Eskom	Standard	Technology

Title: **New Low Voltage Motors Procurement Standard**

Unique Identifier:	**240-57617975**
Alternative Reference Number:	**N/A**
Area of Applicability:	**Engineering**
Documentation Type:	**Standard**
Revision:	**3**
Total Pages:	**25**
Next Review Date:	**September 2023**
Disclosure Classification:	**CONTROLLED DISCLOSURE**

APPROVED FOR AUTHORISATION
☑ TECHNOLOGY ENGINEERING
DOCUMENT CENTRE ☎ X4962

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Date: 06/09/2018	Date: 06/09/2018	Date: 2018/10/03

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Date: 10/09/2018

PCM Reference : **240-53459028**

SCOT Study Committee Number/Name : **Rotating Electrical Machines**

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1. INTRODUCTION

This document is a standard for the procurement of power station low voltage electric motors. The requirements in this standard shall be followed to ensure that the Eskom motor design base is maintained.

2. SUPPORTING CLAUSES

2.1 SCOPE

This standard specifies the minimum Eskom's requirements for the procurement, design, manufacture, testing, transport, delivery, installation and commissioning of new low voltage electric motors.

2.1.1 Purpose

The objectives of this standard are to:

a. Provide a source of information for Power Station personnel when purchasing reliable low voltage motors for either replacing the existing motors or spares or for new plants.

b. Provide material that should be agreed upon and/or exchanged between the Employer *(Eskom)* and the Supplier. Such material includes technical schedules, quality control and assurance, tests and data packs.

c. Ensure that the Employer receives and accepts a high quality asset that is efficient, reliable and maintainable throughout its intended service life.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

a. The requirements are for the procurement and supply of new motors whose voltage rating is below 1000V.

b. There may be additional requirements with regard to electrical and mechanical components for motors to be used with variable speed drives or at nuclear sites or specialized operating systems and environments. The standard elements of this standard should, however, still be applicable and useful to specialized motors. It is understood that some elements of this standard may be adapted and additional information added through the scope of work for specialized motors and applications.

c. This standard takes precedence over any other standards mentioned in 2.2.

2.1.3 Exclusions

a. Detailed requirements for motors to be procured for specialized applications and environments.

b. While this standard contains quality control and assurance requirements, it does not cover all material and workmanship issues that shall be addressed by the Supplier and/or OEM through a duly certified ISO 9001:2008 quality management system.

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] Low Voltage Induction Motors Technical Schedule A&B Template Document number 240-77100923

[2] ISO 9001 Quality Management Systems.

2.2.2 Informative

[3] Eskom 240-56361435:Rev. 0 2009, *Transport of Power Station Electric Motors*

[4] Eskom 240-56360387: Storage of Power Station Electric Motors

[5] SANS 1804-1:2007, IEC Requirements.

[6] SANS 1804-2:2007, Low voltage three-phase standard motors.

[7] SANS 1804-4:2006, Single phase motors.

[8] SANS IEC 60034-1:2006, Rotating electrical machines. Part 1: Rating and performance.

[9] SANS IEC 60034-2-1:2008, Rotating electrical machines. Part 2: Standard methods of determining losses and efficiency from test (excluding machines for traction vehicles).

[10] SANS IEC 60034-5:2007, Rotating electrical machines. Part 5: Degrees of protection provided by the integral design of rotating electrical machines. (IP Code)- Classification.

[11] SANS IEC 60034-6:1991, Rotating electrical machines. Part 6: Methods of cooling. (IC code).

[12] SANS IEC 60034-7:2001, Rotating electrical machines. Part 7: Classification of types of construction, mounting arrangements and terminal box position. (IM Code).

[13] SANS IEC 60034-8:2007, Rotating electrical machines. Part 8: Terminal markings and direction of rotating of rotating machines.

[14] SANS IEC 60034-9: 2007, Rotating electrical machines. Part 9: Noise limits.

[15] SANS IEC 60034-11: 2005, Rotating electrical machines. Part 11: Thermal protection.

[16] SANS IEC 60034-12:2008, Rotating electrical machines. Part 12: Starting performance of single-speed three-phase cage induction motors.

[17] SANS IEC 60034-14:2007, Rotating electrical machines. Part 14: Mechanical vibration of certain machines with shaft heights 56mm and higher – Measurement, evaluation and limits of vibration severity.

[18] SANS IEC 60034-17:2006, Rotating electrical machines. Part 17: Cage Induction motors when fed from converters- Application guide.

[19] SANS IEC 60034-26: 2006, Rotating electrical machines. Part 26: Effects of unbalanced voltages on the performance of three-phase cage induction motors.

[20] SANS IEC 60034-28: 2007, Rotating electrical machines. Part 28: Test methods for determining quantities of equivalent circuit diagrams for three-phase low-voltage cage induction motors.

[21] SANS IEC 60034-30: 2008, Rotating electrical machines. Part 30 Efficiency classes of single-speed, three-phase, cage-induction motors (IE-code).

[22] SANS IEC 60072-1:1991, Dimensions and output series for rotating electrical machines. Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1080.

[23] SANS IEC 60072-2:1990, Dimensions and output series for rotating electrical machines. Part 2: Frame numbers 355 to 1000 and flange numbers 1180 to 2360.

