WOSS 501/2

British Railways Board

Director of Mechanical and Electrical Engineering

Reinsulation of Electrical Machines

WORKSHOP OVERHAUL STANDARD SPECIFICATION

REVISION RECORD

This Specification will be updated when necessary by the issue of amended pages accompanied by revision letters. The amended or additional part of re-issued pages will be marked with a vertical black line.

If you consider that an amendment is necessary, complete BR Form 14298 and pass it to the local BRB Resident Engineer or Area Quality Engineer. Submission of a form does not authorise the proposed amendments.

Revision No.	Re-issued Page Nos	Date	Inserted by

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Director of Mechanical & Electrical Engineering
British Railways Board
The Railway Technical Centre
London Road
Derby
DE2 8UP

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Should any query arise regarding the contents of this document telephone 0332 42442 Ext. 3516, BR Code is 056 3516, or write to the above address.

REINSULATION OF ELECTRICAL MACHINES

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REFERENCE SPECIFICATIONS

Guide to Quality Assurance Procedures

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1 INTRODUCTION

1.1 This specification details the procedure to be followed by all Contractors when re-insulating or re-winding electrical equipment for British Rail Traction and Rolling Stock.

1.2 Appendix B of this specification gives technical data on some electrical machines where no details are given in a separate specification.

1.3 This specification must be read in conjunction with the BRB publication "Guide to Quality Assurance Procedures".

2 APPROVED CONTRACTORS

2.1 Work must only be carried out by contractors who are approved for that category of work. For the purposes of approval different sites within a given company are regarded as separate contractors.

2.2 A list of contractors and the categories of work they are approved to do is held by the M & EE Quality Assurance Department of the BRB.

3 APPROVED MATERIALS

3.1 A list of approved insulating materials is published as WOSS 501/6.

4 APPROVED PROCEDURES

4.1 Specifications for Work Required

4.1.1 The Contractor shall establish from the Director of Mechanical & Electrical Engineering BRB at Derby (D of M&EE) whether a B.R. Specification exists for the work he is required to do.

4.1.2 Where a suitable Specification does exist the D of M&EE shall supply a copy to the Contractor.

4.1.3 Where a suitable Specification does not exist it shall be the responsibility of the Contractor to submit a technical proposal for approval by the D of M&EE.

4.2 Submission of Proposals

4.2.1 The Contractors technical proposals shall be in accordance with the appropriate procedures described in this specification where possible. If this is not possible deviations shall be described in detail.

4.2.2 Where it is proposed that an insulating material is to be used which is not listed as approved in WOSS 501/6 full details of the material and a sample shall be submitted with the proposals.

4.2.3 The proposals shall be submitted to the D of M&EE on a form of the type shown in "Appendix A" except in cases of urgency when the details required by the form may be submitted by telex.

The proposals shall be addressed to:-

Director of Mechanical & Electrical Engineering
Railway Technical Centre
London Road
DERBY DE2 8UP
Telex No: 37367

FAO: Maintenance Engineer (Electrical),
Room 140 Trent House

4.3. Approval

4.3.1 The D of M&EE shall return a copy of the proposal to the contractor stating whether the proposal is approved or not.

4.3.2 Where the contractors proposals are not approved the D of M&EE shall detail the unsatisfactory processes and/or materials and the contractor must submit a new application.

4.3.3 Where the contractors proposals are approved it shall not relieve him of his responsibility for the satisfactory performance of the repaired equipment.

4.3.4 Until approval is received the Contractor shall only proceed with the work necessary to establish the insulation system he intends to propose.

4.3.5 If any further work is done before approval of his proposals, the Contractor may be required, to modify retrospectively any equipment, so that it complies with the approved standard.

4.4 Compliance with Approved Proposals and Specifications

4.3.6 Approval of the contractors proposals does not imply authorisation of any work. It shall be the responsibility of the contractor to obtain authority for any additional work that becomes necessary during execution of a repair.

4.4.1 The Contractor shall comply with all parts of the approved proposals or BR Specification. No exemptions, deviations from or additions to these shall be made without written approval or instructions from the D of M&EE.

4.4.2 Where no serial number is marked on the equipment the contractor shall indelibly mark it with a serial number and a mark to indicate the repair site. The marks to be approved by the D of M&EE.

4.4.3 The contractor shall record the serial number of the component along with the date completed, the origin of the order and any other details required to be recorded. These records shall be available for inspection by the D of M&EE for at least two years after the repair is carried out.

4.5. Samples

4.5.1 Samples of proposed insulation systems and/or materials, other than those required in 4.2.2, may be required by the D of M&EE and these should be labelled with the Contractors name and any relevant information.

5. Protection During Handling and Storage

5.1 Repaired machines must be suitably packed and protected from both mechanical and environmental damage .

5.2 Machines must have all exposed machined ferrous surfaces protected against corrosion during storage.

5.3 Care must be used when armatures are being handled. Do not place slings around the end windings or commutators. Keep commutators and end windings from contact with the floor, cradles or objects which may cause damage. Use stands or cradles when working on or storing armatures.

6. PROCEDURE FOR THE REWIND OF ARMATURES

Technical proposals for the rewinding of armatures which are submitted for approval must contain the following information.

a. Maximum working Voltage to be used as a basis for test voltages. (see table 1)

b. Proposed minimum commutator rewind diameter (see clause 6.4)

c. Proposed minimum riser width (if TIG welded). (see clause 6.4)

d. Equaliser copper size and insulation. (see clause 6.5)

e. Equaliser Winding Details. (see clause 6.6)

f. Main winding copper size and insulation. (see clause 6.5)

g. Main winding details. (see clause 6.5)

h. Slot insulation material and thickness. (see clause 6.7)

i. Endwinding insulation material and thickness. (see clause 6.7)

j. Winding Bed insulation and thickness. (see clause 6.6 & 6.7)

k. Wedge Material (if fitted). (see clause 6.9)

l. Banding Details. (see clause 6.7 & 6.11)

m. Whether VPI or dip. Type of varnish and cure time. see clause 6.10 & 6.12)

n. Armature maximum speed to be used as basis for balancing. (see clause 6.14)

p. Any deviations from the following specification.

PROCEDURE

6.1. Examine and clean.

6.1.1 Examine the armature noting all damage. If the repair work required is not fully authorised either by an order or an abnormal work authorisation contact the originator of the order or the BRB Resident Engineer for advice.

Procedure For The Rewind of Armatures Contd

6.2. Strip out the old windings. If specifications and data are not available record banding, insulation and winding details for future use.

6.2.1 If any serious damage is revealed during stripping the method of reclamation shall be approved by BRB M&EE Department Derby.

6.3. Attention to Core.

6.3.1 Clean the core removing all old insulation except pre-moulded hoods etc.which are in good condition

6.3.2 Ensure that the core ducts are clear.

6.3.3 Check the core slots for any damage which is likely to damage the windings and rectify.

6.3.4 If no balancing grooves are provided or if any rectification is carried out on the core, balance the core prior to commencing winding.

6.4. Attention to Commutator.

6.4.1 Examine the commutator for signs of serious damage.

6.4.2 If no serious damage exists measure the track diameter and riser width. Change commutators which are below minimum rewind diameter or have risers below the minimum rewind width.

6.4.3 On traction motors, main generators and M/A sets check commutators for soft bars.

On other machines check the commutator for soft bars if it appears to have suffered from overheating.

Checking is to be carried out using a hardness tester. Minimum acceptable reading to be 71 Barcol (65 Brinell, 14 Shore). If more than 10% of the bars are soft or if three adjacent bars are soft the commutator must be changed.

6.4.4 Check that the inter-segment separators are undamaged and free from burns.

6.4.5 Carry out a High Pressure Insulation Test to earth and between bars. The voltages must be in accordance with Table 1.

6.4.6 Change or repair defective commutators. If the commutator is to be re-built the work must be carried out in accordance with WOSS 501/9

Procedure For The Rewind of Armatures Contd

6.4.7 Commutators must be rotationally seasoned in accordance with WOSS 501/8 when any work has been carried out which involves removal of a Vee ring.

6.4.8 Renewal of individual commutator bars must be discussed with and approved by BRB M&EE Department Derby before work commences.

6.5. Coil Forming

6.5.1 Use of re-claimed coils will not be approved for traction motors, main generators and MA sets. When it is proposed to use re-claimed coils this must be discussed with and approved by BRB M&EE Department Derby.

6.5.2 Where the conductors are swaged to fit the commutator, the swaged end must be annealed. All sharp corners are to be removed.

6.5.3 Coil insulation.

6.5.3.1 For traction machines a pressed slot insulation system is preferred. When wrapping the slot cell, taper the insulation on the slot extension so that a good seal can be made between that and the endwinding taping

The endwindings are to be taped with an insulating material which is flexible when fitted. Additional protection such as a layer of glass tape may be required.

6.5.3.2 For machines where a pressed slot insulation system cannot be used, insulate the complete coils using an insulating material which is flexible when fitted. Additional protection such as a layer of glass tape may be required.

