

# **T-T Electric**

## Installation and Maintenance Instruction Manual

### LAKC RANGE

## CONTENTS

<u>Section</u>	<u>Title:</u>
1.	PREFACE.
2.	HEALTH & SAFETY AT WORK.
3.	INTRODUCTION. <ul style="list-style-type: none"><li>• Acceptance.</li><li>• Receiving.</li><li>• Handling.</li><li>• Storage.</li><li>• Description.</li><li>• Classification.</li></ul>
4.	INSTALLATION. <ul style="list-style-type: none"><li>• Location.</li><li>• Mounting.</li><li>• Drive.</li></ul>
5.	POWER SUPPLY. <ul style="list-style-type: none"><li>• Connection diagram.</li><li>• Connections.</li><li>• Earthing.</li><li>• Terminal box.</li><li>• Electrical testing.</li></ul>
6.	PROTECTIVE DEVICES. <ul style="list-style-type: none"><li>• Anti-condensation heaters.</li><li>• Thermistors.</li><li>• Thermostats.</li><li>• Resistance Thermometers.</li><li>• Air Pressure Switches.</li></ul>
7.	VENTILATION. <ul style="list-style-type: none"><li>• AC Fan motors.</li></ul>
8.	OPERATION. <ul style="list-style-type: none"><li>• Inspection after starting.</li><li>• Noise &amp; Vibration.</li><li>• Before putting machine into service.</li><li>• Inspection after short time in service.</li></ul>
9.	MAINTENANCE. <ul style="list-style-type: none"><li>• General.</li><li>• Cleanliness.</li><li>• Brush gear.</li><li>• Commutator.</li><li>• Commutator temperature.</li><li>• Productive Maintenance.</li></ul>
10.	RECOMMENDED MAINTENANCE SCHEDULE. <ul style="list-style-type: none"><li>• Monthly.</li><li>• Six Monthly.</li></ul>

## CONTENTS

<u>Section</u>	<u>Title:</u>
11.	MECHANICAL. <ul style="list-style-type: none"><li>• Bolts.</li><li>• Shaft.</li><li>• Ventilation.</li><li>• Vibration.</li></ul>
12.	LUBRICATION.
13.	REPAIR.
14.	FAILURE.
15.	DISMANTLING. <ul style="list-style-type: none"><li>• Armature removal.</li><li>• Armature installation.</li><li>• Bearing removal.</li><li>• Bearing replacement.</li></ul>
16.	AIR-WATER COOLERS. <ul style="list-style-type: none"><li>• General.</li><li>• Installation.</li><li>• Lifting.</li><li>• Operation.</li><li>• Maintenance.</li><li>• Ancillary equipment.</li></ul>
17.	AIR-AIR COOLERS. <ul style="list-style-type: none"><li>• General.</li><li>• Installation.</li><li>• Lifting.</li><li>• Operation.</li><li>• Maintenance.</li><li>• Ancillary equipment.</li></ul>
18.	FILTERS. <ul style="list-style-type: none"><li>• Cleaning.</li></ul>
19.	MOTOR PROBLEMS – QUICK CHECKLIST. <ul style="list-style-type: none"><li>• Mechanical.</li><li>• Electrical.</li><li>• Commutation.</li></ul>
20.	REPORT FORMS. <ul style="list-style-type: none"><li>• Pre-commissioning.</li><li>• Commissioning.</li><li>• Maintenance.</li></ul>

# T-T Electric

## 1. PREFACE

The purpose of this manual is to describe the Installation, Operation and Maintenance of the LAKC d.c. machines.

The design of LAKC d.c. machines is subject to constant review and the information given may vary from that manufactured due to improvements in design techniques.

The manual has been sectionalised and only the sections applicable to your particular machine should be considered. Before any commissioning or checking of the machines is carried out, the complete book should be studied so that a complete understanding of the operation of the machines is obtained.

**THE INSTRUCTIONS IN THIS MANUAL ARE GIVEN FOR INFORMATION AND GUIDANCE. THE COMPANY CANNOT ACCEPT ANY RESPONSIBILITY EITHER FOR THE MANNER IN, WHICH THEY ARE OBSERVED, OR FOR ANY CONSEQUENCES THEREOF.**

All enquiries for spare parts should be directed to Thrige Electric.

Technical queries or requests for further information should be directed to Thrige Electric.

In any correspondence or enquiry, please quote the serial number and frame size as detailed on the machine rating plate.

## 2. HEALTH & SAFETY AT WORK

THE INSTRUCTIONS IN THIS MANUAL ARE GIVEN FOR INFORMATION AND GUIDANCE. THE COMPANY CANNOT ACCEPT ANY RESPONSIBILITY EITHER FOR THE MANNER IN, WHICH THEY ARE OBSERVED, OR FOR ANY CONSEQUENCES THEREOF.

THE IMPROPER USE OF ELECTRICAL EQUIPMENT IS HAZARDOUS TO HEALTH !  
THEREFORE EVERY PRECAUTION SHOULD BE TAKEN TO MINIMISE THE HAZARD.  
THE FOLLOWING GUIDANCE NOTES, WHEN ACTED UPON, SHOULD CONSIDERABLY MINIMISE HAZARDOUS INCIDENTS.

### INSTALLATION:

Where engineers make installation, suitably qualified personnel in accordance with relevant legislation, regulations and accepted rules of the art should erect the equipment. In particular, the recommendations contained in the regulations with regard to the earthing of electrical equipment must be rigorously adhered to.

### OPERATION & MAINTENANCE:

Engineers responsible for operation and maintenance of the equipment supplied under this contract, should familiarise themselves with the information contained in this manual, and with the recommendations given by manufacturers of the associated equipment and also with the relevant regulations currently in force.

### WARNING!

- It is essential that all covers are in place and that all guards and/or safety fences to protect any exposed rotating parts, surfaces and/or pits, are fitted before the machine is started.
- All adjustments to the machine must be carried out whilst the machine is stationary and isolated from all electrical supplies. Replace all covers and/or safety fences before re-starting the machine.
- When maintenance is being carried out, suitable WARNING signs should be prominently displayed and the necessary precautions taken to ensure power is not inadvertently switched on to the equipment whilst work is in progress, or is not yet complete.
- When power is restored to the equipment, personnel should not be allowed to work on auxiliary circuits, e.g. heaters, temperature detectors, current transformers, etc.
- Lifting procedures - Ensure that the recommendations given in this manual are adhered to at all times.

### 3. INTRODUCTION:

This Installation & Maintenance Manual covers the LAKC range of compensated d.c. machines.

**WARNING!           INSTALLATION OF THE MACHINE WHERE HAZARDOUS, INFLAMMABLE OR COMBUSTIBLE VAPOURS OR DUST PRESENT A POSSIBILITY OF EXPLOSION OR FIRE, SHOULD BE IN ACCORDANCE WITH THE CURRENT NATIONAL STANDARDS AND CONSISTENT WITH SOUND LOCAL PRACTICES.**

These instructions do not purport to cover all details or variation in equipment, or to provide for every possible contingency or hazard to be met in connection with installation, operation and maintenance of the machines. Should further information be desired, or should particular problems arise which are not sufficiently covered for the purchasers purposes, the matter should be referred back to Thrige Electric.

