TRANSNET ENGINEERING

BEST GENERIC PRACTICES FOR ROTATING MACHINES

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BEST GENERIC PRACTICES FOR ROTATING MACHINES

SUMMARY OF REVISION

First issue – 12 MAY 2009 pd perm nat prac 003 Rev00
Second ISSUE – 09 March 2011 PDPERM NAT PRAC 003 Rev 01
Third issue-06 March 2017 PDPERM NAT PRAC 003 Rev 02
Fourth issue – 06 June 2017 PD_PERM_NAT_PRAC_003 Rev 03

The following revisions have been made in this version:

Change	Description
Pg 8	Scope 1.2 To all motors AC and DC within Transnet
Pg 40	5.2.2.1. Where water based primer is used paint inside and outside of frame, allow to dry then paint inside with white air drying varnish and allow to dry.
Pg 41	54.1 Storage procedure PD_COMP_NAT_PROC_066
Pg 1 & 48	Transnet Engineering logo added
All pages	Removed “Rail”

Document Control

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Supporting Procedure	

1. SCOPE

1.1. This standard specification describes the requirement for the contractor/Repairer:

1.2. To cover the division of Transnet Engineering's requirements for the refurbishment of all AC and DC electrical motors used on Transnet Engineering

1.3. To form an integral part of a contract between Transnet Engineering and the Repairer laying down an acceptable standard to which these motor's repair shall comply.

1.4. To supply additional technical information relevant to these motors (not available in catalogues and manuals) relating to a specific repair standard.

1.5. To assist Quality Assurance personnel to maintain and monitor crucial areas, determinate to the correct repair methodology of these motors.

1.6. The repairer must implement a quality system; based on Code of Practice SABS ISO 9000 to ensure that work of a quality acceptable standard to the client is delivered.

1.7. This specification supersedes all other specifications on the refurbishment of motors.

1.8. For the overhaul of specific AC and DC motors, the repairer will be required to read this specification in conjunction with Transnet Engineering's and OEM Maintenance Catalogue and Manuals.

1.9. This specification must be read in conjunction with Specification PD COMP NAT SPEC 781 outlining the procedure to be followed for sending motors to private contractors for repairs

1.10. The Approved Repairer is required to contribute constructively throughout the repair process and motivate fully any deviation or contributions considered necessary.

1.11. Transnet Engineering reserves the right with prior arrangement with the repairer to inspect, audit and monitor any individual motor, or process relating to the repair of the motor.

1.12. Technology Ownership

1.12.1. The Tenderer shall prove his right of ownership or delegated authority of the work done. If the tenderer chooses to use sub-contractors, then he is expected to declare these in full detail as required in this specification. All detail as required in the above clause shall also apply to the sub-contractors.

1.13. Approved Materials

1.13.1. Transnet uses an approved list of material. Tenderers are to state their acceptance to this. Refer to Policy PD PERM NAT POL 516.

1.14. Engineering Support

1.14.1. The Tenderer must state the level of its support and identify who will be providing support.

1.15. Warranties

1.15.1. Warranties must be included in pricing of the repaired product.

2. FAILURES

2.1. The Repairer shall evaluate each failure and maintain records pertaining to serial number, type, date, failure mode. These records shall be made available to Transnet Engineering

3. DEFINITIONS

3.1. Electrical machine: is any rotating electrical motor used on electrical and Diesel locomotives.

3.2. Stator/Frame: a term used on AC and DC machines made from steel casting, carefully machined to ensure accurate alignment of the endshields and pole bores

3.3. Rotor/Armature: a term used for the rotating part of the motor on AC and DC motors.

3.4. End shield: the casting attached to the end of the stator. They house the bearings in which the armature runs.

3.5. Spigot: The part of endshields which guides it into the magnet frame in order to centralize it when it is bolted to the magnet frame.

3.6. N.D.T. (Non Destructive Testing): This is a method used to perform evaluations on a piece of material or structure to determine the presence of cracks that could affect serviceability.

3.7. Chamber: The casting attached to the non drive end of the magnet frame that houses the commutator and brushgear, as well as the armature bearing.

3.8. Main field: Field system that consists of main poles fitted inside the magnet frame, this system provides the magnet field for the torque output.

3.9. Interpole: Field system that consists of commutating poles or interpoles fitted inside the magnet frame, this system ensures satisfactory commutation of the current at the brushes.

3.10. TIR: Total Indicated Run Out

3.11. Bearing housing: Bore at the centre of the endshield that houses the bearing

3.12. Machinery vibration: Is the back and forth motion of machines mechanical components (around the rest position) as they react to internal or external forces.

4. REFERENCES

4.1. SABS ISO 9000: Code of Practice for Quality Systems.
4.2. SABS IEC 34: Numerous Parts
4.3. ISO 1940 - 1: Balancing of rigid rotors.
4.4. BS 4999 PART 101 - Rotating and Performance.
4.5. BS 4999 PART 112 - Starting Performance.
4.6. BS 4999 PART 142 - Standard Dimensions.
4.7. SABS 04 0242 - 1: The rewinding and refurbishing of rotating electrical machines.
4.8. SABS 1561 - 1: 2006: The rewinding and refurbishing of rotating electrical machines.
4.9. SABS IEC 60349
4.10. Rotating Machine Manuals and Drawings as held by Transnet Rail Engineering.
4.11. RS/EE/SP/014: Cleaning compounds used on Electrical Rotating Machinery in Traction Locomotives user Specification
4.12. RS (E). P0006.95: Engineering Practice for commutator Riser condition in service
4.13. RS (E). P0001.94: Engineering Practice for obtaining Feinpruf Recordings of commutators.
4.14. PD PERM NAT PRAC 001: Engineering Practice for Dielectric Evaluations: Traction related Rotating Machines: Electrical Insulation: High Voltage Withstand tests.

4.15. RS(E).P0007.95: Engineering Practice for Armature Band condition in Service

4.16. RS/W 435/March/1: Quality Assurance Specification

4.17. RT/TE/PR/002: Engineering Practice for the Surface Conditioning of Seamless PTFE Vee Ring

4.18. RS (E).P0014: Engineering Practice for Hand Bevelling of Commutator Segment Edges.

4.19. RS (E).P0002.93: Traction Engineering procedure for Jointing and termination of H.V. Cables on Locomotives.

4.20. RSE/TE/PRO/0016: Procedure for Brush(Dalic) Plating Repair of Traction motor shafts

4.21. RSE/TE/PRO/0015: Procedure for the thermal Spraying Repair of Traction Motor shafts

4.22. RSE/TE/PRO/0020: Procedure for the welding of Traction Motor Shafts.

4.23. RT/TE/SPC/0151: General Specification for the Storage of Rotating Machines

4.24. RT/TE/SPC/0157:General Specification for the Transport of Rotating Machines

4.25. Refer to Procedure PD PERM NAT PROC 762. Procedure for the torqueing of commutator bolts on traction and auxiliary armatures

4.26. Refer to Specification PD PERM NAT POL 516 High Level View of Accepted Insulation Systems

4.27. Engineering's Specification number PD COMP NAT SPEC 585: Armature Tig welding Procedure

4.28. PD COMP NAT SPEC 583. Vacuum Pressure Impregnation Specification

4.29. PD_PERM_NAT_PROC_681 Curing of Components after VPI

4.30. PD_PERM_NAT_PROC_727 Procedure of Management Control Systems of Testing Resin in VPI Tanks.

4.31. PD PERM NAT PROC 764 Pinion Fitment On Procedure.

5. REQUIREMENTS FOR REWINDING AND REFURBISHING

5.1. Numerous manuals and drawings have been purchased from the OEM's at considerable cost and this information lies in cupboards at various workshops without being used. This information should be available to managerial/supervisory personnel under controlled conditions.

5.2. CLEANING AND INSPECTION FOR REWINDING AND REFURBISHING

5.2.1.1. Protective equipment. The equipment used must comply with the requirements of the following SABS Standards, as relevant:

5.2.1.2. SABS 434 (Protective clothing, e.g. overalls);
5.2.1.3. SABS 492 - 2 (Rubbing gum boots);
5.2.1.4. SABS 1404 - 1 (Face shields);
5.2.1.5. SABS 416 (Gloves);
5.2.1.6. SABS 0220 (Respirators or filtering masks).