[24] SANS 1091:2004, National colour standards for paint.

[25] IEEE 112: 2004, IEEE standard test procedure for polyphase induction motors and generators

[26] The South African grid code –Network code Rev. 8.

2.3 DEFINITIONS

Definition	Description
Controlled Disclosure	Controlled Disclosure to external parties (either enforced by law, or discretionary).
Employer	The Eskom business unit purchasing electrical motors to which this document is applicable.
Supplier	The company performing the scope of work as per this standard.

2.3.1 Classification

Controlled Disclosure: Controlled Disclosure to External Parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
IE	International Efficiency – efficiency Class
IE1	Standard efficiency (equivalent to EFF2)
IE2	High efficiency (equivalent to EFF1)
IE3	Premium efficiency
IEC	International Electrotechnical Commission
IEEE	Institute of Electronic and Electrical Engineers.
IR	Insulation resistance.
LV	Low Voltage.
PI	Polarisation index
SANS	South African National Standards

2.5 ROLES AND RESPONSIBILITIES

None

2.6 PROCESS FOR MONITORING

None

2.7 RELATED/SUPPORTING DOCUMENTS

The requirements in this standard supersede the low voltage requirements in 240-56357518.

3. PROCUREMENT OF POWER STATION LOW VOLTAGE MOTORS STANDARD

3.1 TECHNICAL REQUIREMENTS

3.1.1 General Requirements

a. All motors shall be designed, manufactured, tested and perform in accordance with the latest revision of SANS IEC 60034 and also comply with this standard.

b. The motor Supplier shall take into consideration all relevant characteristics and operating conditions pertaining to the driven machine and the motor environment and shall be responsible for designing or selecting from a standard range, a motor that will perform as required by the purchaser.

c. The preference is for motors to be selected from a standard range. Where this is not possible, the Employer shall be notified for approval on non-standard motor design. For replacements, the responsible person shall make sure that the new motor is interchangeable with the old motor or as stated in the contract.

d. Only service proven designs (all components) shall be tendered. If a design has a component/s that has/ve not been proven for at least two years in service, the affected parts and the extent of their experience shall be declared in the tender/proposal.

e. Motors shall not be under-loaded (e.g. loading below 75%) unless otherwise specified in Appendix C: Technical Schedule A&B (Template 240-77100923) and is required by the application. The loading of 75% of rated output power and above (75% - 90%) is required for better efficiency, power factor and power utilization. The design shall have reasonable design margin of at least 10% to accommodate power supply variations in Appendix C: Technical Schedule-A&B, reduced cooling and system inefficiency during the life of the plant.

f. A minimum efficiency class code of IE3 for S1 duty and intermittent duty with 80% or higher cyclic duration factor motors shall be supplied for new plants and replacements. Reliable motors with high efficiency, high power factor and low input power consumption values are required to support the Eskom Energy Efficiency drive.

g. Electric motors for converter applications shall be selected and sized to accommodate additional losses and stresses associated with converters (electric drives) in order to maintain the motor service life.

h. The Supplier to confirm all the interfacing with related equipment and subcontractors to ensure the motor will function reliably within the required environment. The Employer to be made aware of all shortcomings and risks which may affect the functioning of the motor.

3.1.2 Electrical Details

3.1.2.1 Motor Rating

a. The motor ratings shall be specified in Appendix C: Technical Schedule A&B (Template 240-77100923) of an enquiry document.

b. Motor voltage and power ratings shall be in accordance with Appendix A unless otherwise specified in Appendix C: Technical Schedule A&B (Template 240-77100923) or if the application requires an optimized/economic solution which differs from Appendix A requirements.

c. The kilowatt (kW) rating of each motor shall not be less than the maximum operating design loading (in kW) of the driven machine.

3.1.2.2 Power Supply Variation

a. The standard parameters of the power supply system (Grid Code requirement) under normal and abnormal conditions are listed in Appendix C. Motors shall be suitable for use on the system specified for the particular application.

b. Under normal power supply conditions, motors shall be capable of:

   b1. Running continuously at rated output without exceeding the temperature rises permitted in 3.1.2.3b as per SANS IEC 60034-1,

   b2. The specified number of starts per hour and momentary overload in accordance with SANS IEC 60034-1 without exceeding the motor insulation class temperature rise.

c. Under sustained abnormal conditions specified in Appendix C: Technical Schedule A&B (Template 240-77100923), motors shall be capable of starting and driving the driven equipment without exceeding the motor insulation class temperature rise.

d. Under transient abnormal conditions specified in Appendix C: Technical Schedule A&B (Template 240-77100923), motors shall continue operating without damage and without exceeding the motor insulation class temperature rise.

3.1.2.3 Temperature Class Limits

a. The stator windings shall be insulated with a Class F (155°C) or higher insulation system such a Class H (180°C).

b. The winding temperature rise at rated output shall not exceed 80K above the maximum coolant/ambient temperature of 40ºC (Class B Insulation temperature rise) measured using the resistance method. This is applicable for both Direct-on-Line and converter-driven motors.