#### ACCEPTANCE:

Thoroughly inspect the equipment before accepting delivery from the carrier. If any of the equipment details in the Advice Note arrive damaged, or the quantity short, ensure that the carrier is notified and information sent to Thrige Electric in writing immediately.

#### RECEIVING:

The equipment should be placed under adequate cover immediately upon receipt, as packing covers are NOT suitable for out-of-doors or unprotected storage. This includes adequate protection from construction dirt, during and after installation.

#### HANDLING:

Four lugs are provided for lifting. Ensure that all lugs are used, and that a suitable sling is employed so that the angle is not so great as to impose excess strain on the lugs. The lugs are intended for lifting only the machine with standard accessories such as tachogenerators, blower units, etc. Do not lift the machine by the shaft extension(s). The machine weight is stamped on the rating plate.

**WARNING!           Before attempting to lift any machine, check the outline drawing for the lifting points and their limitations. Unless otherwise specified on the outline drawing, lifting points are intended to support only the part to which they are attached. The devices are not suitable, in general, for lifting the total weight of the assembled machine. They are not to be used to lift the machine plus additional equipment such as driven equipment or heat exchangers, etc. Failure to observe these precautions may result in damage to equipment, injury to personnel, or both.**

The handling of individual armatures or machine parts is described in the Maintenance Section.

STORAGE:

If a machine, or any part of a machine, is not to be installed immediately, it should be stored in a clean, dry atmosphere, free from extreme variations in temperature. Outdoor storage or fluctuating temperatures may cause condensation, which must be avoided.

If the temperature of the storage room varies to such an extent that the windings and coils are exposed to moisture condensation, the machine should be protected by a safe, reliable heating system such as anti-condensation heaters, which will keep the internal temperature of the machine slightly above that of the storage room.

Brushes should not be allowed to remain in contact with the commutator surface during prolonged storage; otherwise corrosion may occur and later result in flat spots on the commutator, with corresponding poor and destructive commutation.

The presence of moisture on the internal machine parts can cause electrical failure of insulated windings and/or mechanical failure of highly stressed armature glass banding.

If the machine has been exposed to low temperatures for an extended period of time, unpacking it before it has reached room temperature will cause it to sweat. If any internal condensation occurs, then the machine(s) must be thoroughly dried out and the insulation resistance checked prior to being put into service.

If the machine(s) is to be in storage for any length of time, it should be arranged that the shaft be rotated to a different position every two months, to prevent bearing damage due to brinnelling or fretting corrosion.

If for any reason the machine(s) is to be stored for more than one year, bearings should be flushed of old lubricant and re-lubricated prior to being put into service.

All exposed machine parts are coated with a rust inhibitor prior to shipment. These surfaces should be examined carefully for signs of rust and moisture, and re-coated if necessary. Once started, rust will continue if the surface is re-coated without first removing all rust and moisture. Rust may be removed by careful use of fine abrasive paper. The rust inhibitor can be removed by use of solvent such as mineral spirits.

**WARNING!**

**Mineral spirits are flammable and moderately toxic. The usual precautions for handling chemicals of this type should be adhered to, these include:**

- **Avoid excessive contact with the skin.**
- **Use only in well ventilated areas.**
- **Take the necessary precautions to prevent fire or explosion hazards.**

DESCRIPTION:

The LAKC range of compensated dc machines has a family resemblance, even though it covers a wide range of sizes. All standard machines are equipped with a shaft extension and key at the drive-end and a mounting arrangement suitable for mounting all standard tachogenerators, encoders or speed limiting devices at the non-drive/commutator end.

CLASSIFICATION:

The LAKC range of compensated dc motors is a robust standard dc machine designed for general industrial service. IEC 34 define these motors.

#### 4. INSTALLATION:

**WARNING!** DC machines have characteristics, which can cause serious or fatal injury unless they are selected, installed, maintained and operated by qualified personnel familiar with the special requirements of DC machines.

Disconnect power before touching any internal part. High voltage may be present even when the machine is not rotating. If used with a rectifier excitation supply, disconnect all ac line connections to the excitation source. Disconnect all dc field connections. Failure to observe these precautions may result in injury to personnel.

Installation should be in accordance with the National Electrical Regulations and consistent with all local codes of practice. All exposed rotating parts such as couplings; belts and chains should be guarded as necessary to prevent accidental contact with moving parts. Machines accessible to the public should be further guarded by screening, guard rails, etc., to prevent the public from coming into contact with the equipment. Failure to observe these precautions may result in injury to personnel.

#### LOCATION:

Locate the machine(s) where clean air has free access to the ventilation intake and outlet openings. The ambient temperature of the air entering the machine should be warmer than 10°C but not greater than 40°C unless the motor has been specifically designed for a higher temperature. To avoid the collection of condensation in the machine, the dew point of the air should be lower than the minimum surface temperature of any upstream air cooler.

In no circumstances should the machine be enclosed by a covering or placed in a position where the cooling air cannot circulate away from the machine or is re-circulated through the machine before it has a chance to re-cool back to ambient temperatures.

Contaminated cooling air must be avoided. Contaminants such as moisture, dust, and liquids and oil are easily recognised and can be eliminated. Gaseous contamination such as silicone vapour is difficult to detect but must be guarded against.

**NOTE:** **Silicone vapour may be present and originate from sealing compounds, electrical cable sheaths and room transformers. These sources must be eliminated or guarded against.**

Ready access for inspection and maintenance purposes should also be considered when siting the machines.

They should be installed where they will not be exposed to moisture, escaping steam, dripping pipes, paint over spray, acid, alkali, oil, gas, dust, dirt, lint, silicone vapours, or other injurious substances.

#### MOUNTING:

Machines must be mounted level on rigid foundations, and shims used where necessary to achieve this to avoid distortion of the machine frame. During installation, all ventilation and cable entries should be wrapped or otherwise protected against the ingress of dirt, moisture or other foreign matter.

If machines are to be mounted on slide rails against a vertical surface, then steel slide rails must be used.



DRIVE:

Standard machines are fitted with ball bearings without allowance for endplay. Proper alignment is therefore essential otherwise severe strain may be imposed on the shaft and bearings.

For direct-coupled drives, flexible couplings are preferable and essential if there is no endplay in the driven shaft. Ease of rotation is not conclusive proof of true alignment, which should be checked by measuring the distance between the coupling faces at several points. Also the peripheries of the half coupling must line up.

For belt drives, the driving and driven tension must be adjusted as required for proper operation. The driving pulley should be placed as close as possible to the motor bracket.

**WARNING!**            **All shafts, coupling, belts, chains, etc. must be guarded to prevent injury to personnel.**

## 5. POWER SUPPLY:

Check machine rating plate to ensure the voltage and type of power rating is compatible with the power source.

### CONNECTION DIAGRAM:

LAKC machines are normally with a connection drawing fixed within the terminal box lid and a further copy inside this Installation and Maintenance manual.

### CONNECTIONS:

Before connecting, insulation resistance should be checked between all windings and earth to ensure that the machine has not suffered in transit, storage or installation.