5.3. Initial Cleaning

5.3.1.1. On receiving a motor for rewinding and refurbishing, cover the air inlet and outlet openings in the motor frame to prevent ingress of dirt. Clean exterior surfaces, to remove grease, oil, dirt and any contaminants. Avoid forcing air inside the motor to ensure that the bearings, armature and motor fields are not contaminated during this process.

5.3.1.2. After exterior cleaning, remove the protective covering from the motor openings.

5.3.1.3. Using compressed air in conjunction with vacuum, blow out the interior of the motor to remove all possible carbon dust, (where applicable) road dirt.

5.3.1.4. Care should be taken that the winding is not damaged due to the force of the compressed air jet. For this method of cleaning, at least a face shield and respirator or a filter mask should be worn.

5.4. Visual Inspection (Exterior)

5.4.1.1. Visually inspect it for any signs of external damage to the frame, feet and terminal box. Check the shaft to see if it can be rotated easily. Inspect for missing items.

5.4.1.2. Inspect to see that Magnet frame is not cracked or distorted.

5.4.1.3. Inspect to see that end shields or bearing housings are not cracked or distorted.

5.4.1.4. Inspect to see if insulation damage is present on all leads and that lugs are nor damaged and that leads are correct length.

5.4.1.5. Inspect to see that inspection covers are not damaged or missing.

5.4.1.6. Inspect to see that Protection grids are not damaged or missing.

5.4.1.7. Inspect to see that inlet grid is not damaged or missing.

5.4.1.8. Inspect to see that Inlet duct is not damaged or missing.

5.5. Visual Inspect (Interior)

5.5.1.1. Visually inspect commutator – PTFE Vee Ring for burnt or damaged. See Engineering practice RT/TE/PR/002

5.5.1.2. Inspect commutator out of round if greater than 80 microns turn commutator in lathe or grind in situ (See spec P0001.94)

5.5.1.3. Check commutator mica depth if less than 1, 00 mm undercut commutator.

5.5.1.4. Inspect brush gear stand off insulators. If damaged replace or repair.

5.5.1.5. Inspect brush gear fingers. If flash over damaged replace.

5.5.1.6. Inspect brush gear pressure fingers. If damaged replace.

5.5.1.7. Inspect brush box body. If light flash over damage clean or repair. If extensive flashover damage replace.

5.5.1.8. Inspect arc horn gaps.

5.5.1.9. Inspect band condition. If loose send for stripping and rebanding.

5.5.1.10. Inspect pinion end bearing clearance. If excessive replace bearing

5.5.1.11. Inspect pinion end bearing for axial clearance. If excessive replace bearing.

6. RECORD/CHECK SHEET

6.1. For each motor, use a suitable record sheet to record all the results of inspection and also record all the necessary information marked on the nameplate of the motor. Use the same sheet to record all other

necessary details throughout the process of rewinding and refurbishing of the motor.

6.2. The following information to be available from the owner of the asset:-

6.2.1. Client
6.2.2. Stator /armature numbers
6.2.3. Reason for removal
6.2.4. Locomotive/Coach number
6.2.5. Date of removal

7. PRINCIPLES APPLICABLE TO STRIPPING AND ASSEMBLY OF MOTORS

7.1. If a traction motor is damaged as a result of derailments the bearing and axle bores must be carefully evaluated for distortion on approved measuring equipment. This will include line boring assessment.

7.2. Should a motor pass all electrical and mechanical tests as stipulated in Clause 5.4and 5.5. then a light repair may be possible whereby the motor will need a clean out only and must be prepared for service as per clause 53of this specification.

7.3. Should a motor fail stipulated electrical and mechanical tests as stipulated in Clause 5.4/ 5.5 and 12 then a decision will be made to determine whether the motor will be a medium or heavy repair. A medium repair would constitute as motor been stripped of the endshields and armature/rotor and repairs been carried out to any mechanical component and an electrical repair been carried out to 1 or 2 field and IP coils in the case of D.C. A heavy repair would constitute the armature/rotor been rewound and the replacement to 2 or more field and IP coils in the case of D.C. and rewinding the stator in the case of A.C. Should this be determined then the motor will proceed as per clause 6 onwards.

7.4. All shaft / pinion breakages shall be sent to PD Business for metallurgical assessment.

7.5. If the stator was assembled less than 2 years ago then the bearings must be removed using special bearing removal tools (heating rings) for the bearing inner and press for the outer races. The use of gas in this instance is unacceptable.

7.6. All parts that are stripped must be marked with a tag so that parts can be returned to the machine they were removed from.

7.7. Every endeavor must be made to re-assemble the motor unit using the same components that came off the motor when it was stripped.

7.8. Stator and end shields must be kept as a unit unless one of them is so badly damaged that it must be renewed.

7.9. If a new end shield is fitted, it must be marked and punched with the stator number it is being matched to.

7.10. If a new end shield is fitted, the requirements necessary for line boring, (see section 17) must be adhered to.

7.11. Poles, pole pieces, fan impellers, etc. need not be, identified by punching, but must be identified with tags during the motor repair period.

7.12. All bearings must be renewed and fitted with the maker's number showing on the outside.

7.13. All parts not immediately used, must be properly cleaned, protected against rust, covered and stored in a suitable place to avoid re-contamination, damage to parts.

7.14. The pinion or coupling must be removed slowly in accordance with best practices without distorting the pinion or shaft.

8. DISMANTLING OF MOTOR

8.1. Marking of end shields and bearing axle keeps

8.1.1.1. Before dismantling the motor, punch or stamp identifying markings on the end shield and the magnet frame, on both the driving end (DE) and the non-driving end (NDE) of the motor, thus ensuring correct location of each end shield with respect to the stator. The endshields and bearing/axle keeps are to be tagged with stator number for later matching at reassembly with the same stator.

8.2. Dismantling the rotor/ armature from the stator

8.2.1.1. Dismantle the motor carefully, ensuring that the end shields are very evenly separated from the magnet frame, using stud removal facilities. Take extreme care to prevent damage when mating flanges are being separated. Leave the fan on the rotor (unless it is obviously loose).

8.2.1.2. **NB:** Do not use Tommy bars or heavy copper hammers.

9. REMOVAL OF BEARINGS

9.1. These bearings are mounted with an interference fit on the shaft and must be dismantled using a conventional puller or a vertical press to remove the bearing from the endshield housing. The puller must engage the inner ring. Remove the bearing with a steady force until the bearing bore completely clears the entire length of the cylinder seat. If it is not possible to engage the inner ring with the puller, then apply the puller to the outer ring.

9.2. The outer ring must be rotated during dismantling and this can be done by locking the screw and turning the puller continuously until the bearing comes free.

9.3. **Handling of components disassembly:**

9.3.1.1. Apply acceptable identifying markings to the stator, the rotor/armature and all other mechanical components. Keep all the components in a bin or container that is marked that it can be positively distinguished from other bins or containers in which components of other motors are being kept. The minor components comprising wipers, bearing caps, bolts, covers must be placed in the special container for later matching with stator on reassembly if the motor was classified as operational and devoid of damages mentioned above. The reason for consolidating these parts is in order to ensure they are not damaged as they came in working it is expected that they are in good condition for re-assembly.

10. INSPECTION OF WINDINGS BEFORE CLEANING (ROTOR AND FIELD SYSTEM)

10.1. Visually inspect the winding and check for the following:

10.2. Any visible electrical/mechanical defects (See 5.4, 5.5).

10.3. Moisture in the stator frame.

10.4. Grease or oil.

10.5. Excessive dirt and other contaminants (e.g. carbon black, metallic dust and chips) that make it difficult to assess the condition of the winding.

11. CLEANING OF ALL COMPONENTS OF MOTOR

11.1. Cleaning shall be carried out by an experienced operator wearing properly designed, modern and effective protective equipment as described in 11. Any cleaning will be conducted in areas which are ideally suited for the purpose and environmentally acceptable. All electrical products being cleaned shall be lifted off the ground and be free of sludge type material.

11.2. Use the following method of cleaning:

11.3. Steam cleaning;

11.4. A winding that is saturated with oil, dirt and grease can be effectively cleaned by means of a steam cleaning method (which sprays a high velocity jet of steam and water that may contain a mild detergent). If the detergent is found to be necessary, the recommendations of the varnish manufacturer and the wire manufacturer shall be followed. All cleaning products must not cause detrimental damage to copper, steel, insulation aluminium and must be recommended by the supplier for these purposes.