6.5.5.3 For small machines wound with enamelled wire a slot liner made from Nomex/Polyester film laminate or similar may be used and the coils wrapped with glass tape only.

6.5.4 Carry out a HPIT on sample coils, i.e. one from each armature set but a minimum of two coils. Test between adjacent but unconnected conductors and between all conductors and a piece of metal foil wrapped tightly round the slot portion of the coil, including slot liner where used. Voltages in all cases are to be as detailed in Table 1.

Procedure For The Rewind of Armatures Contd

6.6. Fitting Equalisers Under CE Endwindings (Where Applicable)

6.6.1 Construct the equaliser winding beds using micanite or another material which retains some flexibility after curing .

6.6.1.1 Machines working in a dirty environment may require a flexible endwinding hood incorporating into the bed. This must be made from strips of flexible insulation faced with glass cloth. The strips should be long enough to be subsequently turned back and cover the evolutes and about one third of the endwinding. The strips must be half lapped.

6.6.2 Insulate between top and bottom limbs with micanite or glass/mica/glass.

6.6.3 Pack around evolute end and behind the risers with stoving putty.

6.6.4 Insulate over the equalisers with micanite or glass/mica/glass then band over with glass banding tape.

6.6.5 HPIT between each equaliser and the rest of the windings and to earth at the voltage specified in Table 1. Rectify any faults.

6.6.6 Cure the putty and banding by stoving.

6.7. Fitting Main Windings

6.7.1 Construct the winding beds using micanite or another material which retains some flexibility after curing. The overall height of the winding bed must be about 0.5 mm above the bottom of the core slots.

6.7.1.1 Machines working in a dirty environment may require a flexible endwinding hood incorporating into the bed. This must be made from strips of flexible insulation faced with glass cloth. The strips should be long enough to be subsequently turned back and cover the evolutes and about one third of the endwinding. The strips must be half lapped.

6.7.2 Fit pieces of suitable packing into the enlarged slot ends if present.

Procedure For The Rewind of Armatures Contd

6.7.3 Insert a thin sheet of insulation at both ends of the core to cover the junction between the enlarged and normal slot.

6.7.4 Fit the coils to the armature.

6.7.4.1 Where a pressed slot cell is used, fit strips of insulation below and above the lower limb in the slot to ensure that when the coils are pulled down the endwindings and slot portion are evenly supported.

6.7.4.2 Pack between the coils at both ends of the core and behind the commutator with stoving putty.

6.7.4.3 Pack the eye of the evolutes with insulation and feed in pieces of flexible insulation e.g. glass/mica/glass between top and bottom layers of the endwindings.

6.7.5 Trim the conductors to length.

6.7.6 Temporarily band the armature in accordance with the procedure set out in CEPS 38.

6.7.7 HPIT the windings to earth at the voltage specified in Table 1.

6.7.8 Carry out a bar to bar drop test as follows

Select a commutator bar and identify it with a chalk mark. Using a d.c. supply capable of delivering approximately 25A over a pole span proceed to check the voltage drop between segments. Record each reading. Alternatively proprietary drop testing equipment may be used.

Should any abnormal reading be obtained ie. greater than $\pm$ 5% from the average, the affected riser is to be examined for a high resistance joint or if short circuits are found the commutator is to be examined and cleaned if necessary . Any defects are to be repaired and the armature re-tested.

6.8. TIG weld or solder the commutator riser joints as approved by BRB M&EE Department Derby.

6.8.1 If solder is used it must be to BS 219 grade 95A and non-corrosive non-hygroscopic flux used.

6.8.2 Soldering will not be approved on traction motors, main generators and MA sets.

6.8.3 After soldering or welding, wire brush the commutator risers to remove all debris.

Procedure For The Rewind of Armatures Contd

6.9. Remove the core section of the temporary banding and apply core banding or slot wedges as appropriate.

6.9.1 When core bands are used, suitable insulation must be placed between the bands and the coils.

Banding details must be as specified by BRB M&EE Department Derby, or in accordance with the details obtained in operation 1, and applied in accordance with the procedure set out in CEPS 38.

6.9.2 Wedging.

6.9.2.1 Refit non-magnetic steel wedges if such were originally fitted. Insulate metallic wedges from the core using Nomex/Polyester Film laminate or similar.

6.9.2.2 High Strength epoxy bonded woven glass laminate wedges must be used on all traction machines except those covered by 9.2.1.

6.9.2.3 Sufficient strips of insulation must be placed under the wedges to ensure the windings are tight. All wedges must be checked by tapping with a small hammer.

6.9.2.4 HPIT at the voltage specified in Table 1.

6.10. Impregnate the windings using stoving varnish and cure.

6.11. Remove the temporary banding and apply final band in accordance with CEPS 38. Banding details must be as specified by BRB M&EE Department Derby or in accordance with the details obtained in clause 6.1.

6.12. Dip or VPI the armature in stoving varnish and cure.

6.13. Carry out a final HPIT on the windings at the voltage specified in Table 1. Armatures which fail the test must be rectified in accordance with the appropriate parts of this specification and subsequently re-tested.

Procedure For The Rewind of Armatures Contd

6.14. Dynamically balance the armature in accordance with Table 5 for auxiliary machines or Table 6 for traction machines noting the following points.

6.14.1 Use should be made of any balancing grooves provided.

6.14.2 If balancing grooves are not provided, balance using solder on the bands or by machining the core.

6.14.3 All dismountable components which form part of the armature e.g. main generator fans and barring rings must be statically balanced separately and the whole assembly dynamically balanced.

6.14.4 All attachments to the armature which may be changed without dismantling the machine e.g. impellers must be dynamically balanced separately

Any balancing arrangements provided must be used but on fabricated steel components the following alternatives may be used if no other provision has been made:

One bolt with one nut and up to two washers, secured with Loctite Grade 270

Mild steel weights, no more than 2mm thick securely attached by means of at least 2 nuts and bolts locked with Loctite Grade 270, or brazing or tack welding.

6.15. Protect the vee ring extension in accordance with CEPS 25.

6.16. Resurface the commutator in accordance with WOSS 501/3. Carry out a bar to bar voltage drop test in accordance with clause 6.7.8.

TABLE 1 INSULATION TESTING OF ARMATURES

The voltages to be used when testing an armature depend on its working voltage and duty. There are 5 categories of machines as follows:-

Cat. 1 Auxiliary Machines Operating at up to 50 volts
Cat. 2 Auxiliary Machines Operating at up to 200 volts
Cat. 3 Auxiliary Machines Operating at up to 600 volts
Cat. 4 All Other Machines fitted to vehicles fed from AC or DC overhead or third rail supply
Cat. 5 All Other Machines fitted to Diesel Electric Vehicles.

NOTES

1. HPIT means High Pressure Insulation Test and shall be carried out using AC at 50 Hz.
2. Megger testing shall be carried out at room temperature using a proprietary insulation tester supplying d.c. at the appropriate voltage.
3. The Final HPIT shall be carried out at the voltage given in the Table unless a different figure is specified in writing by BRB M&EE Department Derby.
4. The Value 'F' shall be equal to the voltage used for the Final HPIT as specified in Note 3.
5. The value 'U' shall be the Highest Voltage to Earth on machine in normal service
6 Where a machine falls into two categories the higher test requirement shall apply.

MACHINE CATEGORY:-		1	2	3	4	5
TEST	TIME	VOLTAGE				
1. MEGGER TESTING						
Minimum Value 20 megs.	-	100 V	500 V	1000 V	1000 V	1000 V
2. FINAL HPIT ON FINISHED COMPONENT (see notes)						
Rewound Components	1 min	250 V	1000 V	U+1000 V	2.25xU+2000 V	2xU+1000 V
Overhauled (Not Rewound) Components	1 min	N/A	500 V	U+500 V	2.25xU+500 V	2xU+500 V
3. PROGRESSIVE TESTING DURING BUILDING						
HPIT Commutator Bar to Bar	15 secs	50 V	100 V	250 V	500 V	500 V
HPIT Commutator to Earth (see note 4)	15 secs	250 V	1500 V	F+1000 V	F+1600 V	F+1600 V
HPIT Interturn test sample coils	15 secs	100 V	100 V	250 V	500 V	500 V
HPIT test to earth on slot portion of sample coils	15 secs	N/A	1500 V	F+1000 V	F+1600 V	F+1600 V
HPIT between each installed equaliser and the rest of the equalisers	15 secs	N/A	100 V	250 V	500 V	500 V
HPIT installed equalisers to earth	15 secs	N/A	1300 V	F+800 V	F+1200 V	F+1200 V
HPIT Armature to earth after Temporary Banding	15 secs	150 V	1200 V	F+600 V	F+800 V	F+800 V
HPIT Armature to earth after wedging	60 secs	120 V	1100 V	F+400 V	F+400 V	F+400 V

7 PROCEDURE FOR REINSULATION OF D.C. FIELD SYSTEMS

Technical proposals for the reinsulation of field coils or complete field systems which are submitted for approval must contain the following information.

a. Maximum working Voltage to be used as a basis for test voltages. (see table 2)

b. Coil type (e.g. fully wrapped, edgewound, bonded see clause 7.3).

c. Coil insulation specification including material and thickness. (see clause 7.3)

d. Material for insulating washers if fitted. (see clause 7.3)

e. Resins/Varnish to be used. (see clause 7.3 & 7.5.7)

g. Connection insulation details. (see clause 7.5)

h. Any deviations from the following specification.