All terminal connections should be checked against the machine's connection drawing to ascertain that the polarities or direction of rotation will be correct. Ensure that all bolted connections are tight and that adequate clearances exist between conductors of opposite polarity and between conductors and earth.

### EARTHING:

Earthing points are supplied on each side of the motor carcass and labelled with an earthing symbol. Ensure that all machines are earthed correctly by scrapping back the paint to bare metal surrounding the earthing point. Please note that any earthing stud is not designed to take any fault currents, only to clamp the earthing cable lugs.

**WARNING!**                    **Machines must be properly earthed to avoid injury to personnel. Earthing should be in accordance with the current National Standards and consistent with sound local practices.**

### TERMINAL BOX:

The terminal box is mounted on the right hand side of the machine when viewed from the drive-end as standard. The machine leads are suitable for turning the terminal box through 90° steps.

A blank un-drilled gland plate is supplied with the terminal box to facilitate the customer's specific gland requirements.

An auxiliary terminal box is supplied when specified at time of ordering and is mounted on the side of the main terminal box.

### ELECTRICAL TESTING:

As indicated above, electrical tests must be completed on the motor prior to installation; these should include measurement of winding resistances and measurement of insulation resistance to earth.

**WARNING!**                    **Following the insulation resistance measurement, which is usually completed using 500V or higher, ensure that all windings are earthed momentarily to avoid the risk of electric shock.**

## 6. PROTECTIVE DEVICES:

Ensure that all protective devices, e.g. thermistors, thermostats, over speed switches, bearing temperature sensors, etc., are connected and will function properly. Ensure that all coupling guards, shaft protectors, earth connectors, covers and other safety devices are properly attached.

### ANTI-CONDENSATION HEATERS:

Anti-condensation heaters are furnished in the machine when ordered. These should be energised with the correct ac voltage as shown on the rating plate.

### THERMISTORS / THERMOSTATS:

Thermostats and thermistors are protective devices. They are not intended to limit machine loading or provide normal insulation life. When supplied they are mounted in the stator coils. One set consists of three devices; one fitted in the excitation winding, one in the compensation winding and one in the interpole winding. These devices are wired back to the main terminal box, or auxiliary terminal box (if fitted) and are coded at the terminal bar.

Since the armature rotates there is no thermal trip device fitted in the armature.

Factors such as shaft speed, ventilation, current ripple and short time overloads affect the temperature relationship between the armature and the interpoles, therefore complete protection from all conditions resulting from over-temperature is not possible. Thermistors or thermostats are especially useful in guarding against loss of normal ventilation air; high ambient temperatures and prolonged operation of self ventilated motors at very low speeds.

Thermostats may be used in alarm or relay circuits within the designated ratings.

Thermistors must be used with a thermistor control circuit within the designated ratings.

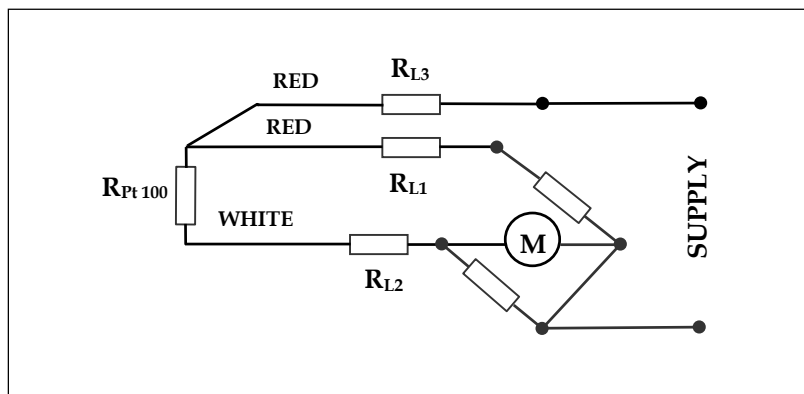
**WARNING!** Thermistors and thermostats automatically reset after the motor has cooled somewhat. In order to prevent injury to personnel or damage to property, the control circuit should be designed to prevent the automatic starting of the machine when the device resets.

### THERMOCOUPLES & RESISTANCE THERMOMETERS (Pt 100):

Temperature monitoring devices such as thermocouples and platinum resistance thermometers (Pt 100) are furnished in the machine when ordered. These are fitted in the same windings as the thermistors/thermostats; i.e. one fitted in the excitation winding, one in the compensation winding and one in the interpole winding. These devices are wired back to the main terminal box, or auxiliary terminal box (if fitted). The Pt 100 devices normally fitted are of the 3-wire configuration and are colour coded.

Thermocouples and Pt 100 devices are furnished in the bearing housings when ordered. These devices are wired back to the main terminal box, or auxiliary terminal box (if fitted).

### 3-WIRE Pt 100 – WHEATSTONE BRIDGE:



### AIR PRESSURE SWITCHES:

Air pressure switches are furnished in the machine when ordered. These are generally pre-set at the factory at test. If they are not set, there will be a label indicating the setting procedure. This is only likely on machines supplied for use with a separate source ventilation system.

Air pressure switches are generally located on the high-pressure side of the fan and only indicate the existence of an air source. On machines fitted with air intake/circuit filters, they are set to operate when the filters are  $\frac{1}{3}$  blocked. On machines without filters, they are set to operate at 90% of nominal airflow.

## 7. VENTILATION:

Ensure that all blowers, heat exchangers or central cooling systems are ready to supply the cooling air. All filters should be in place. Blowers should be checked for the correct direction of rotation. The blower ac motors are high inertia items and repeated starting in a short period of time should be avoided. Star/delta starting is preferred in motor powers above 4.0kW.

**WARNING!**                    **Incorrect direction of rotation of cooling fans will result in reduced airflow rates and the consequential overheating of the machine.**

**WARNING!**                    **It should be noted that there are two independent electrical circuits within the dc machine, the load circuit (armature) and the excitation circuit (field). In fixed field machines, i.e. without field regulation, the excitation field still requires adequate airflow, even though the load/armature circuit may only be lightly loaded.**

Ensure that all air intakes are sited away from contamination or hot air sources. Ensure there is sufficient room around the machine so as to avoid the possibility of re-circulating the cooling air. This along with local hot air sources will effectively increase the ambient air into the machine and could result in overheating.

### CLOSED AIR CIRCUIT COOLERS:

Refer to the specific chapters on Air-Water and Air-Air Heat Exchangers before putting the machine into service.

### AC FAN MOTORS:

Check all rating plate data, especially voltage and winding connection (star or delta).

Measure insulation resistance before commissioning and when winding dampness is suspected.

**WARNING!**                    **Windings should be discharged immediately after measurement to avoid risk of electric shock.**

### DIRECT-ON-LINE OR STAR/DELTA STARTING:

A diagram of connections for the motor will be found either inside the terminal box or on the motor rating plate.

The terminal box normally contains six (6) winding terminations and at least one earth terminal.

Earthing shall be carried out in accordance with sound local practices and regulations, before the machine is connected to the supply voltage.

The voltage and connection are stamped on the nameplate.

- DIRECT-ON-LINE (DOL):

Y or  $\Delta$  winding connections may be used.