11.5. It is important that during cleaning, grease, oil, dirt and other contaminants be removed from the winding surfaces and also from mechanical components.

11.6. A winding that has been cleaned with the help of a solvent shall be thoroughly rinsed with steam or shall be water blasted to remove all traces of solvent. During either of these methods of cleaning, the necessary protective equipment described in 5.2.1.1should be worn. Care should be taken that the winding is not damaged due to the force of the water - blast jet.

11.7. All the air vent ducts of the motor should be cleaned by means of either water blasting or compressed dry air, care being taken that the winding is not damaged due to the force of the compressed air jet. For this method of cleaning, at least a face shield and a respirator or a filter mask should be worn.

11.8. After cleaning the winding and components, dry the winding by heating it in an oven to a temperature not exceeding 150°C (and in the case of a winding with Class B insulation, to a temperature not exceeding 120°C) for at least 8 hours, ensuring that the insulation is not damaged during the drying period Refer to Specification number PD PERM NAT PROC 680. After drying, visually inspect the winding for the typical types of failure described in clause 12.2,12.3,12.4. Examine the mechanical

components for wear and damage in accordance with clause 14, and submit the winding to the electrical tests described in clause 31.

11.9. Torque commutator bolts to correct value. Refer to Procedure PD PERM NAT PROC 762.

11.10. In order to confirm that the cleaning process is adequate a white clean lint free cloth should be rubbed across/inside any or all, parts cleaned. The cloth should remain white and dirt free.

11.11. All steel surfaces must be protected whilst in process from rusting.

11.12. Tectyl if it will not be worked on for a month.
11.13. Densol Tape less than a month.
11.14. Oil wipes less than a week inside the shop.

11.15. No rust shall be observed on any mating surfaces at any time in the shop.

12. INSPECTION OF STATOR /ROTOR AND ARMATURE WINDINGS FOR TYPICAL TYPES OF FAILURES

12.1.1. 11.1Preliminary inspection guidance:

12.1.1.1. Any visible electrical defects, rewinding may be necessary. In this case, proceed in accordance with section 31. Any visible mechanical defects, submit the winding and components for cleaning in accordance with 11.

12.1.1.2. No visible electrical or mechanical defects use the apparatus described in SABS 0242-1: 1999 section 4.8.2.1.1 to check whether the winding is earthed.

12.1.1.3. If the measured insulation resistance is found to be very low (Less than kV+1) after stoving and temperature compensated. Refer to specification PD PERM NAT PRAC 001 for values, rewinding may be necessary. Proceed then in accordance with section 31 and submit components other than the winding for cleaning in accordance with 11.

12.1.1.4. If the measured insulation resistance is found to exceed minimum values as per PD PERM NAT PRAC 001, consider the winding not to be earthed. In this case, submit the winding and components for cleaning in accordance with clause 6.1 and 6.2 of SABS 0242-1 1998.

12.2. Stator

12.2.1. Winding single-phased (star or delta connected);
12.2.2. Winding shorted phase-to-phase;
12.2.3. Winding with interturn insulation failure;
12.2.4. Winding open - circuited;
12.2.5. Winding earthed at end of slot;
12.2.6. Winding earthed in the slot;
12.2.7. Shorted connection;
12.2.8. Phase damage due to unbalanced voltage;
12.2.9. Winding damage due to overload;
12.2.10. Winding damaged due to locked rotor;
12.2.11. Winding damaged due to high voltage surges;
12.2.12. Stator core laminations damaged due to rubbing by the rotor;
12.2.13. Defective welded joints in the stator casing.

12.3. Rotor

12.3.1. Cracks in rotor bars;
12.3.2. Cracks in rotor end rings;
12.3.3. Evidence of overheating due to overload or locked rotor as indicated by any discoloration of rotor bars, laminations or both;
12.3.4. Loose laminations or missing teeth in the rotor;
12.3.5. Excessively damaged or worn slip rings/commutator;
12.3.6. Worn or damaged rotor core pack.

12.4. Armature

12.4.1. Winding burnt C.E. Side
12.4.2. Winding burnt P.E. Side
12.4.3. Winding burnt in slot
12.4.4. Winding centrifuged
12.4.5. Winding low meggar reading
12.4.6. Banding unraveling
12.4.7. PTFE sleeve loose
12.4.8. PTFE sleeve burnt
12.4.9. Commutator burnt segments
12.4.10. Shaft broken
12.4.11. Core damaged

13. Record/Check sheet

13.1. After the visual inspection, record (on the individual record sheet of the motor) the types of failure, if any found.

13.2. If one or more of the typical types of failure are found in the winding, determine whether rewinding is necessary or not. Refer to Clause 4.6.1 and 4.6.2. of SABS 0242-1 1998

13.3. If no failures are found in the winding, proceed in accordance with section 44.

14. INSPECTION OF MECHANICAL COMPONENTS FOR WEAR AND DAMAGE

14.1. The repairer must be equipped with all gauges, measuring instruments, etc. necessary to establish the correctness of crucial areas of motors to the relevant technical data.

14.2. The measuring instruments, gauges, etc. must have been verifiable calibration traceability and must form part of the repair process. The repairer will be responsible for verifying these values.

14.3. Micrometer, calibrated setting pieces and article to be measured must be kept in the same room (or workshop) where they will be at equal temperature. At least 12 hours must be allowed when a component enter the workshop from another workshop or area which is at different temperature.

14.4. All equipments (calibrated setting pieces as well as instruments) to be protected against dust rust and must be clean. A special storage facility, which must be close to the workshop, must be arranged therefore.

14.5. The workshop where work is undertaken must be so that relative stable temperature is experienced, and the temperature in one part of the workshop must not differ from other areas.

14.6. Measurements must be taken during the part of the day where changes, in workshop ambient temperature is the lowest.

14.7. Where critical components are manufactured (i.e. armature shafts) measurements of critical dimensions for final acceptance must be made in a temperature controlled room.

14.8. In addition to the inspections carried out in clauses 5.4– 5.4 and 6 and 12carry out the inspections as in clauses 13 and 16 and record the findings.

15. PERSONNEL REQUIREMENTS

15.1. Only trained personnel's may take and record measurements according to this specification. This training must be to standard so that repeatability can be guaranteed for tolerances specified.

15.2. A suitable qualified and trained person must be appointed to act as custodian of all measuring equipment kept in the workshop. He must ensure that all equipment remain in good condition, is calibrated at least 1/year and all record keeping.

15.3. Workshop management must ensure that trained backup staff is available.

16. MEASURING PROCEDURE

16.1. Where 10 micron (10µ) accuracy is required, a three digit instrument, certified to ± 3 microns, must be used.

16.2. Where one micron (1µ) accuracy is required, measurements must be taken at centers where work of this nature is concentrated. A three point snap gauges for shafts (outside diameter measurements) and 3 point bore micrometer for housing (and inside diameter measurements) must be used. These instruments must have 0,5 micron capacity(minimum requirement)

16.3. During measuring, the measuring instruments should be re checked against calibrated setting piece. As measuring proceed, the time between re-checking must not exceed 30 mins.

16.4. When measurement(s) is undertaken in a temperature controlled room, the equipment to be measured, the calibrated setting piece(s) as well as the measuring instrument(s) must be allowed to stabilize for at least 24 hours.

16.5. Visually inspect the mechanical components for typical damage such as:

16.5.1. Cracked or distorted end shields, damaged spigots and securing holes;
16.5.2. Damaged bearing housing covers;
16.5.3. Damaged flange of flange mounted motor;
16.5.4. Bent or damaged extension shaft;
16.5.5. Damaged keyways of extension shaft;
16.5.6. Broken or missing fan blades;
16.5.7. Fan loose on the shaft;

16.5.8. Damaged fan cowl;
16.5.9. Damaged securing bolts/studs, nuts and washers of end shields and grease covers;

16.6. In the case of a DC motor or slip-ring motor, excessively worn brushes and damaged brush boxes;

16.7. Damaged terminals, terminal blocks, terminal box cover and gaskets;

16.8. Damaged grease nipples (end shields);

16.9. If more than 10% fretting corrosion on the bearing seating of the shaft and the end shields.

17. MAGNET FRAME (HEAVY REPAIRS ONLY)

17.1. After all necessary electrical test have been carried out, the main field and interpole coils, brushes and brush gear must be removed in the case of heavy repairs. Clean magnet frame with clean hot water (75°C±5°C) and dry with compressed air/ or oven at a temperature less than 80°C. This is followed by shot blasting the frame. Care should be taken that the mounting face of the main poles, interpoles, spigot faces, u tube faces and mounting faces of the endshields are protected before the shot blasting.