PROCEDURE

7.1. Examine and Clean

7.1.1 Examine the components noting all damage. If the repair work required is not fully authorised either by an order or an abnormal work authorisation contact the originator of the order or the BRB Resident Engineer for advice. If either the order received or the condition of the components indicate that all coils require re-insulating omit operations 7.1.2 to 7.1.4.4.

7.1.2 Using a megger measure the insulation resistance between the coils and the frame and between adjacent but unconnected coils. The voltage and minimum acceptable reading must be in accordance with Table 2.

7.1.3 If the insulation resistance is acceptable and no other damage is evident contact the originator of the order for advice.

7.2. Remove faulty coils as follows.

7.2.1 Measure the pole bore radii of both main and interpoles and record for future reference.

Procedure For Reinsulation of D.C. Field Systems Cont'd

7.2.2 Note the position of all connections and record for future reference.

7.2.3 Remove faulty coils and their pole bricks noting the position and thickness of any liners, washers and spring plates. Mark the items removed with their respective position and frame number to ensure correct replacement .

7.3. Repair of Coils

7.3.1 Insulated type.

7.3.1.1. Remove the outer taping and insulation.

7.3.1.2 Check for damaged copper. On coils formed from copper strip bent edge the following repairs are permitted

If the conductor is slightly damaged (maximum 25% of the cross section burnt away x 25 mm length) clean up the damaged area. If the conductor is more seriously damaged braze in a new section. Use a scarfed joint .

No repairs are permitted on other types of coil.

7.3.1.3 Check for damaged interturn insulation by visual examination and using an approved tester such as a growler. On coils formed from copper strip bent edge the following repairs are permitted

If the insulation is damaged separate the turns and repair the damage.

On other types of coil only minor localised damage may be repaired as described above.

7.3.1.4 Impregnate the coil with stoving varnish and cure.

7.3.1.5 If space permits fit washers made from Nomex/Polyester laminate either side of the coil.

7.3.1.6 Insulate the coil then apply a half lapped layer of glass tape as mechanical protection.

7.3.1.7 Repeat 7.3.1.4.

Procedure For Reinsulation of D.C. Field Systems Cont'd

7.3.2 Bare Midriff type.

7.3.2.1 Remove the insulating spools and liners from the coil. Clean the coil removing all loose varnish etc.

7.3.2.2 Examine the taping on the outer turns and the interturn insulation on the rest of the coil. Check for shorted turns using a growler.

7.3.2.3 If more than 25% of the interturn insulation is damaged strip out all the insulation and anneal the coil.

7.3.2.4 Renew damaged or missing insulation. Use a resin coated or resin rich material for the interturn insulation. Cure the insulation.

7.3.2.5 Impregnate the coil with stoving varnish and cure.

7.3.2.6 Renew or repair the insulating spools and liners, and re-assemble the coil and insulation.

7.3.3 Coils Bonded to Pole Brick

7.3.3.1 Examine and re-insulate the coil in accordance with 7.3.1 or 7.3.2 above. In addition the following points should be noted:-

a) The formation of large voids within the insulation adjacent to the pole shall be avoided.

b) Solventless resin must be used throughout.

7.3.3.2 Clean the pole brick and fit the coil using suitable packings to ensure that it is correctly positioned. (See 7.4.2.1).

7.3.3.3 Fill the void between the coil and pole brick with a suitable resin. Cure the resin.

7.4. Refitting Coils

7.4.1 Coils not Bonded to Pole Brick

7.4.1.1 Fit the coil and pole brick to the carcase in accordance with the details noted in 7.2.

Procedure For Reinsulation of D.C. Field Systems Cont'd

7.4.1.2 If insulating packing washers are used those adjacent to the coil must be made from an impervious insulation such as Nomex/polyester laminate.

7.4.2 Coils Bonded to Pole Brick

7.4.2.1 Fit the complete pole. Some machines are designed so that there is intimate contact between the back of the coil insulation and pole brick and the carcase. In this case the pole brick should be positioned about 0.5 mm proud of the back of the coil and a washer made from resin impregnated felt fitted to the back of the coil. Cure the felt after fitting the coil to the frame.

7.4.3 Measure the pole bore radii. Subtract the armature radius. The front air gap must be within 3% of the average gap determined from the measurements taken in 7.1.7.

7.5. Re-connection

7.5.1 Thimble connections should have the contact area checked. Renew or repair any which have less than 50% contact area.

7.5.2 Clean contact faces of all bolted joints and re-tin.

7.5.3 When brazing, all adjacent insulation should be protected.

7.5.4 Re-make and tighten all connections.

7.5.5 Machines which work in a dirty environment must have the connections insulated as follows:-

7.5.5.1 Build up around the joint using two pack epoxy putty to provide a smooth surface on which to apply tape.

7.5.5.2 Insulate the joint with at least 3 layers of resin impregnated sealing tape applied half lap.

7.5.5.3 Overtape the seal with a layer of varnished glass tape.

7.5.6 Wrap cables adjacent to the frame staples with insulation and lash the cables to the staples.

7.5.7 If some of the field or interpole coils have not been re-insulated heat the frame to 160°C to dry it out. Allow to cool to 40°C. Treat tapped holes, connection surfaces and machined surfaces with release agent. Immerse the complete frame in stoving varnish until all bubbling stops. Remove from the varnish, allow to drain and stove to cure. Remove varnish from tapped holes, connection surfaces and machined surfaces.

Procedure For Reinsulation of D.C. Field Systems Cont'd

7.6. Testing

7.6.1 Measure and record the circuit resistance(s). If a value has been specified by BRB M&EE Department Derby the figure must be within 5% of that.

7.6.2 Measure and record the insulation resistance using a megger, the voltage and minimum value must be in accordance with Table 2.

7.6.3 If the IR value is acceptable carry out a final HPIT of the coil or field system at the value specified in Table 2.

7.6.4 Repeat operation 7.6.2. If the value obtained is more than 10% below the previous value investigate the cause, rectify in accordance with the appropriate parts of this specification and re-test.

TABLE 2 INSULATION TESTING OF D.C FIELD SYSTEMS

The voltages to be used when testing a field system or individual coil depend on the working voltage and duty of the machine. There are 5 categories of machines as follows:-

Cat. 1 Auxiliary Machines Operating at up to 50 volts
Cat. 2 Auxiliary Machines Operating at up to 200 volts
Cat. 3 Auxiliary Machines Operating at up to 600 volts
Cat. 4 All Other Machines fitted to vehicles fed from AC or DC overhead or third rail supply
Cat. 5 All Other Machines fitted to Diesel Electric Vehicles.

NOTES

1. HPIT means High Pressure Insulation Test and shall be carried out using AC at 50 Hz.
2. Megger testing shall be carried out at room temperature using a proprietary insulation tester supplying d.c. at the appropriate voltage.
3. The Final HPIT shall be carried out at the voltage given in the Table unless a different figure is specified in writing by BRB M&EE Department Derby.
4. The Value 'F' shall be equal to the voltage used for the Final HPIT as specified in Note 3.
5. The value 'U' shall be the Highest Voltage to Earth on machine in normal service
6 Where a machine falls into two categories the higher test requirement shall apply.

MACHINE CATEGORY:-		1	2	3	4	5
TEST	TIME	VOLTAGE				
1. MEGGER TESTING						
Minimum Value 20 megs.	-	100 V	500 V	1000 V	1000 V	1000 V
2. FINAL HPIT ON FINISHED COMPONENT (see notes)						
Rewound Components	1 min	250 V	1000 V	U+1000 V	2.25xU+2000 V	2xU+1000 V
Overhauled (Not Rewound) Components	1 min	N/A	500 V	U+500 V	2.25xU+500 V	2xU+500 V
3. PROGRESSIVE TESTING DURING BUILDING						
HPIT Coil on Pole	15 secs	F+200 V	F+400 V	F+400 V	F+400 V	F+400 V

8 PROCEDURE FOR REINSULATION OF ALTERNATOR STATORS

Technical proposals for the reinsulation of alternator stators which are submitted for approval must contain the following information.

a. Maximum Working Voltage to be used as a basis for test voltages. (see table 3)

b. Copper size and insulation. (see clause 8.3)

c. Slot insulation material and thickness. (see clause 8.3)

d. Endwinding insulation material and thickness. (see clause 8.3)

e. Wedge material. (see clause 8.5)

f. Packing material for endwindings and phase rings. (see clause 8.5)

g. Whether VPI or Dip and type of varnish.(see clause 8.7)

h. Any deviations from the following specification.