- STAR/DELTA STARTING (Y/Δ):

This method of starting is preferred for motor powers above 4.0kW. The supply voltage must be equal to the rated voltage of the machine in Δ-connection. Remove all connection links from the terminal block.

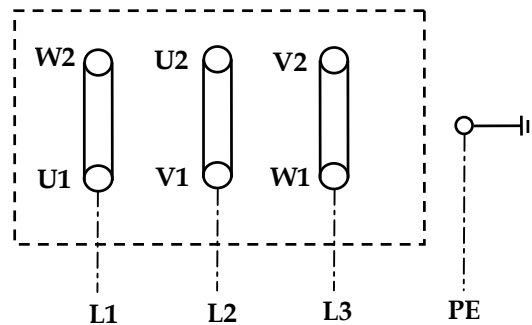
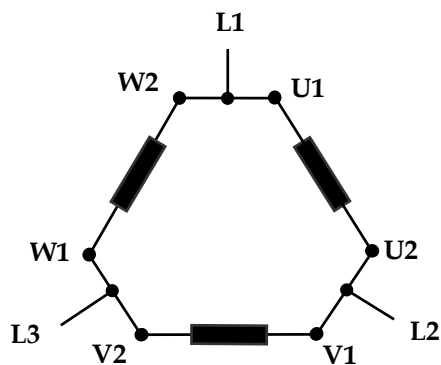
TERMINALS & DIRECTION OF ROTATION:

Direction of rotation is clockwise when viewing from the shaft end, when the line phase sequence L1, L2, L3 is connected to the terminals as shown in the diagram below.

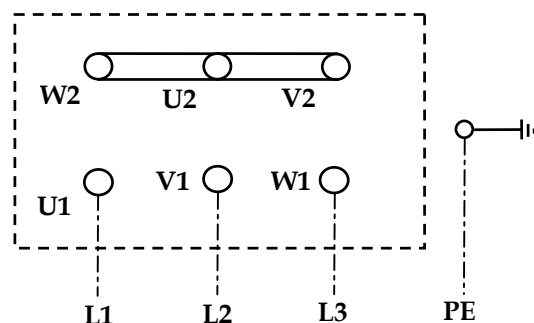
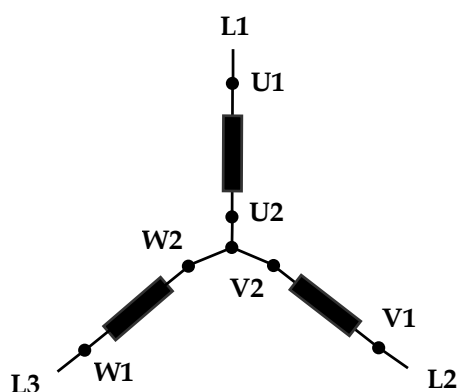
To alter the direction of rotation, interchange the connection of any two-line cables.

CONNECTION DIAGRAM:

DELTA (Δ) CONNECTION:



STAR (Y) CONNECTION:



**8. OPERATION:**

Before attempting to start the machine, ensure that:

- You have read through the Installation & Maintenance Manual and are familiar with all aspects of running the motor and with the auxiliary equipment included for the monitoring and protection of the machine and cooling systems.
- The carbon brushes are seated correctly on the commutator, move freely in the brush holders and that the brush springs are firmly in position. Broken brushes must be replaced.
- The machine shaft rotates freely when turned by hand.
- The interior of the machine is dry and clean and free from any tools, metal chips or other foreign material that may have accumulated during transit, storage or installation.
- All connections are checked for tightness.
- All covers and shaft guards are in position and that any temporary covers fitted over ventilation openings during transit, storage or installation, are removed.
- Grease relief cover plates should be loosened or removed for a short time during initial running to allow excess grease to be ejected.
- All terminal box covers are in place.
- The ventilation fan is running in the correct direction of rotation, and is not sucking in contamination.
- All filters are in place and that any in-transit protection is removed and not blocking the airflow.
- All protection devices such as thermal trips, airflow switches, etc., are connected into circuit.
- If the machine is to be used in a contaminated atmosphere, e.g. with heat exchanger or ducted ventilation, check that all seals are fitted between ventilation mating flanges, inspection/access covers and terminal box lids/gland-plates.
- In the case of machines fitted with air-water coolers, the water supply is connected correctly, i.e. the inlet should be to the bottom flange/pipe and the outlet via any water flow switch or control valve to the top flange/pipe.

Machines designed for forced cooling from separate source, e.g. blower unit, ducting, heat exchanger, etc., MUST NOT BE operated without the cooling air supply.

INSPECTION AFTER STARTING:

The following items should be checked after the machine is running.

**WARNING!**            **Avoid contact with moving, hot or live parts when working with rotating electrical machines. Avoid wearing loose clothing or jewelry.**

BEARINGS:

Monitor all bearing housings for a few hours with the grease relief cover plates loosened or removed to allow excess grease to be ejected. Ball and roller bearing housing temperatures should not be more than 25°C above the local ambient temperature or a maximum of 65°C at the air inlet end and 80°C at the air discharge end. Higher temperatures than this indicate problems. Check alignment and lubrication. Do not over-grease.

NOISE & VIBRATION:

Check for unusual vibrations or noises that might indicate rubbing or interference. New machines may smell warm or have the odour of varnish but should not smell scorched.

Vibration of new machines should not exceed 0.05mm at the bearing housings. The most likely cause of excessive vibration in new machines is misalignment due to improper installation, loose foot bolts, uneven shimming under feet, or damage to the machine during shipment or installation. Current ripple from a rectified power source may also be a source of vibration and audio noise.

All LAKC series machine armatures are balanced in accordance with IEC 34, i.e. with HALF KEY. Ensure that the fitted coupling is balanced accordingly to suit this format. Out of balance couplings can be another source of vibration.

BEFORE PUTTING THE MACHINE IN SERVICE:

Run at light loads or at no load for a few hours to determine that no unusual bearing temperatures occur, that no localised electrical heating results and (in the case of machines with unseated brushes) that the brushes get the proper fit. Be sure that any carbon dust resulting from brush seating is cleaned up before full load operation. Check for satisfactory commutation when the load is first applied.

INSPECTION AFTER SHORT TIME IN SERVICE:

After a machine has been operating for a short time, an inspection should be made to ascertain that there have been no changes since installation.

- Check for increased vibration, signs of change in alignment or foundation settings, bolts that may have loosened, rubbing parts and loosened connections.
- Check for abnormal or uneven brush wear.
- Check internal filters for fouling.
- Check for unusually high temperatures at the bearings or machine surface.
- Check for any unusual odours.

Take the proper steps to correct any problems encountered.



## 9. MAINTENANCE:

**WARNING!** The internal parts of a DC motor may be at line voltage even when the motor is not rotating. Before attempting any maintenance that would result in contacting any internal part, ensure that the motor is disconnected from the power supply.

- Motors using rectified power sources – disconnect all ac line connections.
- Motors using rotating power source – disconnect all dc line, field and protecting circuit connections.

### GENERAL:

Check all nuts, bolts and fastenings are tight, all covers and guards are secure, and all electrical connections are tight and secure.