17.2. Use dye penetrant detection method to check for any cracks. If cracked Transnet Rail Engineering's Product Development Department must advise the type of welding necessary. Unauthorized welding must not be undertaken as this will interfere with the magnetic properties of the frame and may result in changes of commutation characteristics. This may also distort the frame.

17.3. Inspect U tube faces for any damage. If damaged repair with a suitable process approved by Transnet rail Engineering Product Development. U Tube faces must be brought back to required specification.(See relevant drawings or Maintenance Manuals)

17.4. Inspect holes of mounting bolts of the field system for any damage. If damaged repair with a suitable process approved by Transnet rail Engineering Product Development. Holes must be brought back to required specification.(See relevant drawings or Maintenance Manuals)

17.5. After the bearing has been removed from the end shield/ commutator chamber or endshield and cleaned, mount pinion endshield and commutator chamber/endshield to magnet frame and set up magnet frame as for line boring and measure for the following:

17.6. Distance between the bearing outer ring abutment shoulders. If distance between bearing abutment shoulders do not comply with specification, endshields and magnet frame must be measured up to determine which component must be replaced.

17.7. With the commutator endshield removed and pinion endshield mounted measure:

17.8. The run out between the main field coil and interpole pads in relation to the centre of the pinion endshield bearing bore

17.9. The flatness of the main field pole and interpole pads

17.10. Measure from the centre of the main field coil pad to the mounting faces of the pinion endshields and commutator endshield/commutator chamber.

17.11. Refer to applicable maintenance manuals and drawings for all dimensions.)

18. LINE BORING

18.1. The line boring method been used, must be evaluated and approved by Transnet Engineering, Product Development and Supplier Evaluation Services.

18.2. Before line boring, ensure that all components which were exposed to a welding process, is stress relieved as approved by Met. Lab

18.3. Ensure that magnet frame and endshield/commutator chamber complies dimensionally with drawings (except the bearing bore of the endshields and spigots faces of the end shields of the magnet frame which must be 2mm undersize.

18.4. Before line boring ensure all mating faces are clean and smooth

18.5. The endshields/commutator chamber must be mounted in position to the magnet frame.

18.6. Use the U-Tube face as a reference line

18.7. Ensure that all reference points and centre lines are correct in relation to the magnet frame and end shields.

18.8. Machine the bearing bore of the endshields/commutator chamber to specification.

18.9. The line boring process must be such that once the machine is set up and machining starts from the one end, (commutator) the machining must end without turning the magnet frame around.

18.10. This process must be done in an environment and where the temperature changes do not differ more than 5°C. All measuring instruments must have proof of calibration certificates.

18.11. The machine used to perform the line boring process, must have proof of regular maintenance and calibration certificates.

19. BEARING CAPS

19.1. Bearing caps must be machined on the frame and then carefully marked clearly with the frame number.

19.2. The number should be about 20 mm high either by welding or deep (2mm) engraving.

20. END SHIELD

20.1. Measure the inside diameter of each bearing end shield for the following :

20.2. Nominal diameter;

20.3. Cylindricity (taper) of the bearing seat;

20.4. Surface roughness of bearing seat.

20.5. Take at least three measurements approximately equally spaced from one another. See also applicable overhaul manuals whether each bearing end shield is still within the specified tolerances. Measurements must be taken and recorded as per SKF and FAG accepted procedures in South Africa. IT Values to be checked.

20.6. Measure spigot of endshield as well as frame internal dimensions

21. CLEANLINESS

21.1. All metal filings/shavings must be removed after any welding or / and machining.

21.2. It is advantageous to clean the product with a solvent to remove any oils such as that used initially.

21.3. A magnet could ease the cleaning process

22. EXTERNAL CABLES

22.1. The grommets which protect the cables where they go through the frame must fit both the cable and the frame. That is the internal diameter of the grommet must be the same as the outside diameter of the cable.

22.2. The frame must be cleaned with an etching compound and the area the covered with silicone.

23. FIELD COILS

23.1. Before any work is commenced the following information is critical

23.1.1. Mechanical:

23.1.1.1. Copper cross sectional area.

23.1.1.2. Any rewound copper must conform to original size.

23.1.1.3. Critical dimensions of outer length and outer width with tolerances

23.1.1.4. The gap between adjacent coils should be checked as some coils are very close and this will affect the tolerancing of sizes.

23.1.1.5. Critical dimensions of inner length and inner width with tolerances in order to ensure copper and insulation are close to the pole piece.

23.1.1.6. The dimensions of different coil layers being consolidated may not differ by more than 0.5mm overall in either the length or width. This dimension may vary if the coil design allows for steps in the layers.

23.1.1.7. No copper turn within the layer may vary out of the cross plane by more than 0.5mm unless the design includes a radius.

23.1.1.8. Radii of inner corners.

23.1.1.9. Position of lug, lead positions

23.1.1.10. Lead cross sectional area.

23.1.1.11. Pole piece threads

23.1.2. Electrical:

23.1.2.1. The voltage to earth. This should consider the number of motors connected in series.

23.1.2.2. Megger to pole piece and frame side of coil

23.1.2.3. Hi Pot to pole piece and frame side of coil

23.1.2.4. Surge test and characteristic trace

23.1.2.5. Resistance value and tolerance then thermally compensate if necessary. Resistance should be ± 3% normally.

23.2. Any coils which weigh more than 15 kg must be placed into the carcass with appropriate lifting equipment.

23.3. The brush boxes must be aligned in a frame with appropriate gauges.

23.4. The gap between the two main field pole pieces at the PE and CE shall be measured between every pole piece and information. This

information shall be documented and the standard deviation shall be less than 0.3 mm. The skewness must also be less than 0.3 mm. This measurement should be undertaken on the first 7 motors in order to ensure the process is correctly undertaken and thereafter every 15 motors.

23.5. The centre of a brush must be aligned with the centre of the main field coils.

23.5.1. Some pole pieces have pins which align them.

23.5.2. Other frames may have holes drilled accurately in the frame and coil securing bolts/studs have very little clearance so that the coil is accurately positioned.

23.5.3. Other coils need to be accurately aligned with the use of special equipment. The coils need to be tangentially positioned within 0.2 mm of the pole piece centre line and skewness axially to be less than 0.2 mm. The final position of the pole pieces can be checked by either measuring the centre point of one pole piece to another or/and measuring the gap between adjacent pole pieces.

23.5.4. The internal dimensions between opposite pole pieces both at DE and NDE should be measured and the tolerance is about o.3mm unless otherwise specified

23.6. Coils should be located firmly between the pole piece and the frame to improve thermal transfer

23.7. Coils should be secured to the pole piece to improve thermal transfer.

23.8. Bolts and studs must be carefully selected in respect of length, magnetic qualities, torque.

23.9. All bolts and studs must be secured as required. Normally welding a bar onto the frame across the flat is preferred

23.10. Bolts on top of the frame must be sealed with silicone.

23.11. Shims must be selected as required in order to attain the correct airgap and commutation.

24. SHAFT

24.1. Measure the outside diameter of each bearing journal for the following:

24.1.1. Nominal diameter;

24.1.2. Cylindricity (taper) of the bearing seat;

24.1.3. Surface roughness of the bearing seat;

24.2. Where possible the rectangularity of the abutment shoulder to the bearing seat.

24.3. Take at least three measurements approximately equally spaced from one another. Measurements must be taken and recorded as per

SKF and FAG accepted procedures in South Africa. IT Values to be checked.

25. IF DURING VISUAL INSPECTION AND THE MEASURING OF END SHIELDS AND SHAFT, THERE ARE:

25.1. Any visible defects as described in clause 24 is present, the shafts must be renewed, as per specification PD_COMP_NAT_SPEC_SHAF_514B if the steel is not EN 19, 25, 26. If it is EN 19, 25, 26 then it must be renewed.

25.2. End shields must be welded and machined in accordance with a specified procedure provided and made available by a recognized welding expert.

25.3. Any end shield and shaft measured as described in clauses 20 and 24 and does not comply with the specified tolerances, the shaft must be renewed and the end shield must be repaired in accordance with clause 26.

