definition	Description
Check	Examination, recording, deduction or calculation and proposal for corrective action if necessary.
Components	The individual parts which each piece of equipment exists out of.
Condition	The state in which equipment and components have to perform to optimum.
Equipment	All the structures as well as electrical and mechanical machinery required to obtain the expected level of performance applicable.
Mechanisms	Clusters or groups of components or even one component to perform a specific action or task at a given time.

Definition	Description
Preventative maintenance	The wear and changes that a system will undergo during operation is anticipated and continuous corrective action is taken to minimize deterioration. This would require periodic inspections and replacements of components as normal wear occurs to prevent equipment failure. Preventative maintenance involves a planned and controlled programme of inspections, adjustments, repairs and analysis of performance designed to keep a system operating at peak efficiency.

2.3 Abbreviations

Abbreviation	Description
HIRA	Hazard identification and risk assessment
OHS Act	Occupational Health and Safety Act
ORHVS	Operating Regulations for High Voltage Systems
PPE	Personal Protective Equipment

3. Document Content

3.1 Safety

It is the responsibility of each person to ensure that the correct plant is isolated according to a specific regulation (ORHVS or Plant Safety) a permit has been issued, all staff has signed the workers register, a proper job brief has been done and that the days HIRA were completed. Adhere to the OHS Act.

No	Possible risks, hazards and danger	Compulsory required precautionary measures
1	Physical electrical contact during testing.	a) All equipment used must adhere to OHS Act. b) Use all test equipment according to prescribed procedures and manuals. c) Unauthorised access prohibited (Only PTM staff, barricading tape, lock gates, etc.) d) Ensure that plant is properly earthed and that the earthing arrangement meets the requirement of the isolations and at the point where work has to be performed. On the LV supply there is no earth facility and isolation is still required.

2	Safe Handling of Refrigerants	a) Ensure that safe handling of refrigerants certificate is valid and MSDS for the refrigerant are reviewed. b) Wear safety goggles and gloves at all times when handling refrigerants or servicing a refrigeration system. c) Wear the proper respiratory protection while working with refrigerants. Check the MSDS for the proper level of protection required. d) Proper ventilation or respiratory protection is required for any work on equipment in an enclosed area where a leak is suspected. e) Always ventilate or test the atmosphere of an enclosed area before beginning work. Many refrigerants which may be undetectable by human senses are heavier than air and will replace the oxygen in an enclosed area causing loss of consciousness. f) Inhaling refrigerants can cause sudden death. Intentional inhalation of refrigerants to produce intoxication can cause the heart to cease functioning properly and may be fatal. g) Refrigerant cylinders should never be filled over 80% of their capacity (liquid expansion may cause the cylinder to burst). h) Inspect refrigerant cylinders regularly. Do not use the cylinders if they show signs of rust, distortion, denting, or corrosion. Store cylinders secured and upright in an area where they will not be knocked over or damaged. i) Safe handling of refrigerants SANS 10147 must be adhered to. j) Pressure Regulation equipment 17 SANS 347 must be adhered to. k) Refrigerant usage and recycled register must be in place.
3	High elevated position. Work that needs to be performed at an elevated level.	a) Compulsory use of safety belt / harness is required when the possibility exists that a person can fall from an elevated position. **Complete Q-411 and send to SHEQ office**
4	Slippery surfaces, oil spillages, leaks, etc.	a) All slippery surfaces to be kept clean before commencing with work. b) Avoid spillages.
5	Use of scaffolding.	a) Safe for use sign displayed. b) Access ladder fitted. c) No openings in/on platform. d) Kick plates fitted. e) Handrails fitted.
6	Personnel injury.	e) Wear appropriate PPE.
8	Unsafe working conditions.	f) Report any unsafe act / condition.