### CLEANLINESS:

Keep the interior and exterior of the motor(s) dry and clean. The interior should be kept free from dust, dirt, corrosion, oil and moisture. Ensure that all ventilation openings are kept clear.

Where fitted, ventilation air filters, internal and external, must be kept clean or replaced to ensure full volume of cooling air. When replacing filter elements check rubber gaskets are undamaged and are not distorted.

It is preferable to use a vacuum cleaner rather than a blower or airline to clean out motor interiors, as a blower is liable to drive the dirt into the motor windings instead of removing it. This can eventually lead to earth related faults on the motor windings.

### BRUSH GEAR:

Periodically check that the carbon brushes move freely in the holders and that they are not worn below the recommended minimum brush length. Replace any broken carbon brushes.

Any accumulation of carbon dust at or around the brush gear should be removed.

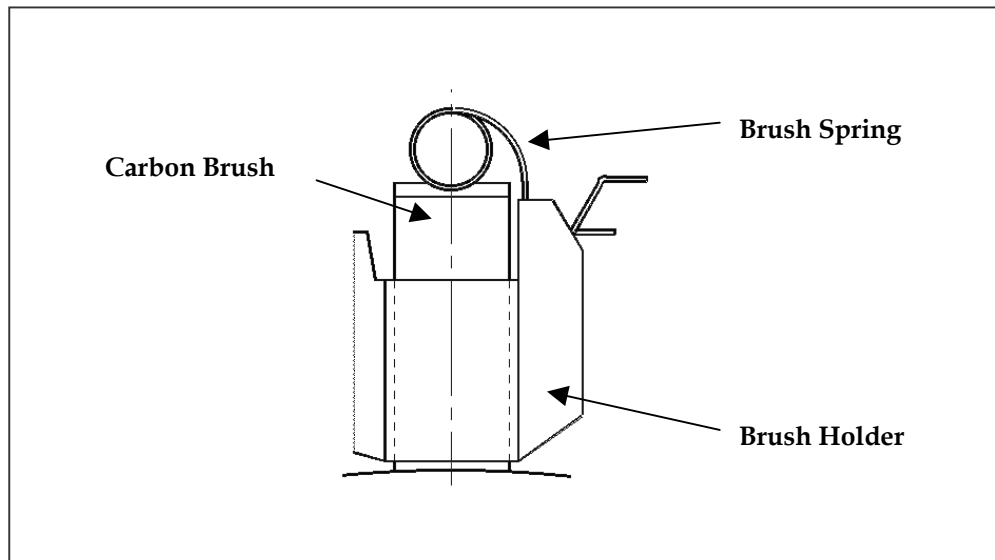
Check that all brush ligaments and other connections are secure.

Check that the brush ligaments have not been distorted such that they prevent the brushes sliding in their holders.

When replacement of carbon brushes becomes necessary, use only replacements of the same grade and quantity as those originally fitted. Refer to paragraph under maintenance for details diagram of carbon brush and brush holder.

New brushes must be bedded to the commutator by applying the normal spring pressure and passing a strip of glass paper backwards and forwards around the commutator surface. Ensure that the rough surface of glass paper is towards the carbon brush.

After bedding, ensure that all carbon dust is removed by vacuum. Do not use compressed air. Keep carbon brushes and their holders clean.



**WARNING!** High voltage and rotating machinery can cause serious or fatal injury. Brushes must not be touched or replaced while the machine is energised or rotating.

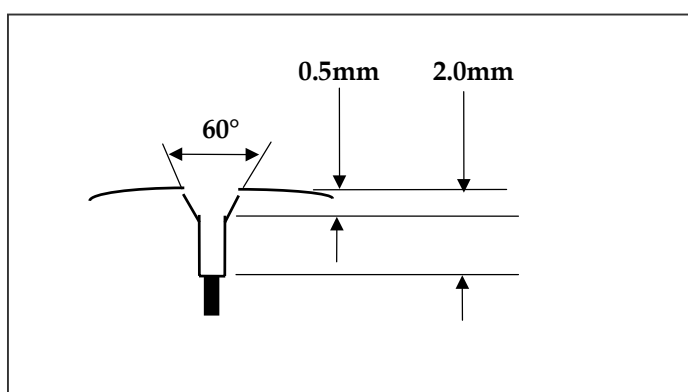
#### COMMUTATOR:

Keep the commutator clean.

Under the correct condition the commutator will develop a healthy brown skin or 'patina'. This is an ideal condition and the skin should not be removed.

To clean the commutator, wipe with a piece of canvas or other non-linting cloth. Do not use any solvent, lubricants or abrasives unless abnormal conditions prevail.

Check for commutator wear and grooving/ridging. If this is of a minor nature then an abrasive commutator stone may be used to restore the commutator surface. If the wear is excessive, then the armature should be removed and turned in a lathe to maintain concentricity, and the minimum materials removed to restore the commutator surface.



After turning, clean between each commutator segment to remove all particles of copper. Under-cut the mica and bevel the segment edges as indicated in the sketch above.

### COMMUTATOR TEMPERATURE:

For optimum brush life and ideal running conditions, the commutator operating temperature should be maintained between 60°C and 100°C.

Temperatures above or below this level can lead to high brush wear and subsequent likelihood of carbon contamination of the windings.

This condition is more critical in machines with heat exchangers, especially when light loading conditions accompany, or contribute to the low temperature of the commutator.

If this condition occurs contact Thrige-Scott Limited and advice will be given as to a remedy, once all the site parameters have been assessed.

### PRODUCTIVE MAINTENANCE:

Productive maintenance goes a step beyond preventative maintenance techniques. Productive maintenance means that the maintenance should pay for itself in terms of less down time, money saved in repairing equipment, and more total production for each unit spent on maintenance operations.

- Keeping good records of machine data and setting up a means of recording maintenance performed and the measurements taken.
- Establishing a routine of measurements to be taken and inspection operations to be performed. Without other experience to guide you, utilise the suggested maintenance schedule that follows. Experience can be quickly built up by performing the inspections and measurements called for. These records will show whether or not various components of the machine change quickly or slowly. Maintenance schedules can be re-adjusted as experience dictates. Making more frequent, elaborated inspections at first and carefully recording the results will indicate the feel for important items and timing of critical inspection times. Set up a program to balance between spending more on maintenance and inspection than a failure would cost.

In some cases, it is less expensive to repair or replace a part rather than to maintain it regularly.

A suggested schedule of routine maintenance operations and measurements is provided (see **recommended maintenance schedule**). This time schedule may be modified as a record of experience is built with equipment in particular applications. Machines on continuous process lines will have more operating hours than intermittently run machines and will need more frequent attention.

## 10. RECOMMENDED MAINTENANCE SCHEDULE

Adjust this schedule as necessary (guided by your records). It will show if more or less attention is justified.

### MONTHLY:

- BEARINGS:

Make sure that excessive grease or oil is not leaking out of the bearing housings, if any leakage is present; correct the condition before continuing to operate. Accumulation of large amounts of grease inside the motor should be cause for immediate concern. The bearing cap and metering plate (if fitted) should be pulled back to check for adequate grease fill inside the metering plate.