PROCEDURE

8.1. Examine and Clean

8.1.1 Examine the stator noting all damage. If the repair work required is not fully authorised either by an order or an abnormal work authorisation contact the originator of the order or the BRB Resident Engineer for advice. If the stator obviously requires rewinding or if the order stated that a rewind was required omit operations 8.1.2 to 8.1.4.3.

8.1.2 Measure the insulation resistance using a megger. The voltage and minimum acceptable reading must be in accordance with Table 3.

8.1.3 If the insulation resistance is acceptable contact the originator of the order for advice.

Procedure For Reinsulation of Alternator Stators Contd.

8.1.4 If no fault exists except low insulation reading, carry out the following work.

8.1.4.1 Remove the wedges. Release the endwindings and ease the windings away from the frame and phase ring supports. Clean the windings using a high pressure hot water/detergent lance. Stove to dry.

8.1.4.2 Measure the insulation resistance using a megger. The voltage and minimum acceptable value must be in accordance with Table 3.

8.1.4.3 If the insulation resistance is acceptable omit operations 8.2 to 8.5.2.

8.2. Removal of Defective Windings

8.2.1 Remove all wedges and lashing. If specifications and data are not available record banding, insulation and winding details for future use. Remove defective coils and ease all other coils away from the frame. If a part rewind is proposed it must be approved by BRB M&EE Department Derby.

8.2.2 If any serious damage is revealed during stripping the method of reclamation shall be approved by BRB M&EE Department Derby.

8.2.3 Clean the laminations and frame. If any windings are left in the frame clean the laminations, frame and remaining coils in accordance with WOSS 501/1.

8.2.4 Check the core slots for any damage which is likely to damage the windings and rectify.

8.2.5 If any serious damage to the stator laminations or frame is revealed during stripping the method of reclamation must be discussed with and approved by BRB M&EE Department Derby.

8.3 Coil Insulation

8.3.1 When it is proposed to use re-claimed coils this must be approved by BRB M&EE Department Derby. For traction and train heating alternators a pressed slot insulation system is preferred. When wrapping the slot cell, taper the insulation on the slot extension so that a good seal can be made between that and the endwinding taping.

Procedure For Reinsulation of Alternator Stators Contd.

8.3.2 The endwindings are to be taped with an insulating material which is flexible when fitted. Additional protection such as a layer of glass tape may be required.

8.3.3 For machines where a pressed slot insulation cannot be used insulate the complete coils using a tape which is flexible when fitted. Additional protection such as a layer of glass tape may be required.

8.3.4 For small machines wound with enamelled wire a slot liner made from Nomex/polyester film laminate or similar may be used and the coils wrapped with glass tape only.

8.4. Carry out a HPIT on sample coils i.e. one from each alternator set but a minimum of two coils. Test between adjacent but unconnected conductors and between all conductors and a piece of metal foil wrapped tightly round the slot portion of the coil including slot liner where used. Voltages must be as detailed in Table 3.

8.5. Fitting Coils

8.5.1 Where a pressed slot cell is used fit strips of insulation either side of the bottom limbs of all coils.

8.5.2 Trim the ends of the conductors and TIG weld or braze the connections.

8.6. Wedge the coils in the core and lash the endwindings and phase rings into position packing with insulation to provide firm support and mechanical protection.

8.7. Measure and record the insulation resistance using a megger, the voltage and minimum value must be in accordance with Table 3.

8.8. If the IR value is acceptable carry out a final HPIT between the windings and earth at the voltage specified in Table 3.

8.9. Repeat operation 8.7. If the value obtained is more than 10% below the previous value investigate the cause, rectify in accordance with the appropriate parts of this specification and re-test.

8.10. Measure and record the circuit resistance - maximum variation phase to phase to be 5%.

8.11. Impregnate the windings using stoving varnish and cure.

TABLE 3 INSULATION TESTING OF ALTERNATOR STATORS

The voltages to be used when testing an alternator stator depend on its working voltage and duty. There are 5 categories of machines as follows:-

Cat. 1 Auxiliary Machines Operating at up to 50 volts
Cat. 2 Auxiliary Machines Operating at up to 200 volts
Cat. 3 Auxiliary Machines Operating at up to 600 volts
Cat. 4 All Other Machines fitted to vehicles fed from AC or DC overhead or third rail supply
Cat. 5 All Other Machines fitted to Diesel Electric Vehicles.

NOTES

1. HPIT means High Pressure Insulation Test and shall be carried out using AC at 50 Hz.
2. Megger testing shall be carried out at room temperature using a proprietary insulation tester supplying d.c. at the appropriate voltage.
3. The Final HPIT shall be carried out at the voltage given in the Table unless a different figure is specified in writing by BRB M&EE Department Derby.
4. The Value 'F' shall be equal to the voltage used for the Final HPIT as specified in Note 3.
5. The value 'U' shall be the Highest Voltage to Earth on machine in normal service
6 Where a machine falls into two categories the higher test requirement shall apply.

MACHINE CATEGORY:-		1	2	3	4	5
TEST	TIME	VOLTAGE				
1. MEGGER TESTING						
Minimum Value 20 megs.	-	100 V	500 V	1000 V	1000 V	1000 V
2. FINAL HPIT ON FINISHED COMPONENT (see notes)						
Rewound Components	1 min	250 V	1000 V	U+1000 V	2.25xU+2000 V	2xU+1000 V
Overhauled (Not Rewound) Components	1 min	N/A	500 V	U+500 V	2.25xU+500 V	2xU+500 V
3. PROGRESSIVE TESTING DURING BUILDING						
HPIT Interturn test sample coils	15 secs	100 V	100 V	250 V	500 V	500 V
HPIT test to earth on slot portion of sample coils	15 secs	N/A	1200 V	F+600 V	F+600 V	F+600 V
HPIT Windings to earth after earth after wedging	60 secs	120 V	1100 V	F+400 V	F+400 V	F+400 V

9 PROCEDURE FOR REINSULATION OF MACHINES NOT COVERED BY CLAUSES 6 TO 8 (eg Alternator Rotors, Chokes, Transformers)

Technical proposals for the reinsulation of machines not covered by clauses 6 to 8 which are submitted for approval must contain the following information.

a. Maximum Working Voltage to be used as a basis for test voltages. (see table 4)

b. Copper size and insulation to be renewed.

c. Full details of proposed insulation system.

d. Type of repair.

e. Full details of proposed testing.

f. Any other details required by D of M & EE, BRB.

PROCEDURE

9.1. Examine the components noting all damage. If the repair work required is not fully authorised either by an order or an abnormal work authorisation contact the originator of the order or the BRB Resident Engineer for advice.

9.2. Measure the insulation resistance using a megger. The voltage and minimum acceptable readings to be in accordance with Table 4.

9.3. If the insulation resistance is acceptable and no other damage is evident contact the originator of the order for advice.

9.4 If no fault exists except low insulation resistance, carry out the following work:

9.4.1 Clean the component in accordance with WOSS 501/1

9.4.2 Using a megger measure the insulation resistance. If the insulation resistance is acceptable renew damaged insulation. Impregnate the insulation with varnish.

9.5. If a specific fault is located or if the insulation resistance cannot be raised to an acceptable level by cleaning, repair the fault.