26. REPAIR BEARING BORE OF END SHIELDS

26.1. To repair the bearing bore of the end shield, use one of the following acceptable engineering practices:

26.1.1. **Fit of steel sleeve (aluminium end shields)**

26.1.1.1. The dimensional tolerances of the steel sleeve and bearing bore of the end shield must be such that the correct interference between the steel sleeve and the bearing bore of the end shield must be obtained. This interference must be documented in detail. The thickness of the sleeve used, should correspond to prescribe dimensions (this office can be approached) to ensure that the strength of the end shield's bearing bore is not compromised.

26.1.1.2. Fit of rencoll tolerance rings (aluminium end shields)

26.1.1.3. The approved supplier of these tolerance rings can be approached for correct guidance in conjunction with Transnet Rail Engineering Product Development.

26.1.2. **Metal arc spray (aluminium and steel end shields)**

26.1.2.1. This technology is the latest and is mainly used to build up the bearing bore of steel end shields. If the wall thickness of the bearing bore of a aluminium end shield is to thin to obtained the correct interference between a steel sleeve and the bearing bore, this method can be used to build up the bearing bore with metal. The method in (4.1.9.2) can also be used.

26.1.2.2. After the repair of an end shield, proceed in accordance with clause 18.

26.1.2.3. NB: When the metal arc spray method is used, the "Metallurgist Engineering Department" of Transnet Rail Engineering product Development must be approached for an approved specification.

27. REPLACEMENT AND REFURBISHED END SHIELDS

27.1. All new end shields and refurbished end shields must comply with the original manufacturer's drawings/specification. If the drawings or specification are not available, this office can be approached. If aluminium

27.2. end shields must be replaced, they must be replaced with steel casting end shields. Proceed in accordance with 5.2.1.

27.3. **<u>Line boring of end shields</u>**

27.3.1. Any new end shield or an end shield of which the bearing bore must be brought back to the specified tolerances, the bearing bore of the end shield must be machined to 1mm undersize of the specified minimum diameter of the bore. The drive and non-drive end shields must be mounted in position to the stator and must be with an acceptable line boring method (approved by this office) be line bored.

27.4. With the end shields still in the mounting position to the stator, ensure that the axial and radial run out between the drive and non-drive end shield is to specification.

28. AIR GAP

28.1. Measure the inside of the stator core and measure the outside diameter of the rotor/armature. In each case take at least three measurements approximately equally spaced from one another. Check for compliance with design data, if available. See also Transnet Rail Engineering's General Catalogues and Manuals for air gap tolerances.

29. REPLACEMENT AND REFURBISHED BEARING ASSEMBLIES

29.1. The assemblies are considered to be critical in terms of there being rotating members with fine tolerances. The replacement of these items can only be undertaken in terms of:-

29.2. Manufacture new from existing drawings.

29.3. Re-engineer and provide Transnet Rail Engineering Product Development with copies of the drawings for sustainability.

29.4. Procure from original supplier of the product.

30. VENTILATION FANS

30.1. Visually inspect the ventilation fan for the following damage:
30.2. Damaged impeller blades;
30.3. Where possible, check for incorrect clearance between the tips of the impeller blades and the fan casing. Check the clearance by means of a suitable feeler gauge and ensure that the measured clearance is within the manufacturer's specified limits.
30.4. Wear of the fan's boss.

31. ELECTRICAL TESTS ON WINDINGS

31.1. FOR AC MACHINES Electrical tests must be performed in
31.1.1. In accordance with SABS 0242 - 1: 1999 section 4.8.1 to 4.8.7.as well as Specification PD PERM NAT PRAC 001
31.2. FOR DC MACHINES
31.2.1. The following electrical tests must be performed in accordance with SABS 0242 - 1: 1999: as well as Specification PD PERM NAT PRAC 001
31.2.2. Insulation resistance tests;
31.2.3. High voltage withstand test;
31.2.4. Interturn test;
31.3. Surge comparison test/bar to bar test for commutator
31.3.1. Core loss test. For auxiliary motors and traction armatures <20 Kw/kg
31.4. In spite of all testing parameters the lifespan of the insulation is important as well as the strict compliance with repair procedures.
31.4.1. The life of insulation can be up to 15 years but this is dependent on operational requirements. After 15 years the motor should be rewound on its next visit to the workshop.
31.4.2. The necessity to wash, stove and test must be followed up with the appropriate re-impregnation and rotation cure.
31.4.3. Even though the product passes all tests a visual inspection may reveal insulation deterioration due to flakiness, looseness, airgaps,.
31.4.4. A armature re-banded with poor quality insulation may fail prematurely due to increased stress on coils.

32. COMMUTATOR

32.1. Check commutator for eccentricity. See Transnet Rail Engineering's Engineering Practice No. P0001: Engineering Practice for obtaining Feinprüf recordings of commutators.

32.2. Check commutator surface for faults, such as:

32.3. Steering;

32.4. Grooving;

32.5. Threading;

32.6. Pitch-bar marking;

32.7. Copper drag;

32.8. Heavy slot-bar marking.

33. BRUSH GEAR

33.1. Ensure that the brush holders function correctly.

33.2. Ensure that the distance of the holder from the commutator is correct.

33.3. Check that the brush arms are equal distance apart. The difference between any adjacent brush box shall be less than 0.5 mm.

33.4. Check that brush spring tension is correct. See Transnet Rail Engineering's General Catalogues and Manuals.

33.5. Ensure that the brush grades are not mixed on a motor. See Transnet Rail Engineering's approved list No. 9: Approved brands of carbon brushes for electrical traction purposes. Refer to specification RT/TE/POL/0006

33.6. Ensure that the brushes are free in the holders.

34. BRUSH NEUTRAL SETTING

34.1. If the brush gear was removed, it is necessary to check the brush neutral setting.

34.2. Disconnect the shunt field winding and any other winding that may be connected into electronic circuits.

34.3. Variable supply 220 V AC to the field winding.

34.4. Install a low reading AC volt meter with a full scale deflection of minimum 20mV either side of OV middle between the two brush gear

rings, or to adjacent brush arms. The brush gear is moved until the lowest reading is recorded on the meter.

34.5. If the brush gear is moved in the wrong direction, or overshot the mark, the reading will increase from this low reading.

34.6. With the voltmeter still connected, lock the brush holder.

34.7. Lock up brush gear in sequence to ensure that the brushes stay in the correct position as indicated by the meter. Reconnect all fields as per original.

34.8. If the brush gear is not movable then the neutral axis must be checked with paper around the commutator and mark then measure

34.9. Use a brush setting jig

34.10. Measure the voltage on each segment within two adjacent brush boxes looking for the lowest voltage.

35. COMMUTATOR REPAIRS

35.1. The replacement of copper will only be undertaken by an approved supplier that complies with relevant procedures from Transnet Rail Engineering and Transnet Freight Rail.

35.2. The replacement of mica V-rings can be undertaken by Transnet Rail Engineering Centres of Excellence that comply with the same procedures.

35.3. Commutator line out gauges must be used to guarantee that the slot is aligned with the commutator within 0.2 mm.

35.4. Commutators must be torqued and bolts secured at 150 degrees Celsius.

35.5. Investigations are under way to replace Teflon sleeves with a special silicone paste.

35.6. Undercutting into the segment is unacceptable.

36. REWINDING

36.1. All components must be heated up for stripping in a burn out oven. The armature commutator is to be submerged into a water reservoir to keep the commutator cool during burnout. The use of handi gas been applied to cores is not an acceptable method to Transnet Rail Engineering but Product Development may be approached for approval

should a burnout oven not be available. Refer to SABS 0242 – 1 1999 Clause 5.1.3 – 5.2.

36.2. Using diamond tip cutting blade .Turn a groove behind the risers so that all the copper is cut away in order to reduce heat transfer from the water to the core.

36.3. Turn/cut off tigweld using a lathe or cutting blade

36.4. Use Burnout oven with fire suppression if there is thermal runaway.

36.5. Armature must be grayish white before commencing to pull the coils out, Coils that are black have not been oxidized.

36.6. The cleaning and stripping shall be carried out by an experienced operator wearing protective clothing. Refer to SABS 0242 – 1 1999 Clause 5.2

36.7. After stripping the core test shall be conducted on all components i.e. Stator cores/ Armature cores and the following readings are acceptable to Transnet Rail Engineering.