- BALL AND ROLLER:

Listen to a few bearings on a sampled basis. Bearings that get progressively noisier will need replacement at next shutdown.

- CARBON BRUSHES:

Check the brush length. Replace when minimum length has been exceeded. Inspect for worn or shiny brush clips, frayed or loose pigtails, chipped or broken brushes and cracked brush springs. Remove a few brushes to check the brush-commutator contact face. Burned areas indicate commutator trouble. Loosen each brush in its holder. Blow out area of the holder and brush holder stud insulation with clean, dry air to remove brush dust. Wipe brush holder stud insulation to remove contamination.

**WARNING! High voltage and rotating machinery can cause serious or fatal injury. Brushes must not be touched or replaced while the machine is energised or rotating.**

- COMMUTATORS:

Check the commutator for roughness by carefully feeling the brushes with a fibre stick. Jumping brushes give advanced warning of a commutator going rough. Observe the commutator for signs of threading. Check for excessive commutator wear rate, streaking, copper drag, bar marking and heavy slot bar marking. Commutators should not have more than 0.064mm bar-to-bar steps. Check commutator-running temperature.

- FILTERS:

Check internal and external filters for cleanliness. Clean or replace as necessary, ensuring that the gaskets, where fitted are undamaged and undistorted.

- INSULATION:

Perform a visual inspection. Measure and record insulation resistance values.

**SIX MONTHLY:**• **BEARINGS:**

Listen to all bearings. Pull back bearing cap and metering plate (if fitted) to inspect grease conditions on a few representative machines.

• **COMMUTATORS:**

Check risers for cracks and dirt. If there are cracks, also check end of shaft keyway and shaft fan. (Cracks in this area mean extreme torsional vibration in system). Dirt should be cleared out of risers to maintain good ventilation.

• **INSULATION:**

Measure one-minute insulation resistance. Compare with records. Wipe deposits from brush holder stud insulation and commutator creepage path. Remove heavy deposits from around field coil connections where earthing might occur. Blow deposits out of commutator riser area with clean dry air. Blow out any blocked ventilation openings in windings. Make visual inspection for signs of over heating (dry, cracked, "roasted out" insulation and varnish).

**11. MECHANICAL:****BOLTS:**

Check all electrical connections for tightness. Look for signs of poor connections (arcing, discoloration, and heat). Adjust inspection period to suit experience. Inspect foundation for signs of cracking and displaced foot shims; also check foot bolts for tightness. Check brush holders, brush holder studs, bracket bolts, etc., on a sampling basis. Check all coupling bolts. Check pole bolt torque. Check tightness of vee ring commutator bolts. (This may be done yearly if justified by experience.)

**SHAFT:**

Check corners of exposed end of shaft keyway for cracks (due to extreme torsional vibration). If there are cracks check fan and commutator risers.

**VENTILATION:**

Check for clogged screens, louvres, external & internal filters, etc. When replacing filters, ensure that the rubber gaskets are undamaged and not distorted.

**VIBRATION:**

Check for excessive vibration (more than 0.05 to 0.08mm), which will indicate change in balance or alignment.

**12.     LUBRICATION:**

Re-lubrication periods vary from six months to five years dependent on site conditions, degree of operating and ambient temperature. As a general rule, normal continuous running, eight hours per day - re-grease every two years; running twenty-four hours per day - re-grease every twelve months. However, where machines are subjected to high ambient temperatures, and/or severe duty, more frequent lubrication, i.e. every six months is advisable.

When adding or renewing grease, ensure that only the correct or equivalent high quality grease is used.

Do not over grease, as excessive greasing causes churning, high temperature and subsequent lubrication failure.

Grease relief cover plates (if fitted) should be removed during regreasing to allow excess grease to be ejected. These plates should be refitted after running the motor for a short period in order to maintain the IP rating of the machine.

Under no circumstances should different types of grease be mixed in the same housing.

Lubrication data is supplied on the bearing detail plates fitted on both bearing housings.

**13. REPAIR:**

Only qualified personnel, using the materials and processes for which the machine was designed should make repairs. To protect the warranty during the warranty period, all repairs must be made by an approved repair facility.

Many repairs can be easily performed with only assembly operations if replacement parts are available. If major repairs are undertaken (such as rewinding an armature), proper facilities should be available and suitable precautions observed.

**WARNING!** When burning off old insulation materials or when welding near insulation during rewinding, adequate ventilation must be provided to avoid exposing personnel to noxious fumes. Combustion of exhaust fumes must be complete and adequately vented to the outside atmosphere.

**WARNING!** Exposure of personnel to airbourne inorganic fibres must be avoided by adequate ventilation or by wetting the remaining insulation components following the burning off of the organic materials.



14. FAILURE:

**WARNING!** An extreme or prolonged overload or electrical failure may result in heating or arcing, which can cause the insulation to give off noxious fumes. All power should be removed from the machine circuit as a precaution even though the circuit may have overload protection. Personnel should not approach the machine until adequate ventilation of the area has purged the air of the fumes. When covers of a machine are removed following a failure, care should be observed to avoid breathing fumes from inside the machine. Preferably, time should be allowed for the machine to cool before attempting any examination or repair. Failure to observe these precautions may result in injury to personnel.

**WARNING!** Water should not be applied to any electrically energised equipment because electric shock could result in serious or fatal injury. In case of fire, disconnect all power from the equipment and use only a carbon dioxide (CO<sub>2</sub>) extinguisher to quench the flames. Before operating any machine after a suspected failure, it should be inspected for damage. Remove covers and make a visual examination of the carbon brushes, commutator, connections and windings. Electrical tests of each winding to check for open or short circuits or earthing should also be made. Any arc damage should be cleaned up and repaired as necessary. Carbon brushes may need re-seating before operation.

## 15. DISMANTLING:

**CAUTION!** Safe practices for lifting and handling equipment should be followed. Hoists, slings or chains of adequate capacity and in good repair only should be used.

### ARMATURE REMOVAL:

#### SPECIAL TOOLS:

- Piping of approximately 1.5m in length, which will fit snugly to the drive end shaft extension when the shaft is protected with heavy cardboard or other suitable material. Ensure the pipe is sufficiently thick as not to bend when the armature is lifted.
- A wooden block of appropriate size to fit inside the commutator end of the machine and to support the armature during removal.

#### PROCEDURE:

- Clean exterior of the machine in order to prevent dirt, chips, etc., entering the machine interior.
- Remove carbon brushes from their holders and raise the holders from the commutator surface.
- Tape a piece of corrugated cardboard around the commutator surface to protect it during handling.
- Disconnect all cables leading from the brush gear assembly to the machine frame. Ensure correct labeling of these leads for re-assembly purposes. Label the brush arms and remove from the rocker ring.
- On the outside, mark the endshield and frames. On the inside mark the rocker ring and endshield. Improper alignment of these parts on re-assembly will cause bad commutation. Remove shaft-earthing brush (if fitted).
- Remove outer bearing caps at both ends of the machine, leaving the metering plates on.
- Unbolt and remove the end shields at both ends and allow the armature to rest on the poles. The armature will need to be supported by a crane until the end shields are clear of the frame.
- Place the protective material around the drive end extension and put on the piping. Ensure the piping is placed far enough along the shaft to prevent slippage. Place the wooden block inside the commutator end endshield at the bottom to form a resisting surface at the same level as the pole.
- Lift armature until it is clear of the poles on the bottom and slide a piece of protective material into the bottom air gap and across the wooden block, to protect the armature and give ease during removal.
- Lift armature and remove via the commutator end by hoisting on the pipe and shaft at the commutator end. Pull out until the core is resting on the wooden block. Disconnect sling on pipe and place around armature core whilst the armature is supported on the wooden block. Using both slings, again lift the armature and effect removal.
- Rest armature on vee-blocks, remove pipe and cover bearings with clean dry cloths. Do not put vee-blocks under armature glass bands or commutator.