9.6. Megger and HPIT test the insulation in accordance with Table 4.

9.7. Measure the circuit resistance.

9.8. Carry out any function tests requested by BRB M&EE Department Derby.

TABLE 4 INSULATION TESTING OF EQUIPMENT NOT COVERED BY TABLES 1-3

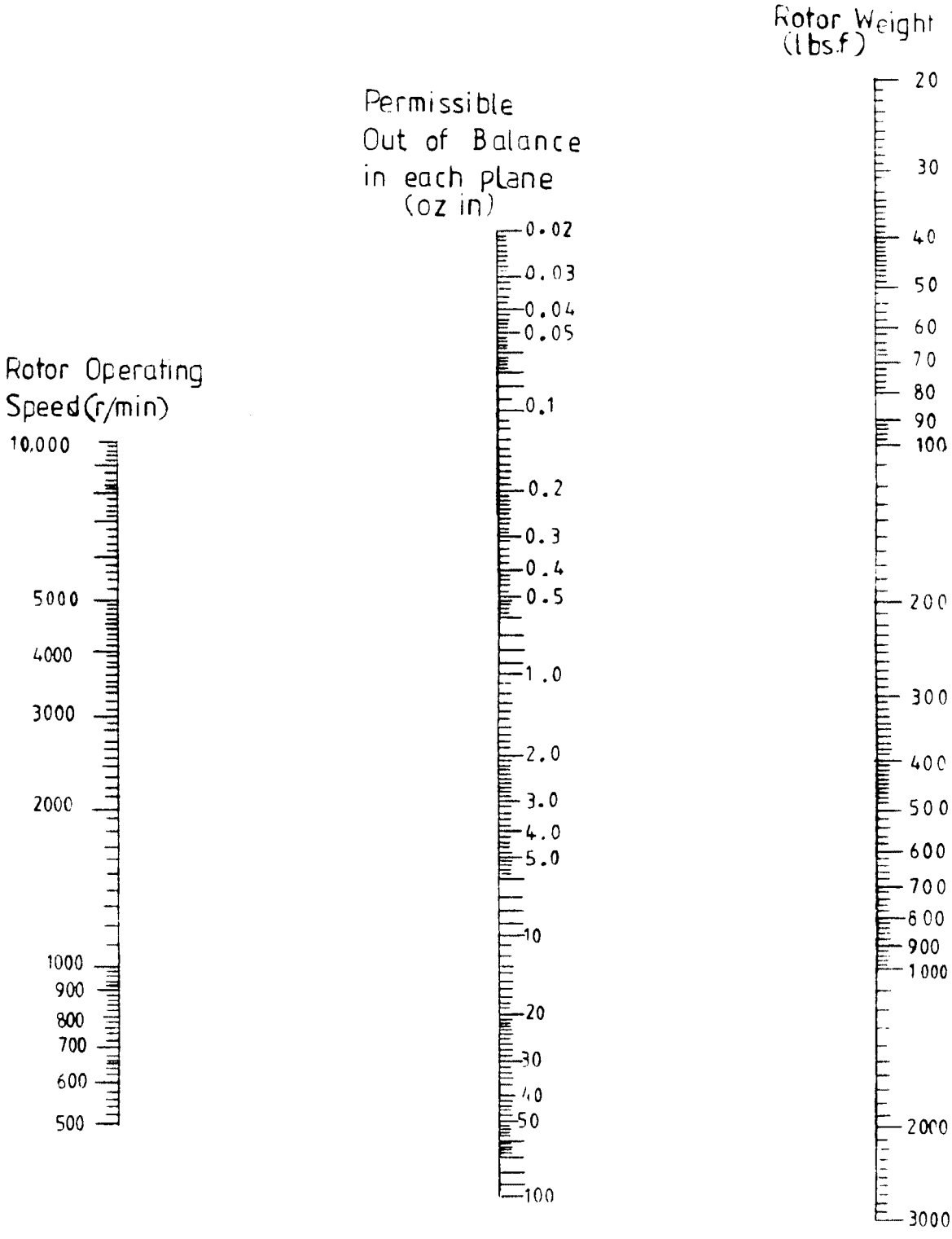
The voltages to be used when testing miscellaneous equipment depend on its working voltage and duty. There are 5 categories of machines as follows:-

Cat. 1 Auxiliary Machines Operating at up to 50 volts
Cat. 2 Auxiliary Machines Operating at up to 200 volts
Cat. 3 Auxiliary Machines Operating at up to 600 volts
Cat. 4 All Other Machines fitted to vehicles fed from AC or DC overhead or third rail supply
Cat. 5 All Other Machines fitted to Diesel Electric Vehicles.

NOTES

1. HPIT means High Pressure Insulation Test and shall be carried out using AC at 50 Hz.
2. Megger testing shall be carried out at room temperature using a proprietary insulation tester supplying d.c. at the appropriate voltage.
3. The Final HPIT shall be carried out at the voltage given in the Table unless a different figure is specified in writing by BRB M&EE Department Derby.
4. The Value 'F' shall be equal to the voltage used for the Final HPIT as specified in Note 3.
5. The value 'U' shall be the Highest Voltage to Earth on machine in normal service
6 Where a machine falls into two categories the higher test requirement shall apply.

MACHINE CATEGORY:-		1	2	3	4	5
TEST	TIME	VOLTAGE				
1. MEGGER TESTING						
Minimum Value 20 megs.	-	100 V	500 V	1000 V	1000 V	1000 V
2. FINAL HPIT ON FINISHED COMPONENT (see notes)						
Rewound Components	1 min	250 V	1000 V	U+1000 V	2.25xU+2000 V	2xU+1000 V
Overhauled (Not Rewound) Components	1 min	N/A	500 V	U+500 V	2.25xU+500 V	2xU+500 V
3. PROGRESSIVE TESTING DURING BUILDING						
As Requested by D of M & EE BRB						



Copied from BR Drawing TEE A4 9028987

Table 5 Nomogram for balancing auxiliary rotating machines.

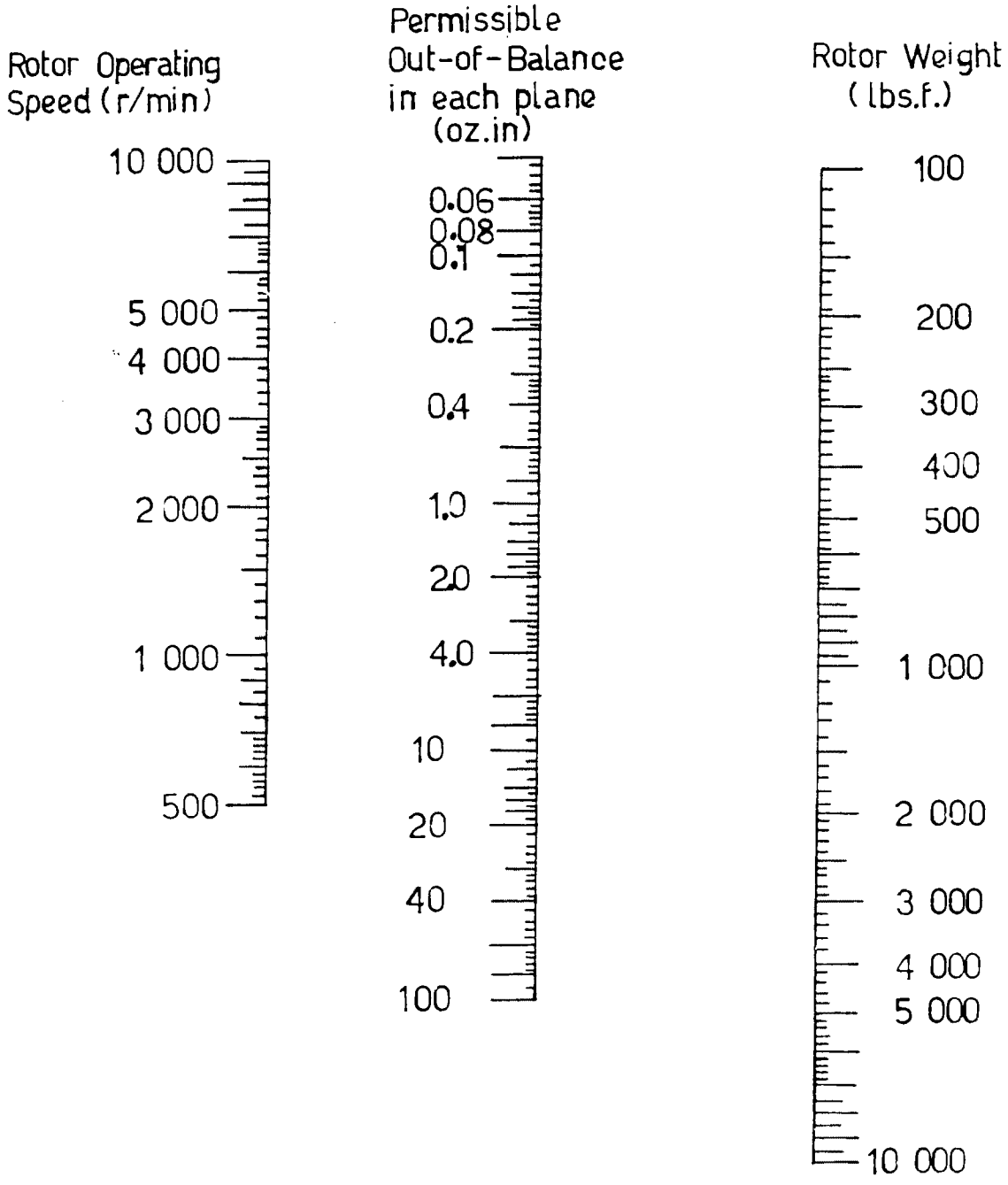


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Table 6 Nomogram for balancing traction machine armatures.

APPENDIX A

Application for approval of repair procedure for Electrical Equipment fitted to BR Traction and Rolling Stock.

1. From

2. Details of Equipment to be repaired.....
(give brief description if type and manufacturer is not known).

3. Type of repair .....

4. Origin of order(s).....

5. Quantity to be repaired .....
(If several orders are expected approval will be considered for the estimated quantity to be repaired during a 12 month period)

6. Details of proposed repairs:-

Signed .....

Date .....

Ref. No. .....