3.1.2.4 Starting Current Requirements

a. Motors shall be suitable for direct-on-line starting unless otherwise specified in Appendix C Technical Schedule A&B (Template 240-77100923).

b. Motors shall be designed for at least three consecutive starts per hour when initially cold. Motors shall be designed for at least two consecutive starts per hour when hot.

c. Valve actuator motors, boiler damper motors, float operated motors and motors used for control and regulating functions shall be capable of at least 20 starts per hour.

d. The direct-on-line starting currents for cage induction motors under normal conditions on the specified power supply shall not exceed the following values:

   e1. 8 per unit for standard motors (IE1),

   e2. 9 per unit for high efficient motors (IE2) and premium efficiency motors (IE3).

Lower starting currents are preferred. Motors with lower starting currents, high efficiency and high power factor shall be considered.

3.1.2.5 Starting Torque Requirements

a. Motors shall be capable of accelerating the driven load from standstill to full speed and operate the driven equipment taking into account the load inertia, load torque, and power supply variations provided in this standard.

b. Unless otherwise specified in Appendix C: Technical Schedule A&B (Template 240-77100923), the pull-up torque and breakdown torque shall not be less than the values specified in SANS IEC 60034-12.

c. The minimum difference between the motor torque and load torque under normal supply condition shall not be less than 10% at any speed to avoid stalling during starting.

3.1.2.6 Tolerance

Motor efficiencies, power factors and torques guaranteed by suppliers shall not be subject to decreases in respect of tolerances of any kind. Similarly, guaranteed starting currents shall not be subject to increases for any reason.

3.1.3 Mechanical Details

3.1.3.1 Inter-Changeability of Parts

All corresponding parts of all motors of the same type and size from the same manufacturer shall be interchangeable.

3.1.3.2 Stator Windings and Insulating System

a. Vacuum pressure impregnated (VPI) stator windings are preferred. The continuous resin flow process is also acceptable. Any other winding impregnation system should be approved by the Employer.

b. End-windings shall withstand direct-on-line starting under maximum voltage conditions.

c. The connections between the windings and terminals shall carry the maximum starting current for the worst case run-up time without overheating, and shall withstand the forces arising from the starting current without damage.

d. Motors for converter applications shall be supplied with insulation system that can withstand voltage spikes, rise time and harmonics without damage or loss of life.

3.1.3.3 Stator Core and Winding

a. The stator core and winding of motors 55kW and above shall be constructed as a separate entity thus allowing for easy repair and replacement of the winding if necessary.

b. The core laminations shall have no ragged edges before stacking.

3.1.3.4 Rotor, Shaft and Coupling

a. Die-cast aluminium, Die-cast copper and fabricated copper rotors are allowed.

b. For copper bar rotors, the laminations shall be fixed to the shaft so that the maximum torque is transmitted without distortion of, and without separation between, the rotor laminations.

c. For copper bar rotors, precautions shall be taken for the case where a rotor bar breaks that it will not come out of the rotor slot and damage the stator winding.

d. Unused shaft extensions shall be enclosed in robust metal covers.

e. Shaft ends shall be protected from corrosion.

f. Dimensions of shaft ends and keys shall comply with the relevant standards in Section 2.2.

g. When the complete coupling for each motor drive is provided by the Supplier of the driven machine, the motor manufacturer shall be responsible for its fitting and balancing.

3.1.3.5 Bearings

a. In general, motor bearings and lubrication shall be of the same type as those of the driven machine.

b. The bearing type shall be anti-friction (ball or roller) bearing unless otherwise specified in Appendix C: Technical Schedule A&B (Template 240-77100923).

c. Ball and/or roller bearings shall be conservatively loaded: grease renewal periods shall be not less than 4000 hours. Grease relief devices shall be provided to prevent over-greasing and shall discharge excess grease external to the motor from an easily accessible position.

d. The greasing arrangements for ball and roller bearings shall be such that greasing can be carried out safely while the motor is running. Greasing facilities shall be easily accessible when the motor is in service.

e. The life of ball/roller bearings, calculated by an approved method, shall be at least 40 000 hours (L10). Air Cooled Condenser (ACC) motors shall have at least 100 000 hours (L10).

f. Motor with frame size up to 180 may include life-lubricated tight bearings that require no maintenance throughout its service life.

g. Motors for converter applications shall be supplied with insulated bearings to limit circulating currents.

h. The bearing for immersed motors may be lubricated by the fluid conveyed.

3.1.3.6 Enclosure and Cooling

a. Motors shall be of standard dimensions as specified in relevant standards in Section 2.2

b. All motors for use in hazardous area (e.g. oil pumps) shall be non-sparking, flame-proof and explosion-proof.

c. Separate motor driven fans for motor cooling will not be accepted unless in low speeds converter application. Approval is required from the Employer. Motor oversizing to cater for low speed converter application is the preferred option.

d. The motor housings for power station motors shall be made of either cast iron or fabricated steel. Aluminum motors will only be considered for small motors outside the cast iron frame range.

e. Vertical motors shall be provided with cowls to prevent the accumulation of foreign matter and water on the motor.

f. The enclosures (IP code) for general purpose indoors motors, outdoor motors, and material handling (coal and ash) plant shall be as stated in Appendix B.

g. Cooling methods shall be as stated in Appendix B unless otherwise specified in Appendix C: Technical Schedule A&B (Template 240-77100923).