3.2 Operation and Maintenance Strategy

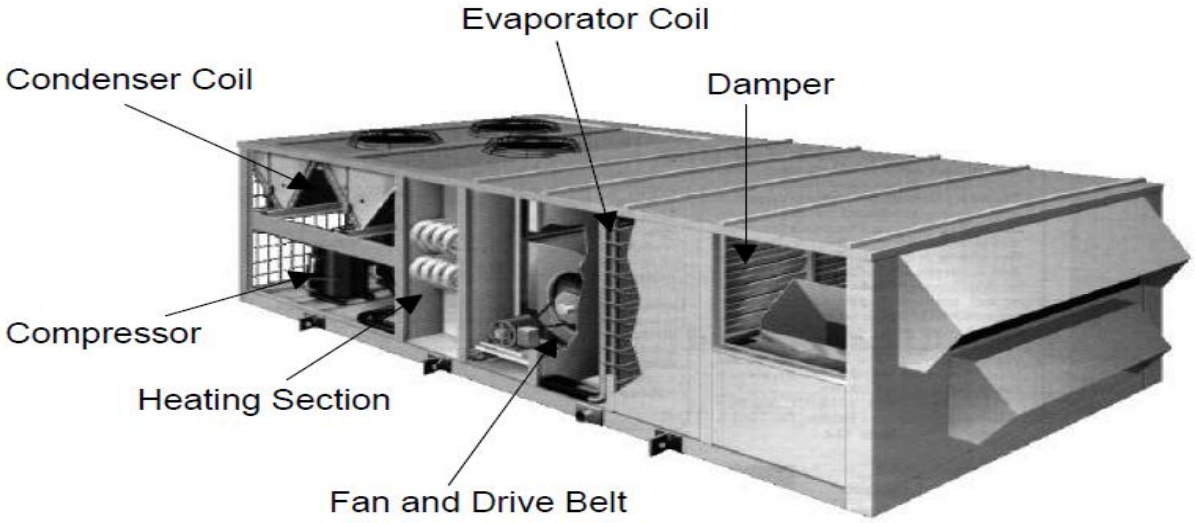

Fig 1 – Typical Packaged Roof Top Equipment

3.2.1 Regular maintenance saves energy by keeping packaged HVAC units running at optimal efficiency and performance.

3.2.2 Dirty condenser coil and evaporator coil reduce cooling capacity and make the compressor work harder and longer.

3.2.3 Improper refrigerant charge results in inefficient compressor operation.

3.2.4 Dirty filters and dirty fan blades increase static pressure and reduce airflow, reducing efficiency and capacity.

3.2.5 Air leaks in cabinet and ducts waste conditioned air, reducing system efficiency and occupant comfort.

3.2.6 Improper belt alignment and adjustment reduces fan drive efficiency.

3.2.7 Dirty heat exchange surfaces and improperly adjusted combustion controls decrease heater efficiency.

3.3 Maintenance Requirements

3.3.1 Turn off electrical power to the unit before performing any tasks maintenance or service.

3.3.2 Use extreme caution when removing panels and parts. As with any mechanical equipment, personal injury can result from sharp edges.

3.3.3 Never place anything combustible either on or in contact with the unit.

3.3.4 Clean, replace and inspect air filter(s) during each maintenance cycle.

3.3.5 Inspect indoor coil, outdoor coil, drain pan and condensate drain for cleanliness and clean when necessary.

3.3.6 Inspect blower motor and wheel for cleanliness, during each maintenance cycle season. Clean when necessary.

3.3.7 Check electrical connections for tightness and controls for proper operation during each maintenance cycle.

3.3.8 Check the drain channel in the top cover periodically for blockage (leaves, insects etc.) Clean as needed.

3.4 Air Filters

3.4.1 Never operate the unit without a suitable air filter in the return air-duct system. Always replace the filter with the same dimensional size and type as originally installed.

3.4.2 Inspect air filters and replace throw-away types or clean – cleanable types - at least twice during each maintenance cycle or whenever the filters become clogged with dust and lint.

3.5 Unit Top Cover Removal (Condenser-Coil Side)

3.5.1 When performing maintenance or service procedures that require removal of the unit top, be sure to perform all of the routine maintenance procedures that require top removal, including coil and condensate drain pan inspection and cleaning.

3.5.2 ***Disconnect electrical power to the unit before removing top. Failure to adhere to this warning could cause personal injury or death*.**

3.5.3 Lift top from unit carefully. Set top on edge and make sure that top is supported by unit side that is opposite duct or plenum side.

3.6 Evaporator Blower, Motor, Bearings and Belts

3.6.1 For longer life, operating economy, continuing efficiency, clean accumulated dirt and grease from the blower wheel and motor annually.

3.6.2 Improperly adjusted belts rob the drivetrain of power, create noise, and must be replaced sooner than well-adjusted belts. Belts should be aligned to prevent lateral wear. Proper tension should be maintained; loose belts slip on the pulley wheels, causing torque loss and rapid wear. Belts that are too tight put an excessive load on the motor and fan shaft bearings, causing early failure of the bearings and / or belts.

3.6.3 **To clean the blower wheel:**

3.6.3.1 Remove top access panel.

3.6.3.2 Remove screws that hold blower orifice ring to blower housing. Save screws.

3.6.3.3 Loosen setscrew which secure wheel to motor shaft.

3.6.3.4 Lift wheel from housing. When handling or cleaning blower wheel, be sure not to disturb balance weights clipped on blower wheel vanes.