INDEX TO DATA SHEETS - Traction Motors

Fitted to	Make	Type	Data Sheet No.
CL.25	AEI	253	A1
CL.25	"	253AY	A2
	"		
CL.503	"	MV221	Contact D of M & EE BRB
	"		" "
CL.31	BRUSH	TM 73/68	A3
CL.26	CROMPTON PARKINSON	C 171A1	A4
CL.33	" "	C 171C2	A5
CL.45	" "	C 172A1	A6
Shunters	ENGLISH ELECTRIC	506A)	
	" "	506/5A)	A7
	" "	506/6A)	
	" "	506/7C)	A8
	" "	506/10C)	
	" "		
CL.20/40	" "	526/5D)	A9
	" "	526/7D)	
CL.504	" "	528/1A	Contact D of M & EE, BRB
	" "		
CL.83	" "	535A	A10
CL.302/308	" "	536A	A11
CL.73	" "	542A	A12
CL.307	GEC	344)	A13
		344A)	
CL.305	"	380	A14
CL.309	"	401	A15
CL.27	"	459	A16

INDEX TO DATA SHEETS - Main Generators

Fitted to	Make and Type		Data Sheet No.
CL.25)	AEI	RTB15656	B1
)		(10 Pole)	
)	"	RTB15656	B2
)		(12 Pole)	
CL.31	BRUSH	TG160-48	B3
CL.26	CROMPTON PARKINSON	CG 391 A1	B4
CL.45		CG 426 A1	B5
	ENGLISH ELECTRIC		
CL.20	" "	819/3C	B6
)		822/10G)	
)		822/13G)	
CL.37)	" "	822/15G)	B7
)		822/16J)	
)		822/18J)	
CL.201-205	" "	824/2C	Contact DM & EE BRB
CL.207	" "	824/4C	" "
CL.27	GEC	WT981	B8

INDEX TO DATA SHEETS - Auxiliary Generators

Fitted to	Make and Type		Data Sheet No.
CL.25	AEI	RTB 7440	C1
CL.31	BRUSH	TG 69-24 Mk I	C2
		TG 69-24 Mk IA	C3
CL.26	CROMPTON PARKINSON	CAG 193 A1	See WOSS 410/13 (data)
CL.45	" "	CAG 252 A1	Contact DM & EE BRB
CL.73	ENGLISH ELECTRIC	908/3C	C4
CL.20	" "	911/2B	C5
CL.37	" "	911/5C	C6
CL.26	GEC	WT 782	C7

SHEET A1

DATA FOR MACHINE TYPE AEI 253 Traction Motor

Thermal Class of Insulation to be used		H
Permissible out of balance		1.5 oz in
Weight of armature		1140 lb
Diameter of armature		18 in
Machine Overspeed		3100 rev/min
Volume of Cooling Air (Force Ventilated Machines)		1850 cf/m
Commutator Working Face Scrapping Diameter		12.0 in
Commutator Working Face Minimum Diameter for Rewinding		12.3 in
Commutator Riser Minimum Diameter for Rewinding		17.57 in
Commutator Riser Width, Minimum Width for Rewinding	Tig Welded:	0.40 in
	Soldered :	0.43 in
Commutator Bolt Tightening Torque		90 lb ft
Continuous Rating	315 V : 650 Amp : 234 HP : 465 RPM	
One Hour Rating	310 V : 660 Amp : 234 HP : 450 RPM	
Maximum Working Voltage	- Across Terminals	500 V
	- To Earth	1000 V
Finished Winding HPIT at		3000 V

SHEET A2

DATA FOR MACHINE TYPE AEI 253 AY (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		1.5 oz ins
Weight of armature		1140 lbs
Diameter of armature		18 ins
Machine Overspeed		3100 RPM
Volume of Cooling Air (Force Ventilated Machines)		1850 cf/m
Commutator Working Face Scrapping Diameter		12.0 ins
Commutator Working Face Minimum Diameter for Rewinding		12.3 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		
Continuous Rating	330 V : 650 Amps : 248 HP : 490 RPM	
One Hour Rating	315 V : 680 Amps : 245 HP : 455 RPM	
Maximum Working Voltage	- Across Terminals	500 V
	- To Earth	1000 V
Finished Winding HPIT at		3000 V

SHEET A3

DATA FOR MACHINE TYPE BRUSH TM73-68 (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		3.2 oz ins
Weight of armature		1998 lbs
Diameter of armature		18.25 ins
Machine Overspeed		2650 RPM
Volume of Cooling Air (Force Ventilated Machines)		2500 cf/m
Commutator Working Face Scrapping Diameter		13.875 ins
Commutator Working Face Minimum Diameter for Rewinding		14.326 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		
Continuous Rating	270 HP : 375 V : 600 Amps : 530 RPM	
One Hour Rating		
Maximum Working Voltage	- Across Terminals	500 V
	- To Earth	1000 V
Finished Winding HPIT at		3000 V

SHEET A4

DATA FOR MACHINE TYPE CROMPTON PARKINSON C171A (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		See Table 6
Weight of armature		1680 lbs
Diameter of armature		17 ins
Machine Overspeed		2740 RPM
Volume of Cooling Air (Force Ventilated Machines)		2250 cf/m
Commutator Working Face Scrapping Diameter		13.5 ins
Commutator Working Face Minimum Diameter for Rewinding		13.85 ins
Commutator Riser Minimum Diameter for Rewinding		16.8 ins
Commutator Riser Width, Minimum Width for Rewinding		0.6 ins
Commutator Bolt Tightening Torque		125 lbs ft
Continuous Rating	440 Volts : 430 Amps : 224 HP : 340 RPM	
One Hour Rating	400 Volts : 470 Amps : 221 HP : 295 RPM	
Maximum Working Voltage	- Across Terminals	840 Volts
	- To Earth	840 Volts
Finished Winding HPIT at		3000 Volts

SHEET A5

DATA FOR MACHINE TYPE CROMPTON PARKINSON $C171C_2$ (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		1.8 oz ins
Weight of armature		1680 lbs
Diameter of armature		17 ins
Machine Overspeed		2740 RPM
Volume of Cooling Air (Force Ventilated Machines)		2250 cf/m
Commutator Working Face Scrapping Diameter		13.5 ins
Commutator Working Face Minimum Diameter for Rewinding		13.85 ins
Commutator Riser Minimum Diameter for Rewinding		16.8 ins
Commutator Riser Width, Minimum Width for Rewinding		0.6 ins
Commutator Bolt Tightening Torque		125 lbs ft
Continuous Rating	580 V : 440 Amps : 305 HP : 450 RPM	
One Hour Rating	530 V : 485 Amps : 305 HP : 388 RPM	
Maximum Working Voltage	- Across Terminals	840 V
	- To Earth	840 V
Finished Winding HPIT at		3000 V

SHEET A6

DATA FOR MACHINE TYPE CROMPTON PARKINSON C172 A1. (T.M)

Thermal Class of Insulation to be used		F
Permissible out of balance		1.8 oz ins
Weight of armature		1388 lbs
Diameter of armature		17 ins
Machine Overspeed		2740 rpm
Volume of Cooling Air (Force Ventilated Machines)		2250 cf/m
Commutator Working Face Scrapping Diameter		13.5 ins
Commutator Working Face Minimum Diameter for Rewinding		13.85 ins
Commutator Riser Minimum Diameter for Rewinding		16.8 ins
Commutator Riser Width, Minimum Width for Rewinding		0.6 ins
Commutator Bolt Tightening Torque		125 lbs ft
Continuous Rating	620 V : 440 Amps : 337 HP : 650 RPM	
One Hour Rating	580 V : 485 Amps : 340 HP : 600 RPM	
Maximum Working Voltage	- Across Terminals	1000 V
	- To Earth	1000 V
Finished Winding HPIT at		3000 V

SHEET A7

DATA FOR MACHINE TYPE ENGLISH ELECTRIC EE506/A-5A-6A(T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		0.75 oz ins
Weight of armature		800 lbs
Diameter of armature		12.0625 ins
Machine Overspeed		3600 RPM
Volume of Cooling Air (Force Ventilated Machines)		1000 cf/m
Commutator Working Face Scrapping Diameter		9.5 ins
Commutator Working Face Minimum Diameter for Rewinding		11.74 ins
Commutator Riser Minimum Diameter for Rewinding		0.6 ins
Commutator Riser Width, Minimum Width for Rewinding		0.6 ins
Commutator Bolt Tightening Torque		85 lbs ft
Continuous Rating	400 V : 235 Amps : 115 HP : 1010 RPM	
One Hour Rating	400 V : 280 Amps : 135 HP ; 920 RPM	
Maximum Working Voltage	- Across Terminals	550 V
	- To Earth	550 V
Finished Winding HPIT at		2100 V

SHEET A8

DATA FOR MACHINE TYPE ENGLISH ELECTRIC EE 506/7c-10c(T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		0.75 oz ins
Weight of armature		800 lbs
Diameter of armature		12.0625 ins
Machine Overspeed		3600 RPM
Volume of Cooling Air (Force Ventilated Machines)		1000 cf/m
Commutator Working Face Scrapping Diameter		9.5 ins
Commutator Working Face Minimum Diameter for Rewinding		9.75 ins
Commutator Riser Minimum Diameter for Rewinding		11.76 ins
Commutator Riser Width, Minimum Width for Rewinding		0.6 ins
Commutator Bolt Tightening Torque		85 lbs ft
Continuous Rating	400 V : 280 Amps : 135 HP : 920 RPM	
One Hour Rating	400 V : 325 Amps : 155 HP : 855 RPM	
Maximum Working Voltage	- Across Terminals	550 V
	- To Earth	550 V
Finished Winding HPIT at		2100 V

SHEET A9

DATA FOR MACHINE TYPE ENGLISH ELECTRIC EE 526-5D/7D (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		
Weight of armature		
Diameter of armature		19 ins
Machine Overspeed		2960 RPM
Volume of Cooling Air (Force Ventilated Machines)		2000 cf/m
Commutator Working Face Scrapping Diameter		15.0 ins
Commutator Working Face Minimum Diameter for Rewinding		15.2 ins
Commutator Riser Minimum Diameter for Rewinding		65 Brinell
Commutator Riser Width, Minimum Width for Rewinding		85 lbs ft
Commutator Segment Minimum Hardness		
Commutator Bolt Tightening Torque		
Continuous Rating	212 HP : 300 V : 600 Amps : 362 RPM	
One Hour Rating	228 HP : 300 V : 650 Amps : 349 RPM	
Maximum Working Voltage	- Across Terminals	
	- To Earth	
Finished Winding HPIT at		

SHEET A10

DATA FOR MACHINE TYPE ENGLISH ELECTRIC EE 535-A (T.M.)