36.8. Core testing 13 W /kg for ac

36.9. 20 w/kg for DC

36.10. Passing a suitable value of current through the cable wound around the core will cause an alternating magnetic flux to flow in the core. Any shorts between the laminations will cause a circulating current to flow between the shorted laminations .creating a" hot spot " at the point of damage. The temperature must not exceed 10°C above the ambient temperature of the core. Refer to SABS 0242 – 1 1999 Clause 5.4

36.11. Clean core initially with scrapers and files. During the cleaning process no excess filing of slots and wedge slots should be carried out to cores. Gauge/measure slot size. Do not file wedge slot as the wedge must fit neatly.

36.12. Riser must be cleaned of all resin from previous VPI

36.13. The rear of the riser must be cleaned of all carbon and dust. Do not use glass blasting machine

36.14. The riser segments must not be bent more than the width of 3 segment.

36.15. After positively establishing in accordance with clause 12 that rewinding is necessary, proceed in accordance with section 5.1 to 5.6 of SABS 0242 - 1: 1999.

36.16. All rewound armatures are to conform to the following winding procedures:

PD COMP NAT SPEC 584 = GM DIESEL D29/D31 REWIND
PD COMP NAT SPEC 586 = GE 761 ARMATURE REWIND
PD COMP NAT SPEC 587 = GE 761 ARMATURE REWIND
PD COMP NAT SPEC 728 = 6E1 TRACTION ARM REWIND
PD PERM NAT SPEC 761 = 7E/7E2 TRACTION ARM REWIND
PD PERM NAT PROC 763 = 7E1/3 TRACTION ARM REWIND
PD PERM NAT PROC 768 = 11E TRACTION ARM REWIND
PD PERM NAT PROC 774 = 9E TRACTION ARM REWIND
PD PERM NAT PROC 775 = 18KW DIESEL AUXILARY GENERATOR REWIND ARM
PD PERM NAT PROC 773 = 5M2AR TRACTION ARM REWIND

36.17. All new undefined windings to be approved by PD Business.

36.18. Lineout and markings to be complied with as per rewinding specifications relevant to armature been rewound. All line out markings to be on the front face of commutator segments. A lineout gauge must be used. The use of string or similar is unacceptable.

36.19. For approved materials for rewinding, see Transnet Rail Engineering's, insulation specifications available from Product Development or local configuration offices. Refer to Specification PD PERM NAT POL 516.

36.20. It is a bad practice not to have the slot full of copper and insulation. The presence of air has a negative impact on thermal transfer.

36.21. Armature coils must be carefully handled and should not be allowed to be bumped or rub due to coil damage.

36.22. For the Tig welding process of commutators, see Transnet Rail Engineering's Specification number PD COMP NAT SPEC 585: Commutator riser condition in service.

36.23. Rewound and repaired mush wound components must be Trickle epoxied in Epoxy 235G compounds (or similar) (heat and excite windings during this process to maintain 60 °C and rotate) or be Vacuum pressure Impregnated as per Specification number PD COMP NAT SPEC 583. Refer to Specification PD PERM NAT POL 516.

36.24. Motors that require VPI must be VPId in Polyester/epoxy resins. Refer to specification PD PERM NAT POL 516.

36.25. Pre heat must be undertaken and armature temperature must be monitored throughout the process.

36.26. All armatures to be reimpregnated as per specification number PD_COMP_NAT_SPEC 583 and PD_PERM_NAT_PROC_681.

36.27. Release agent to be carefully assessed. Should a stator frame with coils require V.P.I. then all bolts must be removed and dressed with release agent and replaced to correct torque values.

36.28. All armatures are to be re-impregnated in the appropriate resin.

36.29. GE armatures are to be impregnated in polyester resin.

36.30. Resins with volatiles cannot be used for environmental reasons.

36.31. The viscosity of the resin shall be carefully monitored continuously and in line with PD Procedure number PD_PERM_NAT_PROC_727

37. COMMUTATOR TIG WELDING

37.1. Cut coil ends – impact processes not allowed
37.2. Clean commutator riser of all carbon dust while tig welding is in process.
37.3. Inspect riser mica for any carry over and clean.

38. COMMUTATOR TURNING

38.1. Obtain concentricity in line with RS (E) .P0001.93
38.2. Machine axial cross section to standard profile as per PD Business. PD COMP NAT PROC 809

39. COIL REFURBISMENT

39.1. The coils (main and interpoles) shall be qualified in terms of PD/TFR procedures before being sent for either outer wall repairs or complete repairs.

39.2. The coils shall be burnt out under controlled conditions as there is a possibility of a major accident taking place. Therefore the quantity and packing method in the burnout oven must be carefully assessed.

39.3. The coil undergoing a complete repair must be shaped and there should be no twist in the copper. No sharp or bent edges.

39.4. All insulation applied as per PD Procedure.

39.5. Pole pieces shall be cleaned of excess insulation before being lightly glass blasted.

39.6. The pole piece shall be protected by painting with clear insulating varnish except on the stator face.

39.7. The coils shall be VPId with the pole piece or to OEM specification where stipulated and the pole piece shall protrude outside or be level with coil. The pole piece must touch the stator frame 100 % when inserted in the frame.

39.8. All coils been transported or stored shall be protected in a manner that no damage can be carried out to them during storage or transportation.

39.9. Fit shims behind pole pieces in accordance with Maintenance Manuals and Catalogues.

39.10. Additional shims required to correct the air gaps must be made of magnetic steels.

39.11. Where non magnetic mounting bolts are specified for the interpoles these must be stainless steel. These bolts must be clearly marked.

39.12. During the fitment of coils no metal shavings must be present and the frame or area where coils are to be fitted must be completely free of contamination.

39.13. Should more than 1 coil be replaced on the GM Diesel/ 7E1 or 7E3 Motor then the correct coil alignment process must be followed using alignment jigs. Refer to Maintenance manuals for reference and procedure.

40. STATOR VPI

40.1. Release agent to be carefully assessed. Should a stator frame with coils require V.P.I. then all bolts must be removed and dressed with release agent and replaced to correct torque values.

40.2. All stators are to be re-impregnated in the appropriate resin.

40.3. Resins with volatiles cannot be used for environmental reasons. Refer to PD PERM NAT POL 516.

40.4. Fields are to be impregnated on the pole piece

41. BRAZING

41.1. Use of high frequency preferred because of the cleanliness of copper.

41.2. Use silver bearing shim stock as well as silver bearing rod (greater than 45 % silver).

41.3. Liquid easy flow flux.

41.4. Maintain all insulation below 70 º C by using water absorbing product.

41.5. Cool joint down immediately with water.

42. REFURBISHING OF WINDING

42.1. After positively establishing in accordance with clause 12 that rewinding is not necessary, proceed as given in 6.1 and 6.2 of SABS 0242 - 1: 1999.

43. DYNAMIC BALANCING OF ROTOR/ARMATURE

43.1. Competent person to have passed approved course.

43.2. Balance each rotating subcomponent. Assemble and check if possible or indications are that it is necessary. Dynamically balance the complete rotor and shaft assembly, including cooling fans and coupling, irrespective of whether the rotor was repaired or not. Balancing specification for all rotatable components will be to standard G2, 5 or less. Refer to ISO 1940-1.

43.3. Balance mass pieces (must be brass or steel –if welded in) shall be fixed and locked into position, using high-tensile steel nuts and bolts of strength grade 8, 8 of SABS 136.

43.4. Balance mass pieces should be shaped to conform to the shape of the area where they are fitted and they should be fitted to the main hub of fan assemblies, balance disc or core press-plates and not blades of fans. Balance weight pieces must not be fitted to any vent holes where the cooling system of the motors will be affected.

43.5. Half key method adopted for all items

43.6. Weights welded in to be fitted by an artisan passed out on welding.

43.7. No alloy steels to be welded in.

43.8. Balancing machines to be checked internally every 20 units and records to be kept.

43.9. Balancing machines to be checked by approved external company every year or as and when concerns are raised.

44. ASSEMBLING OF MOTOR

44.1. FITTING OF BEARINGS ON THE SHAFT

44.2. Clean shaft and end shield bearing seating's with an approved solvent.

44.3. Proceed as described in clause 24 and record measurements.

44.4. All bearings are to be fitted to shafts as per SABS 0242 – 1999 Clause 7.1 Do not tap bearing unevenly

44.5. Ensure that the correct type of bearings are fitted. Specification PD PRSE NAT POL 624.

44.6. On mounting of non-separable bearings, (deep-groove ball bearings), the mounting forces must always be applied to the ring which will have the tight fit.