ARMATURE INSTALLATION:

- When a new or repaired armature is installed in an in place frame, in the reverse order of the armature removal procedure, the following adjustments must be made:
- Marks showing the brush rocker ring position must be re-aligned.
- Brush holders must be adjusted to have a 3.0mm radial spacing from the commutator surface. When installing a replacement armature, which has a commutator larger than the original, it may be necessary to move the brush holders radially away from the commutator surface to prevent damage during installation.
- Variations in manufacture may result in a condition that will require a slight shift in brush gear from the factory settings. Commutation under load should be observed following armature replacement and any unusual sparking, abnormal commutator film or segment burning should be detected and corrected.

#### ANTI-FRICTION BEARING REMOVAL:

- Clean the exterior of the machine to prevent dirt, chips, etc., from getting into the coupling, bearings or interior of the machine.
- Remove the armature from the frame.
- Remove the coupling hub if the unit is fitted with one. If the unit has a hydraulically removable coupling, it should be removed according to the required procedure.
- Remove the outer bearing caps and endshields. Unbolt and remove the commutator-end grease throw. Draw off the drive-end grease throw.
- Draw off the bearings as required.

#### ANTI-FRICTION BEARING REPLACEMENT:

If the old bearing is to be re-used, it should be cleaned and inspected to ensure that the bearing is suitable for further use. The following steps should be followed when reassembling a bearing:

- Ensure that the machine shaft and all parts being used have been cleaned to prevent dirt, chips, etc., from getting into the coupling, bearings or interior of the machine.
- Replace bearing inner caps.
- Pre-heat the bearing in an oil bath or induction heater to 120°C to 130°C.
- Assemble the heated bearings onto the shaft, ensuring that they fit tight up against the bearing location shoulders.
- Pre-heat the drive-end grease throw in an oil bath or induction heater to 100°C to 120°C.
- Assemble the drive-end grease throw onto the shaft ensuring that it fits tight up against the drive-end bearing.
- When cool, grease the bearing using the quantity of grease annotated on the bearing information plate fixed to the endshield.
- Cover the bearings when re-assembling the machine following the re-assembly instructions given above.
- When the machine has been re-assembled, the commutator-end grease throw can be bolted to the end of the shaft.
- Run the machine for several minutes to purge the excessive grease before replacing the grease relief plates.

## 16. GENERAL INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR AIR-WATER COOLED HEAT EXCHANGERS.

### GENERAL:

Successful performance, length of service and ease of operation of heat transfer equipment are mainly dependent on the following factors:

- Manner of installation, including design of connecting pipe work.
- Method of operation.
- Thoroughness and frequency of cleaning.

Failure to perform properly may be due to one or more of the following:

- Heat exchangers being dirty.
- Operating conditions being different from design conditions.
- Air locking.
- Incorrect piping connections.
- Improper application.

### INSTALLATION:

- Upon receipt of the heat exchanger inspect for damage. If there is damage, ensure that the carrier is notified and information sent to Thrige Electric in writing immediately.
- Store under cover in a heated area where it will not be subjected to damage.
- When installing, set the heat exchanger level and square, ensuring that the connections can be made without force.
- Allowance should be made when connection paperwork for expansion and contraction.
- Ensure that all mating flanges between the cooler and the machine are adequately sealed against the ingress of contamination.

**WARNING!** Water should not be applied to or allowed to come into contact with any electrically energised equipment because electric shock could result in serious or fatal injury.

**WARNING!** DC machines have characteristics, which can cause serious or fatal injury unless they are selected, installed, maintained and operated by qualified personnel familiar with the special requirements of DC machines.

Disconnect power before touching any internal part. High voltage may be present even when the machine is not rotating. If used with a rectifier excitation supply, disconnect all ac line connections to the excitation source. Disconnect all dc field connections. Failure to observe these precautions may result in injury to personnel.

Installation should be in accordance with the National Electrical Regulations and consistent with all local codes of practice. All exposed rotating parts such as coupling; belt and chains should be guarded as necessary to prevent accidental contact with moving parts.

Machines accessible to the public should be further guarded by screening, guard rails, etc., to prevent the public from coming into contact with the equipment. Failure to observe these precautions may result in injury to personnel

LIFTING:

Lifting shall be by means of the installed lifting lugs or eyes. It is the responsibility of the site engineer to obtain approval for any other method of lifting. Refer to the rating plate or the drawing for the weight of the equipment. Unless specifically detailed to the contrary lifting by the installed lugs or eyes is limited to the individual components supplied.

**WARNING! Under no circumstances attempt to lift the combined weight of the heat exchanger and machine with the lifting lugs attached to the cooler. Failure to observe these precautions may result in damage to equipment, injury to personnel, or both.**

OPERATION:

- Ensure that the entire system is clean before starting up to prevent internal fouling.
- Before starting ensure that all safety devices fitted are connected in circuit. All pressure switches will have been pre-set before leaving the factory. All water flow switches or valves must be connected to the water outlet side of the system. Ensure that the thermal probe of the water flow control valve (if fitted), is inserted into the pre-cooled air chamber at the opposite end of the cooler from the fan motor, above the commutator.
- Ensure that the water inlet/outlets are correctly connected. It is important that the water inlet must be to the BOTTOM pipe/flange and the outlet to the TOP pipe/flange, as the cooler is designed to take into effect that hot water rises.
- Remove 'leak' plug from bottom of exchanger - please note that this plug should be replaced before running the motor.
- Check the internal air circuit filters are clean and un-blocked.
- Ensure that the drain valve is closed.
- Open the air bleed valve to allow the cooler to fill with water and close once the coolant begins to escape.

N.B. This operation should be repeated after a short period, to ensure removal of all of the air.

- Any water coming out of the 'leak' plughole indicates a possible leak in the cooling element. If no water is coming out, the plug should be replaced now.
- Start up operation gradually, every effort being made to avoid subjecting the units to thermal shock, over pressure, or hydraulic hammer.
- Cooling water should be circulated at the design flow rate before internal air fans are started.

- Bolted joints should be re-tightened after the heat exchanger has reached operating temperature.
- Do not operate the heat exchanger under pressure and temperature conditions outside those specified on the rating plate.