3.1.3.7 Terminal Boxes

a. Motors shall be provided with approved terminating fittings for the required cables. Where a particular type and size of motor is supplied for several different applications, the arrangement of cable terminating fittings shall permit inter-changeability of motors and allow one spare motor to serve for all applications without having to modify the existing cable arrangement.

b. Horizontal motors smaller than 355 frame sizes may be fitted with terminal boxes that allow cable entry from any one of four positions, 90 ° apart, on top of the motor.

c. Terminal boxes shall be provided complete with the internal parts. The cable glands plugs shall be fitted in the cable entries. Cable glands shall be supplied if requested in the enquiry document.

d. Terminal box lids shall be with “lips” over the terminal box flange, so that the gasket will not be exposed to water and dust.

e. Cable tail support bars within the terminal boxes shall be made from non-hygroscopic insulating material.

f. The dimensions of terminal boxes and cable boxes shall be adequate for accommodating the sizes and types of cable specified. The design of the terminal box shall permit the removal of the motor without the need to disturb the termination or bend the cable appreciably.

g. All auxiliary terminal boxes shall be clearly labelled to indicate the circuits for which they are provided. Labels shall be of brass or stainless steel with permanent markings, and shall be securely attached to the motor.

3.1.3.8 Motor Terminals, Connections and Rotation

a. Main terminals and motor leads shall be permanently marked with the letters U-V-W, reading from left to right, if horizontally arranged, or top to bottom, if vertically arranged, when facing the terminal box.

b. Internal leads to reverse the motor rotation shall be easily interchangeable.

c. Motors with only one shaft extension shall rotate in a clockwise direction when looking on the drive end, irrespective of the direction of rotation required on site, when the U-V-W supply leads of a phase rotation system rising in that order, are connected to the motor terminals U-V-W respectively.

d. Each motor shall be provided with an earth terminal mounted.

e. For motors rated above 550 V, the leads between the motor windings and terminals shall pass through bushes or sealing devices to separate the motor interior from the terminal box.

3.1.3.9 Rating Plate and Labels

a. The rating plate shall give the information specified in SANS 1804 and IEC 60034-30.

b. All information on the rating plate or any other plate detailing information shall be marked permanently on securely attached brass or stainless steel plates

c. In addition to the information shown on the rating plate, the following information, if not included in the rating plate, shall be included separately on the motor casing,

c1. make and type of bearings;

c2. grade and type of lubricating oil/grease;

c3. recommended greasing intervals;

c4. bearing reference numbers for ball/roller bearings;

c5. permissible starting intervals.

c6. the IE code and efficiency shall be durable marked on the rating plate

c7. the SABS mark.

3.1.3.10 Corrosion Protection and Paint Finishes

3.1.3.10.1 Paint Finishes

a. The internal surfaces of terminal boxes and motor frames shall be given an approved corrosion-proofing treatment.

b. All external surfaces for new manufactured designs shall be finished with an outer coat of enamel of the colour specified in Appendix C: Technical Schedule A&B (Template 240-77100923). Off the shelve motors can be supplied with their original colours.

c. Any standard painting procedure that differs from these requirements shall be submitted to the Employer for prior approval.

3.1.3.10.2 Noise and Vibration

a. The noise levels shall not exceed the levels given in SANS IEC 60034-9.

b. Levels of vibration generated within motors when running on their own shall not exceed the levels given in SANS IEC 60034-14.

3.1.4 Accessories

3.1.4.1 Temperature Measuring Devices

a. At least one dual type thermistor shall be provided on all crane motors, actuator motors and other short-time rated motors that could overheat as a result of the driven device jamming. The thermistors shall work with the protection relays provided by the Supplier of the control gear.

b. Should there be abnormal alarm and trip requirements, the motor Supplier shall be responsible for informing the Employer of the required alarm and trip settings for the equipment monitoring the thermistors, ETD or thermocouples.

c. The thermistors, ETD or thermocouples shall be fitted in a separate terminal box. Terminal boxes shall be clearly labelled to indicate the circuits for which they are provided. Labels shall be of brass or stainless steel with permanent markings, and shall be securely attached to the motor.

3.1.4.2 Space Heaters

a. Space heaters are only required for motors exposed to low temperatures or high humidity areas which could results in condensation during standby operation or outage. The Employer Engineer has to approve the installation of heaters in critical and non-critical motors depending on the prevailing conditions. Motors that come standard with space heaters are acceptable.

b. The space heaters shall be designed to operate on 230V AC.

c. Separate terminal boxes are preferred. Terminal boxes shall be clearly labelled to indicate the circuits for which they are provided. Labels shall be of brass or stainless steel with permanent markings, and shall be securely attached to the motor.

3.2 QUALITY ASSURANCE AND TESTING

3.2.1 Quality of Material and Workmanship

a. All material shall be new and of the quality required. Unless otherwise specified or approved all material shall comply with the most recent South African Standards applicable or better.

b. No welding, burning in, filling, plugging up or metal deposition to correct defects in any component will be permitted unless agreed to by the Employer in writing, following an inspection of the defect by the Employer or its authorized representative.