3.6.3.5 Remove caked-on dirt from the wheel and housing with a brush. Remove lint and dirt accumulations from wheel and housing with a vacuum cleaner using a soft brush attachment. Remove grease and oil with a mild solvent.

3.6.3.6 Re-assemble blower into housing. Place upper orifice ring on blower to judge location of the blower wheel. Blower wheel should be approximately 5mm below bottom of orifice ring when centred correctly. Be sure that set screws are tightened on motor and not on round part of shaft.

3.6.3.7 Set upper orifice ring in place with screws removed in step 1.

3.6.3.8 Replace top access panel.

3.7 Condenser Coil, Evaporator Coil and Condensate Drain Pan

3.7.1 Inspect the condenser coil, evaporator coil and condensate drain pan during each maintenance cycle. Proper inspection and cleaning requires the removal of the unit top, as explained above.

3.7.2 The coils are easily cleaned when dry; therefore inspect and clean the coils.

3.7.3 Remove all obstructions, including weeds and shrubs that may interfere with the airflow through the condenser coil.

3.7.4 Straighten bent fins with a fin comb. If coated with dirt or lint, clean the coils with a vacuum cleaner, using a soft brush attachment. Be careful not to bend the fins.

3.7.5 If coated with oil or grease, clean the coils with a mild detergent-and-water solution. Rinse coils with clear water using a garden hose.

3.7.6 Be careful not to splash water on motors, insulation, wiring or air filters. For best results spray condenser-coil fins from inside to outside the unit.

3.7.7 On units with an outer and inner condenser coil, be sure to clean between the coils. Be sure to flush all dirt and debris from the unit base.

3.7.8 Inspect the drain pan and condensate drain line when inspecting the coils. Clean the drain pan and condensate drain by removing all foreign matter from the pan. Flush the pan and drain tube with clear water.

3.7.9 If the drain tube is restricted, clear it with a “plumbers snake” or similar probe device. Ensure that he auxiliary drain port above the drain tube is clear.

3.8 Condenser Fan

3.8.1 Keep the condenser fan free from all obstructions to ensure proper cooling operation. Never place articles on top of the unit. Damage to unit may result.

3.8.2 Shut off unit power supply.

3.8.3 Remove the condenser fan assembly (grille, motor, motor cover, and fan) by removing screws and flipping assembly onto unit top cover.

3.8.4 Loosen fan hub setscrews.

3.8.5 Adjust fan height as shown in Fig.1, below.

3.8.6 Replace condenser-fan assembly and tighten screws.

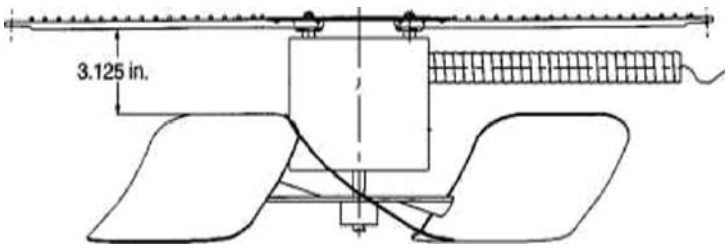

Fig. 1 – Condenser Fan Adjustment

3.9 Evaporator Airflow

3.9.1 The cooling airflow does not require checking unless improper performance is suspected. If a problem exists be sure that all supply and return air grills are open and free from obstruction, and that the air filter is clean.

3.9.2 Airflow can be changed by changing the lead connections of the variable speed blower motor.

3.10 Metering Devices

3.10.1 Refrigerant metering devices are fixed orifices and are located in the inlet header to the evaporator coil.

3.10.2 The metering device is responsible for feeding the proper amount of refrigerant to the evaporator coil. The refrigerant that enters the metering devices is a high temperature, high pressure, subcooled liquid that leaves the devices as a low-temperature, low-pressure saturated liquid.

3.11 Liquid Line Strainer

3.11.1 The liquid line strainer (to protect metering device) is made of wire mesh and is located in the liquid line on the inlet side of the metering device.

3.12 System Unit Controls and Fault Finding

3.12.1 Internal Protection Controls - Compressors

3.12.1.1 HIGH PRESSURE RELIEF VALVE – This valve opens when the pressure differential between the low and high side becomes excessive.

3.12.1.2 **COMPRESSOR OVERLOAD –** This device interrupts power to the compressor when either the current or internal temperature becomes excessive and automatically resets when the internal temperature drops to a safe level. This overload may require 60 minutes or longer in order to reset, if the internal overload is suspected to be opened. Disconnect the power to the compressor and check the circuit through the overload with an ohmmeter.