Thermal Class of Insulation to be used		H
Permissible out of balance		
Weight of armature		1780 lbs
Diameter of armature		
Machine Overspeed		
Volume of Cooling Air (Force Ventilated Machines)		3500 cf/m
Commutator Working Face Scrapping Diameter		14.25 ins
Commutator Working Face Minimum Diameter for Rewinding		14.75 ins
Commutator Riser Minimum Diameter for Rewinding		18.66 ins
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		85 lbs ft
Continuous Rating	750 HP : 837 V : 707 Amps : 1210 RPM	
One Hour Rating	800 HP : 830 V : 760 Amps : 1175 RPM	
Maximum Working Voltage	- Across Terminals	1000 V
	- To Earth	1000 V
Finished Winding HPIT at		4250 V

DATA FOR MACHINE TYPE ENGLISH ELECTRIC EE536/A (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		1.2 oz ins
Weight of armature		990 lbs
Diameter of armature		14 ins
Machine Overspeed		3000 rpm
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		11.75 ins
Commutator Working Face Minimum Diameter for Rewinding		12.05 ins
Commutator Riser Minimum Diameter for Rewinding		13.65 ins
Commutator Riser Width, Minimum Width for Rewinding		0.493 ins
Commutator Bolt Tightening Torque		85 lbs ft
Continuous Rating	232 HP : 620 V : 300 Amps : 1450 RPM	
One Hour Rating	272 HP : 620 V : 350 Amps : 1350 RPM	
Maximum Working Voltage	- Across Terminals	1000 V
	- To Earth	1000 V
Finished Winding HPIT at		4250 V

SHEET A12

DATA FOR MACHINE TYPE ENGLISH ELETRIC EE 542/A (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		1.4 oz ins
Weight of armature		1194 lbs
Diameter of armature		15 ins
Machine Overspeed		3070 RPM
Volume of Cooling Air (Force Ventilated Machines)		2200 cf/m
Commutator Working Face Scrapping Diameter		12.0 ins
Commutator Working Face Minimum Diameter for Rewinding		12.2 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		
Continuous Rating	360 HP : 425 Amps : 675 V : 1050 RPM	
One Hour Rating	400 HP : 475 Amps : 675 V : 101 RPM	
Maximum Working Voltage	- Across Terminals	800 V
	- To Earth	800 V
Finished Winding HPIT at		3800 V

DATA FOR MACHINE TYPE GEC WT.344 (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		1.7 oz ins
Weight of armature		960 lbs
Diameter of armature		13 ins
Machine Overspeed		3000 RPM
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		10.5 ins
Commutator Working Face Minimum Diameter for Rewinding		10.9 ins
Commutator Riser Minimum Diameter for Rewinding		13.0 ins
Commutator Riser Width, Minimum Width for Rewinding		0.65 ins
Commutator Bolt Tightening Torque		120 lbs ft
Continuous Rating	675 V : 190 Amps : 158 HP : 1360 RPM	
One Hour Rating	675 V : 242 Amps : 200 HP : 1050 RPM	
Maximum Working Voltage	- Across Terminals	800 V
	- To Earth	1600 V
Finished Winding HPIT at		5600 V

DATA FOR MACHINE TYPE GEC WT 380 (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		1.6 oz ins
Weight of armature		1100 lbs
Diameter of armature		15 ins
Machine Overspeed		3000 RPM
Volume of Cooling Air (Force Ventilated Machines)		Self vent
Commutator Working Face Scrapping Diameter		12.5 ins
Commutator Working Face Minimum Diameter for Rewinding		12.9 ins
Commutator Riser Minimum Diameter for Rewinding		14.65 ins
Commutator Riser Width, Minimum Width for Rewinding		0.65 ins
Commutator Bolt Tightening Torque		80 lbs ft
Continuous Rating	693 V : 220 Amps : 189 HP : 1140 RPM	
One Hour Rating	680 V : 270 Amps : 226 HP : 1020 RPM	
Maximum Working Voltage	- Across Terminals	830 V
	- To Earth	1000 V
Finished Winding HPIT at		4250 V

DATA FOR MACHINE TYPE GEC WT 401 (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		1.8 oz ins
Weight of armature		1355 lbs
Diameter of armature		16 ins
Machine Overspeed		3000 RPM
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		12.75 ins
Commutator Working Face Minimum Diameter for Rewinding		13.05 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		.4 before .375 after
Commutator Bolt Tightening Torque		123 lbs ft
Continuous Rating	256 HP : 355 Amps :	580 V : 1095 RPM
One Hour Rating	282 HP : 400 Amps :	570 V : 1395 RPM
Maximum Working Voltage	- Across Terminals	830 V
	- To Earth	830 V
Finished Winding HPIT at		V

SHEET A16

DATA FOR MACHINE TYPE GEC WT 459 (T.M.)

Thermal Class of Insulation to be used		F
Permissible out of balance		2.2 oz ins
Weight of armature		1568 lbs
Diameter of armature		18.25 ins
Machine Overspeed		2980 RPM
Volume of Cooling Air (Force Ventilated Machines)		2500 cf/m
Commutator Working Face Scrapping Diameter		15.0 ins
Commutator Working Face Minimum Diameter for Rewinding		15.4 ins
Commutator Riser Minimum Diameter for Rewinding		17.2 ins
Commutator Riser Width, Minimum Width for Rewinding		0.75 ins
Commutator Bolt Tightening Torque		110 lbs ft
Continuous Rating	415 V : 485 Amps : 236 HP : 386 RPM	
One Hour Rating	415 V : 525 Amps : 248 HP : 370 RPM	
Maximum Working Voltage	- Across Terminals	750 V
	- To Earth	750 V
Finished Winding HPIT at		2600 V

SHEET B1

DATA FOR MACHINE TYPE AEI RTB 15656 (10 POLE M.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		26 oz ins
Weight of armature		6100 lbs
Diameter of armature		39 ins
Machine Overspeed		900 RPM
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		37.25 ins
Commutator Working Face Minimum Diameter for Rewinding		37.55 ins
Commutator Riser Minimum Diameter for Rewinding		Pollock Commr
Commutator Riser Width, Minimum Width for Rewinding		Pollock Commr
Commutator Bolt Tightening Torque		Pollock Commr
Continuous Rating	820 KW : 750 RPM : 910 Amps : 900 V	
One Hour Rating	820 KW : 750 RPM : 1300 Amps : 630 V	
Maximum Working Voltage	- Across Terminals	1000 V
	- To Earth	1000 V
Finished Winding HPIT at		3000 V

SHEET B2

DATA FOR MACHINE TYPE AEI RTB 15656 (12 POLE M.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		26 oz ins
Weight of armature		6100 lbs
Diameter of armature		39 ins
Machine Overspeed		900 RPM
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		37.25 ins
Commutator Working Face Minimum Diameter for Rewinding		37.55 ins
Commutator Riser Minimum Diameter for Rewinding		Pollock Commr
Commutator Riser Width, Minimum Width for Rewinding		Pollock Commr
Commutator Bolt Tightening Torque		Pollock Commr
Continuous Rating	750 V : 980 Amps : 750 RPM : 735 Kw	
One Hour Rating	525 V : 1400 Amps : 750 RPM : 735 Kw	
Maximum Working Voltage	- Across Terminals	880 V
	- To Earth	880 V
Finished Winding HPIT at		2800 V

SHEET B3

DATA FOR MACHINE TYPE BRUSH TG160-48 (M.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		12 oz ins
Weight of armature		5486 lbs
Diameter of armature		40 ins
Machine Overspeed		1020 RPM
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		34.75 ins
Commutator Working Face Minimum Diameter for Rewinding		35.25 ins
Commutator Riser Minimum Diameter for Rewinding		39.55 ins
Commutator Riser Width, Minimum Width for Rewinding		0.65 ins
Commutator Bolt Tightening Torque		120 lbs ft
Continuous Rating	980 KW : 816 V : 1200 Amps : 850 RPM	
One Hour Rating	980 KW : 740 V : 1320 Amps : 850 RPM	
Maximum Working Voltage	- Across Terminals	1000 V
	- To Earth	1000 V
Finished Winding HPIT at		3000 V