3.2.1.1 Inspection and Testing

3.2.1.1.1 Inspection and Witnessing of Tests

a. The contractor shall give the Employer not less than seven days' notice of when the inspection may be undertaken. Motors despatched to site without the required inspection, may be returned at the Supplier's cost, at the Employer's discretion or as stated in the contract.

b. For motors of 200 kW and larger, an inspection and test plan shall be submitted for approval or as stated in the contract.

c. Type tests shall be witnessed by the Employer and/or an authority, independent of the Supplier or contractor or as stated in the contract.

3.2.1.1.2 Type Tests

a. The first motor of each size and type manufactured shall be performance tested to prove compliance with the quoted performance. Type test certificates on identical motors may, at the Employer's discretion, be accepted in lieu of these tests.

b. All performance tests shall be in accordance with SANS IEC 60034-1 and SANS 1804. The permissible temperature rise motors shall be in accordance with the limits specified in clause 4.2.3

The temperature rise of the stator windings shall be measured by the winding resistance method

3.2.1.1.3 Routine Tests

a. Each motor shall be tested at the manufacturer's works for no load current, vibration, locked rotor, insulation resistance, high voltage and winding resistances.

b. All motors larger than 200 kW shall be subjected to a no load bearing run for long enough to allow the bearing temperatures to reach equilibrium.

All routine tests shall be in accordance with SANS IEC 60034-1 and SANS 1804.

3.2.1.1.4 Test Certificates

a. The routine and type test certificates shall be submitted to the Employer for approval 30 days before the delivery date of the motors.

b. Type test certificates shall show power factor and efficiency figures calculated from the test results for 100 %, 75 % and 50 % of full load conditions.

c. Motor test results shall be recorded on the Employer standard form. The Supplier's template is acceptable if it is comprehensive and covers all the details required by the Employer.

3.2.2 Delivery, Erection and Commissioning

a. Delivery, erection and commissioning arrangement shall be as per contract conditions and agreed by both parties.

b. Motors shall not be delivered without agreement of readiness to receive them. Motors delivered without such approval may be returned at the Supplier's expense for later delivery at no extra cost to the purchaser.

c. Where erection and commissioning are specified in the contract, the following requirements shall be met.

3.2.2.1 Erection

a. When the motors are erected, care shall be taken to ensure interchange-ability with replacement motors.

3.2.2.2 Bearing Inspection

All motor bearings shall be inspected by the *Employer's* representative on site. On motors fitted with ball/roller bearings, the grease shall be examined prior to commissioning to ensure that it is not hard. If no roughness is felt when the shaft is rotated by hand and if the motor runs without undue noise or vibration, the bearings will be considered acceptable. If the bearings fail or exhibit the symptoms of brinelling during the guarantee period they shall be replaced by the contractor, free of charge and without delay.

3.2.2.3 Alignment

a. The motors, base plates and embedded parts shall be positioned by the party specified in the contract

b. After erection, the alignment of the half-couplings between the motor and the driven machine shall be measured.

3.2.2.4 Drying Out

a. The contractor shall satisfy himself that each motor is dry before it is connected to the supply. Any motor that fails as a result of being commissioned in a damp condition shall be repaired at the expense of the contractor responsible for commissioning.

b. Equipment and personnel to do the drying-out shall be provided by the contractor responsible for commissioning.

c. Failure of the contractor to achieve approval of the dry-out shall entitle *the Employer* to reject the motor concerned.

d. Motors ordered as spares shall be delivered to the specified store and need not be dried out by the Contractor provided the motors meet the approved criteria before despatch or on delivery, at the *Employer's* discretion.

3.3 DOCUMENTATION

3.3.1 Motor Documentation Requirement at Tender Phase

Detailed information and drawings to enable the Employer to make a complete and fair technical analysis of the tender/s shall be supplied for the proposed motor design. The required details shall include but not limited to the following:

a. Preliminary outline drawing indicating motor mounting dimensions, shaft height, shaft diameter and coupling detail, maximum overall dimensions, weight for total motor.

b. A completed Technical Schedule-A&B in Appendix C.

c. Grid code compliance requirements in Technical Schedule A&B (Template 240-77100923).

3.3.2 Motor Documentation Requirement After Contract Award.

The following information shall be provided by the Supplier to the Employer for detailed design review, comment, and acceptance:

a. Detail outline drawing indicating certified motor mounting dimensions, shaft height, shaft diameter and coupling detail, maximum overall dimensions, weight for total motor, interface location for terminal boxes (main power supply, auxiliary, and accessories). The rated kW output, speed, supply voltage, line current, frequency and phases shall be clearly shown.

b. Detailed drawings of the motor base plate showing full construction details with dimensions (where applicable).

c. Power winding diagrams and connection diagrams for auxiliaries (heaters, thermistors, PT100, etc).

d. A completed version of Technical Schedule-A&B that shall, where necessary, show revised data due to the motor detailed design.

e. Torque and Current versus Speed Curves for the motor at 100% and 90% motor rated voltage for motor. The torque versus speed curves shall include the driven load torque versus speed curve to show accelerating torque margins for motors 55 kW and above.

f. Efficiency and Power Factor versus Load Curves from 50% to 100% load, in 25% increments, at rated voltage.

g. Thermal limit curves for motors 55kW motors and above.

h. Start-up times and stall times of the motor at 100% and 90% of the rated voltage.

i. Nameplate drawing with all details to be contained therein.

j. A Quality Control, Inspection and Test Plan for Employer review, influence and approval.

k. An equivalency/interchangeability review for the new versus existing motor designs.