3.12.1.3 **LOW PRESSURE SWITCH –** This switch opens when the suction pressure falls below 14 PSI, indicating a low charge or / and an evaporator coil tubing blockage. Once pressure rises above 25 PSI, the switch can be reset within minutes of the fault.

3.12.1.4 **HIGH PRESSURE SWITCH –** This opens when the discharge pressure rises above 465 – 475 PSI, indicating overcharge or / and condenser blockage. Switch automatically and reset when pressure falls below 320 PSI, with 5 – 10 minutes of the fault.

3.12.2 Sequence of Operation

3.12.2.1 **EVAPORATOR FAN OPERATION –** The FAN SWITCH on the thermostat controls the indoor fan operation. When the FAN SWITCH is placed in the ON position, the IFR (indoor fan relay) is energised through the G terminal on the thermostat. The normally open contacts close, which then provide power to the Indoor Fan Motor (IFM) (evaporator). The IFM will run continuously when the FAN SWITCH is set to ON. When the FAN SWITCH is set to AUTO, the thermostat de-energises the IFR, provided there is not a call for cooling. The contacts open and the IFM de-energise. The IFM will be energised only when there is a call for cooling or the unit is equipped with accessory electric heat, the IFM will also run while the accessory electric heater is energised.

3.12.2.2 **COOLING –** On a call for cooling, the compressor contactor (C) and the IFR are energised through the Y and G terminals of the thermostat. On units with a compressor time delay relay between compressor starts. Energising the compressor contactor supplies power to the compressor and the outdoor (condenser) fan motor (OFM). Energising the IFR provides power to the IFM. When the need for cooling has been satisfied, the OFM, compressor and IFM (FAN on AUTO) are de-energised. If the unit is equipped with a 30 sec delay, the indoor fan will remain energised after the compressor is de-energised.

3.12.2.3 **HEATING –** if accessory electric heaters are installed, on a call for heat, the thermostat energise the W relay which energises the electric heaters. The IFR is energised which starts the indoor fan motor. If the heaters are staged, W2 is energised when the second stage of heating is required. When the need for heating is satisfied, the heater and IFM are de-energised.

3.12.2.4 **The terminals on a thermostat are:**

- G – Fan, usually a green wire.
- R – 24 VAC usually a red wire
- C – 24 VAC Common.
- Y – Compressor, usually a yellow wire.
- W – Heat, usually a white wire.

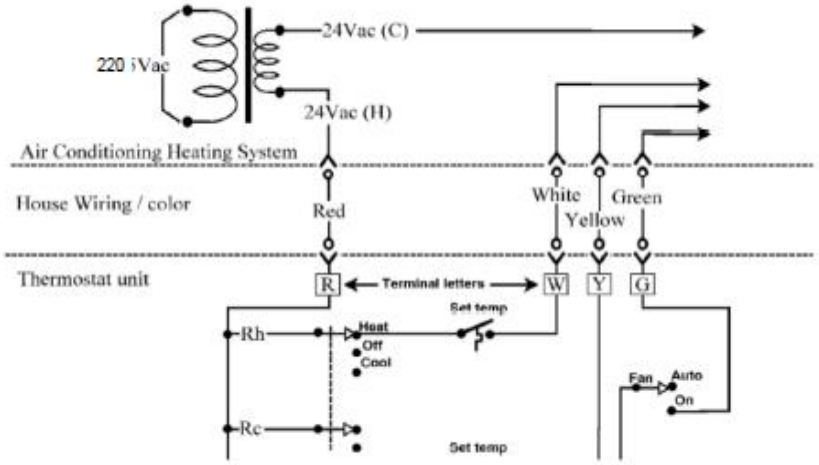

Fig 2 – Thermostat Signals and Wiring

3.12.3 Cooling Section Start-up and Adjustments

3.12.3.1 Place room thermostat SYSTEM switch in OFF position. Observe that the blower motor starts when FAN switch is placed in ON position and shuts down when FAN switch is placed in AUTO position.

3.12.3.2 Place SYSTEM switch in the COOL position and FAN switch in AUTO position. Set Cooling control below room temperature. Observe that compressor, condenser fan and evaporator blower fan starts up. Observe that cooling cycle shuts down when control setting is satisfied.

3.12.3.3 When using an automatic change-over room thermostat, place both System and FAN switches on AUTO positions. Observe that the unit operates in Cooling mode when temperature control is set to ‘call for cooling ‘(below room temperature).