SHEET B4

DATA FOR MACHINE TYPE CROMPTON PARKINSON CG391-A1 (M.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		18 oz ins
Weight of armature		3654 lbs
Diameter of armature		39.5 ins
Machine Overspeed		900 RPM
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		35.5 ins
Commutator Working Face Minimum Diameter for Rewinding		
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		125 lbs ft
Continuous Rating	757/760 KW : 440/800 V : 1720/950 Amps : 750 RPM	
One Hour Rating	752 KW : 40 V : 1880 Amps : 750 RPM	
Maximum Working Voltage	- Across Terminals	
	- To Earth	
Finished Winding HPIT at		3000 V

DATA FOR MACHINE TYPE CROMPTON PARKINSON CG 426 A1 (M.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		12 oz ins
Weight of armature		5910 lbs
Diameter of armature		42 ins
Machine Overspeed		1295 RPM
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		31.5 ins
Commutator Working Face Minimum Diameter for Rewinding		32.0 ins
Commutator Riser Minimum Diameter for Rewinding		not to be machined
Commutator Riser Width, Minimum Width for Rewinding		not to be machined
Commutator Bolt Tightening Torque		125 lbs ft
Continuous Rating	1531 kW : 580 V : 2640 Amps : 1080 RPM	
One Hour Rating	1510 kW : 530 V : 3850 Amps : 1080 RPM	
Maximum Working Voltage	- Across Terminals	1000 V
	- To Earth	1000 V
Finished Winding HPIT at		3000 V

SHEET B6

DATA FOR MACHINE TYPE ENGLISH ELECTRIC EE 819-3c (M.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		
Weight of armature		
Diameter of armature		27 ins
Machine Overspeed		1020 RPM
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		23.0 ins
Commutator Working Face Minimum Diameter for Rewinding		23.4 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Segment Minimum Hardness		Brinell
Commutator Bolt Tightening Torque		
Continuous Rating	640 KW : 600 V : 1070 Amps : 850 RPM	
One Hour Rating		
Maximum Working Voltage	- Across Terminals	850 V
	- To Earth	850 V
Finished Winding HPIT at		2700 V

SHEET B7

DATA FOR MACHINE TYPE ENGLISH ELECTRIC EE 822-/10G,13G,15G,: 16J & 18J

Thermal Class of Insulation to be used		H
Permissible out of balance		
Weight of armature		
Diameter of armature		35 ins
Machine Overspeed		1020 RPM
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		30.25 ins
Commutator Working Face Minimum Diameter for Rewinding		30.55 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		
Continuous Rating	1107 KW : 615 V : 1800 Amps : 850 RPM	
One Hour Rating		
Maximum Working Voltage	- Across Terminals	950 V
	- To Earth	950 V
Finished Winding HPIT at		2900 V

SHEET B8

DATA FOR MACHINE TYPE GEC WT 981 (M.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		12 oz ins
Weight of armature		4689 lbs
Diameter of armature		40 ins
Machine Overspeed		900 rpm
Volume of Cooling Air (Force Ventilated Machines)		Self Vent
Commutator Working Face Scrapping Diameter		36.75 ins
Commutator Working Face Minimum Diameter for Rewinding		37.1 ins
Commutator Riser Minimum Diameter for Rewinding		39.2 ins
Commutator Riser Width, Minimum Width for Rewinding		0.85 ins
Commutator Bolt Tightening Torque		100 lbs ft
Continuous Rating	885 kw : 415 V : 1940 Amps : 750 RPM	
One Hour Rating	385 V : 2100 Amps : 750 RPM	
Maximum Working Voltage	- Across Terminals	700 V
	- To Earth	700 V
Finished Winding HPIT at		2400 V

SHEET C1

DATA FOR MACHINE TYPE AEI RTB 7440 (A.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		4.8 oz ins
Weight of armature		968 lbs
Diameter of armature		18.5 ins
Machine Overspeed		900 RPM
Volume of Cooling Air (Force Ventilated Machines)		From M. G.
Commutator Working Face Scrapping Diameter		13.875 ins
Commutator Working Face Minimum Diameter for Rewinding		14.12 ins
Commutator Riser Minimum Diameter for Rewinding		Pollock Commr
Commutator Riser Width, Minimum Width for Rewinding		Pollock Commr
Commutator Bolt Tightening Torque		Pollock Commr
Continuous Rating	36.5 KW : 330 Amps : 110 V : 325/750 RPM	
One Hour Rating	54 KW : 490 Amps : 110 V : 325/750 RPM	
Maximum Working Voltage	- Across Terminals	110 V
	- To Earth	110 V
Finished Winding HPIT at		2000 V

SHEET C2

DATA FOR MACHINE TYPE BRUSH TG 69-24 MK 1 (A.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		2.6 oz ins
Weight of armature		644 lb
Diameter of armature		17.25 ins
Machine Overspeed		1020 RPM
Volume of Cooling Air (Force Ventilated Machines)		From Main Generator
Commutator Working Face Scrapping Diameter		14.25 ins
Commutator Working Face Minimum Diameter for Rewinding		14.75 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		
Continuous Rating	30 KW : 110 V : 273 Amps : 450/850 RPM	
One Hour Rating		
Maximum Working Voltage	- Across Terminals	110 V
	- To Earth	110 V
Finished Winding HPIT at		2000 V

SHEET C3

DATA FOR MACHINE TYPE BRUSH TG 69-24 MK IA (A.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		2.6 oz ins
Weight of armature		644 lb
Diameter of armature		17.25 ins
Machine Overspeed		1020 RPM
Volume of Cooling Air (Force Ventilated Machines)		From Main Generator
Commutator Working Face Scrapping Diameter		14.25 ins
Commutator Working Face Minimum Diameter for Rewinding		14.75 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		
Continuous Rating	30 KW : 110 V : 273 Amps	
One Hour Rating		
Maximum Working Voltage	- Across Terminals	110 V
	- To Earth	110 V
Finished Winding HPIT at		2000 V

SHEET C4

DATA FOR MACHINE TYPE ENGLISH ELECTRIC EE 908-3C (A.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		2.0 oz ins
Weight of armature		558 lbs
Diameter of armature		17.32 ins
Machine Overspeed		1020 RPM
Volume of Cooling Air (Force Ventilated Machines)		From Main Gen.
Commutator Working Face Scrapping Diameter		14.5 ins
Commutator Working Face Minimum Diameter for Rewinding		14.9 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		
Continuous Rating	29.7 KW : 270 Amps : 110 V : 850 RPM	
One Hour Rating		
Maximum Working Voltage	- Across Terminals	110 V
	- To Earth	110 V
Finished Winding HPIT at		2000 V

SHEET C5

DATA FOR MACHINE TYPE ENGLISH ELECTRIC EEE 911-2B (A.G.)

Thermal Class of Insulation to be used		F
Permissible out of balance		
Weight of armature		
Diameter of armature		17.32 ins
Machine Overspeed		1020 RPM
Volume of Cooling Air (Force Ventilated Machines)		From Main Gen.
Commutator Working Face Scrapping Diameter		14.75 ins
Commutator Working Face Minimum Diameter for Rewinding		15.05 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		
Continuous Rating	43/48 KW : 391/436 Amps : 450/850 RPM : 110 V	
One Hour Rating		
Maximum Working Voltage	- Across Terminals	110 V
	- To Earth	110 V
Finished Winding HPIT at		2000 V

SHEET C6

DATA FOR MACHINE TYPE ENGLISH ELECTRIC EE 911/5c (A.G.)

Thermal Class of Insulation to be used		H
Permissible out of balance		
Weight of armature		
Diameter of armature		17.32 ins
Machine Overspeed		1020 RPM
Volume of Cooling Air (Force Ventilated Machines)		From ETH Gen.
Commutator Working Face Scrapping Diameter		14.75 ins
Commutator Working Face Minimum Diameter for Rewinding		15.05 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		
Continuous Rating	66 KW : 600 Amps : 110 V : 450/850 RPM	
One Hour Rating		
Maximum Working Voltage	- Across Terminals	110 V
	- To Earth	110 V
Finished Winding HPIT at		2000 V

DATA FOR MACHINE TYPE GEC WT 782 (A.G.)

Thermal Class of Insulation to be used		
Permissible out of balance		3.2 oz ins
Weight of armature		800 lbs
Diameter of armature		
Machine Overspeed		900 RPM
Volume of Cooling Air (Force Ventilated Machines)		From Main Gen.
Commutator Working Face Scrapping Diameter		14.0 ins
Commutator Working Face Minimum Diameter for Rewinding		14.4 ins
Commutator Riser Minimum Diameter for Rewinding		
Commutator Riser Width, Minimum Width for Rewinding		
Commutator Bolt Tightening Torque		
Continuous Rating	420/518 Amps : 110 V : 325/450 RPM	
One Hour Rating		
Maximum Working Voltage	- Across Terminals	110 V
	- To Earth	110 V
Finished Winding HPIT at		2000 V