No manufacturing or delivery of motors should be allowed before the designs are finalized and accepted by the Employer. The Employer has the right to reject any motor delivered to site without the signed documentation mentioned above at the Supplier‘s cost

3.3.3 Motor Documentation Requirement prior to scheduled delivery

Information shall be submitted to the Employer for review and approval, and to prepare for motor installation and commissioning.

a. A copy of Installation, Operating and Maintenance Manual. Information contained in this manual shall include but not limited to:

   a1. Installation instructions.

   a2. Operating instructions, including starting limitations.

   a3. Maintenance requirements and data.

   a4. Instructions on how to completely disassemble and assemble the motor for major inspections, repairs and overhauls.

   a5. Replacement parts catalogue.

   a6. Storage requirements.

   a7. Trouble shooting guide.

b. Required Type test certificates and Routine certificates.

c. All signed drawings specified as required in 3.3.2

d. Signed Technical Schedule A&B (Template 240-77100923).

e. Signed Torque vs. speed curves and current vs. speed curves. Signed Efficiency and Power factor vs. load curves. Signed Thermal limit curves for 55kW motors and above

f. Signed Quality control plan.

The Employer has the right to reject any motor delivered to site without the documentation mentioned above at the Supplier‘s cost

3.4 LABELLING

All labels shall be in English and the wording is subject to Employer’s approval. Abbreviations to descriptions shall not be acceptable. Where abbreviations are unavoidable due to database field length limitations or limited number of characters available on labels, the abbreviations shall be in accordance with the Employer’s abbreviation standard. Labels for removable items shall be mounted alongside the item, and not fixed to the item itself.

4. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
[redacted]	Arnot Power Station – Motor Engineer
[redacted]	Camden Power Station – Motor Engineer
[redacted]	Duvha Power Station – Motor Engineer
[redacted]	Hendrina Power Station – Motor Engineer
[redacted]	Komati Power Station – Motor Engineer
[redacted]	Kriel Power Station – Motor Engineer
[redacted]	Lethabo Power Station – Motor Engineer
[redacted]	Tutuka Power Station – Motor Engineer
[redacted]	Manager Engineering - Electrical Design Application CoE
[redacted]	Group Technology Electrical – LV Switchgear Engineer

5. REVISIONS

Date	Rev.	Compiler	Remarks
November 2012	0.1	[redacted]	Draft Document for review created from 474-235
May 2013	1	[redacted]	Final Document for Publication
July 2016	1.1	[redacted]	1. Changes from Specification to Standard and Title 2. Changes in title page signatories from TDAC to SCOT 3. Appendix C Template removed and referenced as a separate Approved Template 240-77100923 to avoid duplication.
July 2016	2	[redacted]	Final Document for Authorisation and Publication Rev 2
September 2018	2.1	[redacted]	Changes in Table 2, Appendix B. No Review completed
September 2018	3	[redacted]	Final Document for Authorisation and Publication Rev 3

6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- [redacted] Group Technology – Electrical
- [redacted] Lethabo Power Station – EPE
- [redacted] Arnot Power Station – EPE
- [redacted] Group Technology – Electrical
- [redacted] Kriel Power Station – EPE
- [redacted] Komati Power Station – CED

7. ACKNOWLEDGEMENTS

None

APPENDIX A: MOTOR VOLTAGES

A.1 Motor voltages are normally based on the following table, but shall be as specified in Technical Schedule A&B (Template 240-77100923) of an enquiry document. Cable types and sizes shall be as specified in Appendix C: Technical Schedule A&B (Template 240-77100923).

Table 1: Motor Voltages

Rated output	Voltage rating
All AC motors below 1 kW	230V/400 V
1 kW to 200 kW or 1 kW to 355 kW	380V/400 V 525V/660V/690V

A.2 New (or upgrade) application requirements may deviate from this range. A life cycle cost shall be done for new applications and has to be approved by the Employer Engineer

APPENDIX B: MOTOR RATING CLASSES

B.1 The following table reflects the usual rating class, type of enclosure, and method of cooling applicable to motors for particular duties. The minimum enclosure rating shall be IP55. The dusty environments enclosure rating shall be IP65.