44.7. Ensure that the bearing is always mounted with the identification number to the outside.

44.8. The use of a mechanical or hydraulic press is preferred.

44.9. Bearings fitted to the shaft by means of heat, the electromagnetic induction heater must have a facility for demagnetizing the bearing after heating it.For sealed bearings do not heat bearings more than 110°C.

45. LUBRICATION OF BEARINGS AND BEARING CAP COVERS (NOT SEALED BEARINGS)

45.1. Proceed in accordance with SABS 0242 - 1: 1999 section 7.2. or as specified in manuals/catalogues.

45.2. Greasing of the bearing prior to assembly should be done using a greasing fixture but where this is not available care must be exercised to ensure that the correct amount of grease has been applied when bearings are hand packed. Refer to relevant maintenance manuals for quantities to be used.

45.3. A protective cover should be placed on the bearing whilst the end shield is being transported to the area where it is assembled to the magnet frame.

45.4. During assembly, particular attention must be paid to ensure that the end float is within the limits recommended by the bearing manufacturer. Incorrect end float can be the cause of bearing failure.

46. INSTALLATION OF OIL SEALS

46.1. Proceed in accordance with SABS 0242 - 1: 1999 section 7.3.

47. TESTING

47.1. CORE TESTING

47.1.1. The purpose of this test is to check the quality of the core generally as well as identify hot spots. The test indicates that the core has failed if core loss is greater than 20 W per kg or any spot is 10 degrees Celsius hotter that the surrounding core. The core loss is negatively affected by over exuberant methods of stripping cores with tools and gas.

47.2. INSULATION TESTING- Megger

47.2.1. Insulation values are affected by relative humidity and time. This measure assesses the overall surface finish. Low megger readings can still allow a motor to function but the COE should make all efforts to ensure the insulation value is as high as possible.

47.3. HIGH VOLTAGE TESTING

47.3.1. Test the strength of insulation between the energized portion and earth. 1st test at incoming must be A.C.

47.4. IMPEDANCE TESTING

47.4.1. This test is carried out to determine whether the coils are secured correctly against the frame and that the pole piece and positioning of coils is acceptable.

47.5. VOLT DROP TESTING

47.6. POLARITY TESTING

47.6.1. This test is necessary when the COE got the lineout incorrect. Only the identified COE's must do this test.

47.7. RESISTANCE TESTING

47.7.1. Resistance measurements must be made using a Kelvin bridge or similar and then be temperature compensated in order to determine then whether the value is within the standard. The resistance value is important.

47.7.2. Lower armature resistance and coil resistance will give a higher powered motor. The resistance of separately excited coils or shunt coils are not that critical.

47.8. SURGE TESTING

47.8.1. Used to identify breakdown in insulation between windings or coil turns.

47.9. BAR TO BAR TESTING

47.9.1. Used to identify breakdown in insulation between adjacent conductors.

47.10. FLASH TESTING OF COMMUTATORS

47.11. OVERSPEED

47.12. NOISE-UNUSUAL

47.13. VIBRATION

47.13.1. Conduct test within accepted standards

47.14. TEMPERATURE RISE

47.15. NEUTRAL AXIS

48. FINAL ASSEMBLY

48.1. In particular, pay attention to the cleanliness of flanges, spigots and all machined surfaces in order to ensure that the assembled components are not misaligned.

48.2. Labyrinth systems must be checked for dents damage

48.3. No labyrinths/bearing assembly parts can be machined without reference to a drawing supplied to or from Transnet Rail Engineering.

48.4. Take extreme care when fitting end shields to bearing housings and also when fitting shaft mounted assemblies, (e.g. couplings) in order to prevent damage to the bearings.

48.5. Measure and record the “Feinpruf profile” in the case of D.C.Motors. This must comply with Engineering Practice no.RS (E). P0001.94: Engineering Practice for obtaining Feinpruf Recordings of commutators.

48.6. Check all threads with an approved GO/NO GO gauge.

48.7. Ensure all bolts are torqued to Locomotive Maintenance Manuals and Catalogues

48.8. For DC machines, see section 31.2,32,33,34

49. PINION FITMENT

49.1. In accordance with PD Business procedure PD PERM NAT PROC 764

50. BEARING FITMENT

50.1. Bearings fitted with thermal difference advantage.
50.2. Heat or freeze with uniform process.
50.3. Pressure applied evenly.
50.4. Use of mallet or copper hammer or any item with impact must not be tolerated.
50.5. Cleanliness
50.6. Correct quantity of grease used.
50.7. Correct type of grease used.

51. TESTING OF ASSEMBLED MACHINES

51.1. The assembled motor(s) shall be tested in accordance with SABS 1561 - 1: 2006. The minimum testing standard shall be SABS 1561 IT 2.

51.2. The following tests are required by Transnet Rail Engineering and must be recorded. Refer to SABS 1561 – 1 2006 Clause 6.
51.3. DC tests speed direction no load both directions
51.4. Vibration
51.5. Load test if indicated for traction and requested
51.6. Overspeed

52. PROTECTIVE COATINGS

52.1. For protective coatings see SABS 0242 - 1: 1999 section 9.0.
52.2. **Painting Stator Frame**

52.2.1. Make sure that the magnet frame is clean. Ensure that areas not required for painting (e.g. pole pad faces, machined surfaces and threaded holes) are adequately protected during the painting process. Paint the inside of the magnet frame first with an oil based primer, allow to dry then paint with white, high gloss enamel paint. Where water based primer is used paint inside and outside of frame allow to dry then paint inside with white air drying varnish and allow to dry.

Paint the outside of the frame either with an enamel paint or a water based paint. The colour of the outside of the magnet frame is to be specified by the scope of work.

53. TRANSPORTATION

53.1. Motors must be protected against the ingress of dust, moisture and salts that can cause corrosion and insulation failures.

53.2. Ensure that all machined surfaces are covered by a protective coating that can be easily removed on site when required.

53.3. Lock rotors from axial and rotational movement.

53.4. The rotating parts of the motors must be perpendicular to the direction of the travel and not in the same line as the travel.

53.5. Motors fitted with anti friction bearings should be transported on anti vibratory mats or supports.

53.6. Ensure that the motors is properly packed and secured so that it is protected against being thrown around and been damaged. Refer to Specification RT/TE/SPC/0157.

54. STORAGE

54.1. Must be in accordance with specification RT/TE/SPC/0151 or PD_COMP_NAT_PROC_066

55. AUDIT

	Aux overhaul	AC Stator rewind	DC Armature rewind	DC Field coils redone	Mechanical frame	Brushbox refurbishment	Commutator refurbishment	Traction Motors
CLEANING AND INSPECTION FOR REWINDING AND REFURBISHING 5.3, 5.4, 5.5 4.7,4.11	X	X	X		X			X
RECORD/CHECK SHEET 6,4.7, 4.16, 4.7,4.8,	X	X	X	X	X	X	X	X
PRINCIPLES APPLICABLE TO STRIPPING AND ASSEMBLY OF MOTORS 7, 4.7, 4.8, 4.10	X							X
DISMANTLING OF MOTOR 8.2, 4.7, 4.8, 4.10	X							X
REMOVAL OF BEARINGS 9, 9.3, 4.7, 4.8, 4.10	X							X
INSPECTION OF WINDINGS BEFORE CLEANING (ROTOR AND FIELD SYSTEM) 10, 4.7, 4.8, 4.14, 4.16, 4.17,	X	X	X	X				X
CLEANING OF ALL COMPONENTS OF MOTOR 11, 4.7, 4.8, 4.11,		X	X		X	X		X
STOVING 11.8, 4.7, 4.8,4.16, 4.29		X	X	X				
Torque com bolts 11.9, 4.25			X				X	
Degree of Cleanliness 11.10, 4.7, 4.8, 4.11		X	X				X	
Protection against rust 11.11, 4.2, 4.7, 4.8,			X		X			