3.12.4 Fault Finding Cooling Chart

Symptom	Cause	Remedy
Compressor and condenser fan will not start.	Supply failure.	Confirm source of supply
	Fuse blown or circuit breaker trip.	Replace fuse or reset circuit breaker.
	Defective thermostat, contactor, transformer or control relay.	Replace component.
	Insufficient line voltage.	Determine cause and correct.
	Incorrect or faulty wiring.	Check wiring diagram and rewire correctly.
	Thermostat setting to high.	Lower thermostat setting below room temperature.
Compressor will not start but condenser fans run.	Faulty wiring or loose connection in compressor circuit.	Check wiring and repair or replace.
	Compressor motor burned out, seized, or internal overload open.	Determine cause. Replace compressor.
	Defective run / start capacitor overload or start relay.	Determine cause and replace.
	One leg of 3-phase power dead.	Replace fuse or reset circuit breaker. Determine cause.
Compressor cycles (other than normally satisfying thermostat).	Refrigerant overcharge or undercharge.	Recover refrigerant, evacuate system and recharge
	Defective compressor.	Replace and determine cause.
	Insufficient line voltage.	Determine cause and correct.
	Blocked condenser.	Determine cause and correct.
	Defective thermostat, contactor, transformer or control relay.	Determine cause and replace.
	Defective thermostat.	Replace thermostat.
	Faulty condenser fan motor of capacitor.	Replace.
	Restriction in refrigerant system.	Locate restriction and remove.
Compressor operates continuously.	Dirty air filter.	Replace filter.
	Unit undersized for load.	Decrease load or increase unit size.
	Thermostat set too low.	Reset thermostat.
	Low refrigerant charge.	Locate leak, repair and recharge.
	Leaking valves in compressor.	Replace compressor.
	Air in system.	Recover refrigerant, evacuate system and recharge.
	Condenser coil dirty or restricted.	Clean coil or remove restriction.
Excessive head pressure.	Dirty air filter.	Replace filter.
	Dirty condenser coil.	Clean coil.
	Refrigerant overcharged.	Recover excess refrigerant.
	Air in system	Recover refrigerant, evacuate system and recharge.
	Condenser air restricted or air short-cycling.	Determine cause and correct.
Head pressure too low.	Low refrigerant charge.	Check for leaks, repair and recharge.
	Compressor valves leaking.	Replace compressor.
	Restriction in liquid tube.	Recover excess refrigerant.
Excessive suction pressure.	High heat load.	Check for source and eliminate.
	Compressor valves leaking.	Replace compressor.
	Refrigerant overcharged.	Recover excess refrigerant.
Suction pressure too low.	Dirty air filter.	Replace filter.
	Low refrigerant charge.	Check for leaks, repair and recharge.
	Metering device or low side restricted.	Remove source of restriction.
	Insufficient evaporator airflow.	Increase air quality. Check filter – replace if necessary. Check for other evaporator coil obstructions.
	Temperature too low in conditioned area.	Reset thermostat.
	Outdoor ambient below 5°C	Install low ambient kit.
	Field-installed filter drier restricted.	Replace.

3.13 Maintenance Records

1. Maintenance records should be completed in accordance with the approved check sheet – TOPAC-004/1 or related PM (Preventative Maintenance) record.
2. Check sheet TOPAC-004/1 or PM must be completed in full, with accurate and relevant information in neat legible hand writing.
3. The latest revision of the check sheet is saved on Hyperwave and may be printed in order to keep records of maintenance and breakdown work completed.
4. The serial numbers of evaporator and condenser units are compulsory. Location and model numbers are equally important for record purposes.
5. All maintenance records to be kept for a period of three years from date of maintenance.
6. Document or records older than three years must be archived appropriately. It should be noted that all results obtained from any test done should be recorded. If the check sheet used does not make provision for the measurement recorded it should be added.

4. Training Providers

Where possible, course should be provided internally at Eskom Academy of Learning (EAL). In the event, that this is not possible, external training providers that are appointed according to Eskom's procedures and standards could be used.

5. Authorisation

This document has been seen and accepted by:

Name and surname	Designation
Abram Motaung	PTM Manager
Bryan Morobi	PTM Group Manager Central
Pranesh Bhugwandin	PTM Group 1(Acting)
Mervin Ramsamy	PTM Group 2
Johan Badenhorst	PTM Technical Support Manager

6. Revisions

Date	Rev	Compiler	Remarks
18 January 2018	0.1	R Niranjan	Document revised and transferred to Eskom format.

7. Development team

The development team consisted of:

- Ronald Niranjan
- Frik Coetzee
- Hennie Botha
- Charles Herrington
- Siyabonga Mngomezulu

8. Acknowledgements

- N/A