Table 2: Motor Rating Classes, Enclosures and Cooling Methods

1	2	3	4
Motors for	Rating class	Type of enclosure	Cooling method
a. Boilers Bulk oil pumps	(S1/S3)	For Zone 1: Flame-proof (Ex d) For Zone 2: Non-sparking (Ex nA)	IC 411
b. Turbo-generators Oil pumps	(S1/S3)	For Zone 1: Flame-proof (Ex d) For Zone 2: Non-sparking (Ex nA)	IC 411
c. Coal, ash, lime and soda plant material handling	(S1/S3)	IP65 for non-classified areas For Zone 21: Dust Ignition proof (Ex tD IP65) For Zone 22: Dust Ignition proof (Ex tD IP65)	IC 411
d. General purpose	(S1/S3)	IP 55	IC 411

APPENDIX C: TECHNICAL SCHEDULE A&B

Refer to Low Voltage Induction Motors Technical Schedule A&B Template Document number 240-77100923

APPENDIX D: STANDARD FORM FOR TYPE TEST CERTIFICATES

Eskom	TYPE TEST ACCEPTANCE FOR LV MOTORS Project Name: Project No:

PLANT DESCRIPTION										
DRIVEN MACHINE (Direct-on-Line)										
MANUFACTURER										
MANUFACTURER Serial No.										
DATE										
1A	Motor Details							Design data		Factory Test Data
A.1	Voltage (V)									
A.2	Frequency (Hz)									
A.3	Frame Size									
A.4	IP Code									
A.5	Connection									
A.6	Phase									
A.7	Uni/Bi directional									
A.8	Insulation class									
1B	Guarantees							Design data		Factory Test Data
B.1	Rated power (kW)									
B.2	Temperature rise (degrees)									
B.3	Rated current (A)									
B.4	Rated torque (Nm)									
B.5	Efficiency at rated load (%)									
B.6	Power factor at rated load									
B.7	Efficiency at 75% load (%)									
B.8	Power factor at 75% load									
B.9	Efficiency at 50% load (%)									
B.10	Power factor at 50% load									
B.11	Starting current ratio									
B.12	Pull-up torque ratio (%)									
B.13	Pull out torque ratio (%)									
B.14	No load current (A)									
2A	Type Tests									
2.1	Winding Resistance(Ω)							2.2 Hot winding temperature		
			Ambient Temp.°C	Phase to Phase				2.3 Winding Temperature rise		
				U - V	U - W	V - W		2.4 Bearing Temperature, DE		
	Stator Cold							2.5 Bearing Temperature, NDE		
	Stator Hot							2.6 Coolant water inlet temp		
2.7	Duration to attain thermal equilibruim			From .....h.....		To .....h.....		2.10 Coolant water inlet flow rate		
2.9	Reading at thermal equilibrium (direct loading)							2.11 Bearing coolant flow rate		
	Voltage	Current	Power in	Power Factor	Speed	Frequency				
								2.14 Losses at rated load		
2.12	Reading at different load point (indirect loading)							Friction and windage losses		
	Voltage	Current	Power in	Power Factor	Speed	Frequency		Core losses		
								Rotor copper losses		
2.13	Load Test With Motor Hot							Stator coper losses		
	Load %		0	25	50	75	100	Total losses		
		Voltage(V)								
		Current(A)						2.15 Overload		
		W1						% Overload		
	Power Input	W2						Overload time (s)		
		kW						Overload speed		
	Power Factor							No load current after test (A)		
	Speed R/Min							2.16 Overspeed		
	Efficiency									
2B	Power Quality							IEC 60034-1 and -2		Factory Test Data

APPENDIX E: STANDARD FORM FOR ROUTINE TEST CERTIFICATES

Eskom	ROUTINE TEST CERTIFICATE FOR LV MOTORS Project Name: Project No:

PLANT DESCRIPTION	
DRIVEN MACHINE (Direct-on-Line)	
MANUFACTURER NAME	
MANUFACTURER Serial No.	
DATE	

1A	Motor Details	Design data	Factory Test Data
A.1	Voltage (V)		
A.2	Frequency (Hz)		
A.3	Frame Size		
A.4	IP Code		
A.5	Connection		
A.6	Phase		
A.7	Uni/Bi directional		
A.8	Insulation class		

1B	Guarantees	Design data	Factory Test Data
B.1	Rated power (kW)		
B.2	Temperature rise (degrees)		
B.3	Rated current (A)		
B.4	Rated torque (Nm)		
B.5	Efficiency at rated load (%)		
B.6	Power factor at rated load		
B.7	No load current (A)		

2A	Routine Tests				
2.1	Cold Winding Resistance (Ohms)		2.2 Cold temperature (degC)	2.3 Heater resistance (ohms)	
	U - V			Heater Voltage (V)	
	U - W			2.4 RTD Resistance	(Ohms)
	V - W			U1	
				U2	
2.5	No load test at rated voltage			V1	
	No-load voltage (V)	No- load current (A)	No- load power (W)	V2	
				W1	
2.6	No load losses			W2	
	No load losses (W)	Friction and windage	Core losses (W) at rated volt	2.7Bearing insulation resistance	(ohms)
				Drive end	
2.8	Shaft voltage (V)			Non-drive end	
2.9	Vibrations		IEC 60034-9 and 14	Design data	Factory Test Data
	Drive End horizontal (mm/s)				
	Drive End vertical (mm/s)				
	Drive End axial (mm/s)				
	Non - Drive End horizontal (mm/s)				
	Non - Drive End vertical (mm/s)				
	Non - Drive End axial (mm/s)				
2.10	Final Bearing Temperature (degC)			2.11 Stator winding insulation resistance and HV test	
	Drive End	Non - Drive End	Ambient temperature	Stator IR (MΩ) 1Min at.....V	
				Stator IR (MΩ) 10 Min	
2.12	Rotation on Drive end	2.13 Run Down (min/sec)		High voltage test at.....V	
				Stator IR (MΩ) 1Min at.....V	
2.14	Locked Rotor Test at ..... Times Full Load Current			Stator IR (MΩ) 10 Min	
	Voltage(V)	Current(A)	Input Power(kW)	2.15 Noise level (dB)	
				Design data	Factory Test Data
2.16	Unsaturated Starting Torque(p.u.)				
2.17	Unsaturated Starting Current (p.u.)				