	Aux overhaul	AC Stator rewind	DC Armature rewind	DC Field coils redone	Mechanical frame	Brushbox refurbishment	Commutator refurbishment	Traction Motors
INSPECTION OF STATOR /ROTOR AND ARMATURE WINDINGS FOR TYPICAL TYPES OF FAILURES 12,13, 4.7, 4.8, 4.10, 4.12, 4.14, 4.15, 4.16, 4.17	X	X	X	X			X	X
INSPECTION OF MECHANICAL COMPONENTS FOR WEAR AND DAMAGE 14,15,16, 4.6, 4.7, 4.8, 4.10, 4.20, 4.21, 4.22	X		X		X			X
MAGNET FRAME (HEAVY REPAIRS ONLY) 17, 18, 18.1,18.2,18.11 4.1, 4.6, 4.10, 4.17								X
LINE BORING 4.1, 4.6, 4.10, 4.17								X
END SHIELD 20, 20.5,25.2, 4.1, 4.2, 4.6, 4.10, 4.16	X							X
SHAFT 24, 24.3, 25.3 4.1, 4.2, 4.6, 4.10, 4.16, 4.20, 4.21, 4.22	X		X					X
REPAIR BEARING BORE OF END SHIELDS 4.1, 4.2, 4.4, 4.6, 4.10, 4.16	X				X			X
REPLACEMENT AND REFURBISHED END SHIELDS 27, 4.1, 4.2, 4.4, 4.6, 4.10, 4.16	X				X			X
AIR GAP 28, 4.1, 4.6, 4.7, 4.8, 4.10, 4.16	X				X			X

	Aux overhaul	AC Stator rewind	DC Armature rewind	DC Field coils redone	Mechanical frame	Brushbox refurbishment	Commutator refurbishment	Traction Motors
REPLACEMENT AND REFURBISHED BEARING ASSEMBLIES 29.1, 4.1, 4.2, 4.6, 4.10, 4.16,4.7								
VENTILATION FANS 30, 4.1, 4.2, 4.3, 4.7, 4.8, 4.16,			X					
ELECTRICAL TESTS ON WINDINGS 31, 4.1, 4.7, 4.8, 4.14, 4.16, 4.26		X	X				X	
COMMUTATOR 32, 4.1, 4.7, 4.8, 4.10, 4.12, 4.13, 4.14,4.16, 4.18, 4.25,			X				X	
BRUSH GEAR 33, 4.1, 4.2, 4.7, 4.8, 4.10, 4.14, 4.16						X		X
BRUSH NEUTRAL SETTING 34, 4.1, 4.7, 4.8, 4.10						X		X
COMMUTATOR REPAIRS 35, 4.1, 4.3, 4.7, 4.8, 4.10, 4.12, 4.13, 4.14, 4.25							X	
REWINDING 36, 0, 36.5, 36.7, 36.12, 36.17, , 36.18, 36.19, 36.20, 36.23, 36.24, 36.25, 36.27, 36.31 4.1, 4.2, 4.3, 4.4, 4.5, 4.7, 4.8, 4.9, 4.10, 4.12, 4.13, 4.14,4.15, 4.16, 4.17, 4.18, 4.25, 4.26, 4.27, 4.28, 4.29, 4.31	X		X				X	
COMMUTATOR TIG WELDING 37, 4.1, 4.7, 4.8, 4.10, 4.12, 4.27			X					
COMMUTATOR TURNING 38, 4.1, 4.7, 4.8, 4.10, 4.16, 4.18, 4.13			X				X	

	Aux overhaul	AC Stator rewind	DC Armature rewind	DC Field coils redone	Mechanical frame	Brushbox refurbishment	Commutator refurbishment	Traction Motors
COIL REFURBISMENT 39, 39.2, 39.4, 39.6, 39.7, 39.12, 39.13, 4.1, 4.7, 4.8, 4.14, 4.16, 4.26, 4.28, 4.29				X				
STATOR VPI 40.1, 40.4, 4.1, 4.7, 4.8, 4.10, 4.28, 4.29, 4.30		X	X	X				
BRAZING 4141.4, 4.1, 4.7, 4.8, 4.10, 4.16, 4.19				X				
REFURBISHING OF WINDING 4.1, 4.3, 4.7, 4.8, 4.10, 4.14, 4.15, 4.16, 4.17, 4.18, 4.20, 4.21, 4.28, 4.29,				X				
DYNAMIC BALANCING OF ROTOR/ARMATURE 43, 43.1, 43.2, 43.4, 43.5, 43.6, 43.9, 4.1, 4.2, 4.3, 4.7, 4.8, 4.10, 4.16, 4.21, 4.22			X					
ASSEMBLING OF MOTOR 44,45, 4.1, 4.2, 4.7, 4.8, 4.10, 4.13, 4.14, 4.16, 4.19, 4.31	X							X
FITTING OF BEARINGS ON THE SHAFT 4.1, 4.2, 4.6, 4.7, 4.8, 4.10, 4.16, 4.20, 4.21, 4.22	X							X
LUBRICATION OF BEARINGS AND BEARING CAP COVERS (NOT SEALED BEARINGS) 4.1, 4.7, 4.8, 4.10	X							X
INSTALLATION OF OIL SEALS 4.1, 4.7, 4.8, 4.10	X							
TESTING 47, 4.1, 4.7, 4.8, 4.10, 4.14, 4.16, 4.26	X	X	X	X		X	X	X
CORE TESTING 47.2 above 4.1, 4.7, 4.8, 4.10, 4.14, 4.16, 4.26			X					

INSULATION TESTING- Megger 47.2, 4.1, 4.7, 4.8, 4.10, 4.14, 4.16, 4.26		X	X	X				

HIGH VOLTAGE TESTING 47.3, 4.1, 4.7, 4.8, 4.10, 4.14, 4.16, 4.26		X	X	X		X	X	
IMPEDANCE TESTING 47.4, 4.1, 4.7, 4.8, 4.10, 4.14, 4.16, 4.26								X
VOLT DROP TESTING 47.5, 4.1, 4.7, 4.8, 4.10, 4.14, 4.16, 4.26			X					
POLARITY TESTING 47.6, 4.1, 4.7, 4.8, 4.10, 4.14, 4.16, 4.26			X					X
RESISTANCE TESTING 47.7, 4.1, 4.7, 4.8, 4.10, 4.14, 4.16, 4.26,		X	X	X				X
SURGE TESTING 47.8, 4.1, 4.7, 4.8, 4.10, 4.14, 4.16, 4.26			X	X				X
BAR TO BAR TESTING 47.9, 4.1, 4.7, 4.8, 4.10, 4.14, 4.16, 4.26			X					

	Aux overhaul	AC Stator rewind	DC Armature rewind	DC Field coils redone	Mechanical frame	Brushbox refurbishment	Commutator refurbishment	Traction Motors
OVERSPEED 47.11, 4.1, 4.2, 4.4, 4.6, 4.7, 4.8, 4.10, 4.13, 4.16,	X							X
NOISE-UNUSUAL 47.12, 4.1, 4.2, 4.4, 4.6, 4.7, 4.8, 4.10, 4.13, 4.16,	X							X
VIBRATION 47.13, 4.1, 4.2, 4.4, 4.6, 4.7, 4.8, 4.10, 4.13, 4.16,	X							X
TEMPERATURE RISE 47.14, 4.1, 4.2, 4.4, 4.6, 4.7, 4.8, 4.10, 4.13, 4.16,	X							X
NEUTRAL AXIS/Commutation 47.15, 4.1, 4.7, 4.8, 4.10, 4.16	X							X
FINAL ASSEMBLY 48.1, 48.3, 48.5, 48.7, 48.8, 4.1, 4.2, 4.6, 4.7, 4.8, 4.10, 4.13, 4.14, 4.16, 4.18, 4.19, 4.31	X							X
PINION FITMENT 49.1, 4.1, 4.7, 4.8, 4.10, 4.31								X
BEARING FITMENT 50.4, 50.6, 4.1, 4.7, 4.8, 4.10	X							X
TESTING OF ASSEMBLED MACHINES 51, 4.1, 4.7, 4.8, 4.10, 4.13, 4.14, 4.16, 4.26, 4.31	X							X
PROTECTIVE COATINGS 52, 4.1, 4.2, 4.7, 4.8, 4.10, 4.16, 4.23, 4.28	X							X
TRANSPORTATION 53, 53.3, 53.4, 4.24	X							X
STORAGE 54, 4.23	X	X	X	X			X	X

DOCUMENT AUTHORITIES

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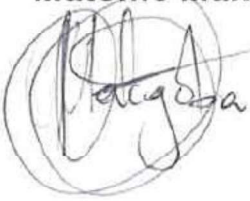
SIGNATURE	
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