2B	Power Quality	IEC 60034-1 and -2	Factory Test Data
	Voltage unbalance (%)		
	Frequency deviation (%)		
	Total Harmonic distortion (%)		

APPENDIX F: DEVIATION SCHEDULE

DEVIATION SCHEDULE

1. Any deviations/modifications/alternatives offered to the standard 240-57617975 shall be listed below with reasons for the departures.

2. No deviations/modifications/alternatives offered to the standard will be recognised unless listed on this schedule.

If no deviations/modifications/alternatives are offered, this schedule must be marked N/A.

Standard Page number	**Standard Clause number**	**Proposed deviation/modification/alternative**

APPENDIX G: MOTOR DOCUMENT SUBMITTAL PROGRAMME

LOW VOLTAGE MOTOR DOCUMENTATION REQUIREMENTS												
DOCUMENT SUBMITTAL PROGRAMME				**PROJECT ACTIVITY**								
DETAILS OF ACTIVITIES				PRE-ENQUIRY REVIEW	TENDERING	DESIGN FREEZE REVIEW	FAT & MAINTENANCE DOCUMENTS REVIEW	FINAL INSPECTION/RELEASE REVIEW	INSTALLATION	PRE-COMMISSIONING REVIEW	ACCEPTANCE TESTING REVIEW	HANDOVER REVIEW
ID	**DESCRIPTION**		**DOCUMENT TYPE**									
1	Motor technical requirements (Works Information)		soft copy	E	E							
2	240-77100923: LV Motor IM Technical Schedule A&B Template (Completed Schedule A)		soft copy	E	E							
3	240-57617975: New Low Voltage Motors Procurement Standard		soft copy	E	E							
4	240-56360387: Storage of Electric Motors Standard		soft copy	E	E							
5	240-56361435: Transport of Power Station electric motors standard		soft copy	E	E							
6	Preferred motor suppliers/vendors list (Applicability based on contract strategy)		soft copy	E	E							
7	**Tender Returnable (Preliminary)**											
	7.1	Completed Motor Technical Schedule A&B Template 240-77100923	Hard and soft copy		T							
	7.2	Dimension outline drawings	Hard and soft copy		T							
8	**Final Design Documents (for review before manufacturing)**											
	8.1	Completed Motor Technical Schedule A&B Template 240-77100923	Hard and soft copy			C						
	8.2	Motor torque-speed curves for all motors	Hard and soft copy			C						
	8.3	Motor torque-speed curves superimposed on driven machine load curves for 55kW and above	Hard and soft copy			C						
	8.4	Motor current-speed curves	Hard and soft copy			C						
	8.5	Thermal-time curves (Motor damage curves for 55kW and above)	Hard and soft copy			C						
	8.6	Detail Dimension outline drawings	Hard and soft copy			C						
	8.7	Power winding diagrams	Hard and soft copy			C						
	8.8	Auxiliaries connection diagrams (thermistors, heaters, PT100, etc.)	Hard and soft copy			C						

	8.9	Quality control plan (For all Motors above 200kW)	Hard and soft copy			C							
9	**Manufacturing, Transportation and Storage (for review before equipment release)**												
	9.1	Type test report	Hard and soft copy				C						
	9.2	Routine test report	Hard and soft copy				C						
	9.3	Transport and storage procedures	Hard and soft copy				C						
	9.4	Installation, operating and maintenance manuals	Hard and soft copy				C						
10	**Motor Data Pack (final equipment documentation - Signed copies)**		Hard and soft copy										
	10.1	Completed Motor Technical Schedule A&B Template 240-77100923	Hard and soft copy					C				C	
	10.2	Motor torque-speed, current-speed, speed-time, thermal-time curves	Hard and soft copy					C				C	
	10.3	Dimension Outline Drawings	Hard and soft copy					C				C	
	10.4	Power winding diagrams	Hard and soft copy					C				C	
	10.5	Auxiliaries connection diagrams (thermistors, heaters, PT100, etc.)	Hard and soft copy					C				C	
	10.6	Quality control plan	Hard and soft copy					C				C	
	10.7	Type test report	Hard and soft copy					C				C	
	10.8	Routine test report	Hard and soft copy					C				C	
	10.9	Transport and storage procedures	Hard and soft copy					C				C	
	12.10	Installation, operating and maintenance manuals	Hard and soft copy					C				C	
11	**Commissioning**												
	11.1	Commissioning procedure	Hard and soft copy							C		C	
	11.2	Pre-, cold and hot commissioning report	Hard and soft copy								C	C	

C – Contractor
E - Employer
O - Others
T - Tenderer