**WARNING!**

Should the machine be run for extended periods in a lightly loaded condition with full flow water cooling, then it is likely that the motor will experience high brush wear due to low commutator temperatures combined with the low current density in the brushes. As indicated above, the water volume control switch is fitted to combat this condition. Should this not prove adequate or if there is no water volume control switch fitted, then the quantity of brushes per brush arm should be reduced proportionally in relation to the actual motor running current against the full load (rating plate) machine current. Alternatively, a brush grade suitable for low temperature and/or low current density operation can be fitted. If in doubt contact Thrige Electric.

MAINTENANCE:

Exchangers subjected to fouling should be cleaned as part of a regular maintenance schedule. The frequency of cleaning is dependent on the nature of coolant being used.

- INTERNAL FOULING:

This can range from a light slime coating to total blockage caused by a build up of corrosion products and deposits from the cooling water. Internal fouling may be treated in-situ if site conditions permit. Tube-side conditions may initially be inspected via the connections after the unit has been drained of coolant and the pipe-work has been broken. Once the need for cleaning has been established, the full header plate may be removed to reveal the tube-plate and tubes. Typical slime deposits may be cleared using a rotary nylon brush. For heavier deposits, a high-pressure water jet with a suitably designed nozzle may prove more effective. With the correct choice of nozzle, almost any amount of internal fouling may be removed. The flow channels of associated valves, strainers and filters should also be inspected on a regular basis.

- EXTERNAL FOULING:

This arises from pollution of the air circuit. This type of fouling may range from dry dust and airborne fibrous matter to oily deposits which are adherent. Treatment of this problem usually necessitates removal of the unit from its surrounding ductwork. The extended surface of a heat exchanger is relatively insensitive to fouling due to the low conductivity of air and the high surface areas being used. Typical fouling factors represent approximately 1% of the external heat transfer coefficient. Cleaning of the external surface is necessary, therefore, not so much to improve the heat transfer, as to prevent obstruction of the airflow. Increased resistance to airflow can result in a reduced air circulation. This adversely affects the overall capacity of the unit. Dry deposits may be removed using a compressed air jet. More stubborn deposits may be removed with the aid of an industrial detergent.

### DAMAGED TUBES:

Should a tube bundle leak, the damage may take one of several forms. Each requires a different procedure to effect repair.

- Leakage at the tube-plate is generally caused by the loosening of an expanded tube. This can be cured by further expansion of the tube into the tube-plate.
- Fracture at some point along the tube length without server distortion of the tube. Such tubes can be lined with a secondary tube that is inserted once the tube bore has been thoroughly cleaned. The liner is then expanded into the damaged tube to seal the leak and permit a limited amount of flow to be maintained.
- Fracture with the tube distortion must be repaired by use of tube plugs. A ring and pin type plug is inserted and expanded into each end of the damaged tube. This can also be used in cases of tube damage covered in paragraph above.

### DAMAGED FINS:

If this occurs without damage to the base tube, careful use of long nosed pliers or a similar tube should effect straightening of the fins.

### SPARES:

Equipment described in the above maintenance instructions, including tube expanders, liners and plugs, can be supplied in the form of a spares kit to suit the requirements of the cooler supplied.

### ANCILLARY EQUIPMENT:

- Full flow air filter.
- Internal air fan.
- Water flow indicator.
- Air pressure switch.



17. **GENERAL INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS  
FOR AIR-AIR COOLED HEAT EXCHANGERS.**

**GENERAL:**

Successful performance, length of service and ease of operation of heat transfer equipment are mainly dependent on the following factors:

- Manner of installation.
- Method of operation.
- Thoroughness and frequency of cleaning.

Failure to perform properly may be due to one or more of the following:

- Heat exchangers being dirty.
- Operating conditions being different from design conditions.
- Air locking.
- Improper application.

**INSTALLATION:**

- Upon receipt of the heat exchanger inspect for damage. If this is evident, notify the supplier immediately.
- Store under cover in a heated area where it will not be subjected to damage.
- When installing, set the heat exchanger level and square, ensuring that the connections can be made without force.
- Before starting ensure that all safety devices fitted are connected in circuit. All pressure switches will have been pre-set before leaving the factory.
- Where emergency doors are fitted, these should be checked for freedom of movement and correct location in the open and closed positions.
- Ensure that all mating flanges between the cooler and the motor are adequately sealed against the ingress of contamination.

**WARNING!**

**DC machines have characteristics that can cause serious or fatal injury unless they are selected, installed, maintained and operated by qualified personnel familiar with the special requirements of DC machines.**

**Disconnect power before touching any internal part. High voltage may be present even when the machine is not rotating. If used with a rectifier excitation supply, disconnect all ac line connections to the excitation source. Disconnect all dc field connections. Failure to observe these precautions may result in injury to personnel.**

**Installation should be in accordance with the National Electrical Regulations and consistent with all local codes of practice. All exposed rotating parts such as coupling; belt and chains should be guarded as necessary to prevent accidental contact with moving parts.**

**Machines accessible to the public should be further guarded by screening, guard rails, etc., to prevent the public from coming into contact with the equipment. Failure to observe these precautions may result in injury to personnel.**

### LIFTING:

Lifting shall be by means of the installed lifting lugs or eyes. It is the responsibility of the site engineer to obtain approval for any other method of lifting. Refer to the nameplate or the drawing for the weight of the equipment. Unless specifically detailed to the contrary lifting by the installed lugs or eyes is limited to the individual components supplied.

**WARNING! Under no circumstances attempt to lift the combined weight of the heat exchanger and motor with the lifting lugs attached to the cooler.**

**Failure to observe these precautions may result in damage to equipment, injury to personnel, or both.**

### INSTALLATION:

Having confirmed cleanliness after receipt or removal from storage the equipment should be mounted making all connections without force or distortion. Closures and supports used for handling and transport purposes must be removed.

Dependent upon operating temperature equipment may expand considerably. Ductwork design must allow for the relative movement of gas connections and as with other types of heat exchangers supports must also be designed to allow free expansion.

### OPERATING AND MAINTENANCE:

To maintain the operational efficiency of the heat exchanger the air passages should be examined and periodically cleaned if necessary. The frequency of cleaning will depend on the environment and the nature of any fouling occurring. Indications of fouling of the heat transfer services are typically, an increase in the system pressure drop, reduction in air volumes circulated and reductions in thermal performance. The way in which fouling will manifest itself will depend upon the plant control.

Light deposits may be removed from the tubes using non-metallic brushes. Care should be taken to avoid damage to corrosion protective coatings caused by excessive force and abrasion being used. Detergent and water may be a useful aid in removing stubborn deposits.

For heavy fouling high-pressure water jetting is recommended where there is no tube bore coatings. Even the most stubborn deposits may be removed by this method, which avoids the problem of tube bore scoring encountered with other mechanical methods.

### ANCILLARY COMPONENTS:

CACA heat exchangers can be supplied with the following ancillary components:

- Fan, for circulating internal air.
- Fan, for external cooling air.
- Air filter, on internal air circuit.
- Air pressure switches.

**18. INTERNAL AIR CIRCUIT FILTERS – AIR-AIR & AIR-WATER COOLERS**

These filters are to EU9 specification.

They should be replaced regularly to maintain the cooling airflow within the machine and to prevent overheating.

**REMOVAL OF AIR FILTERS FROM AIR-AIR & AIR-WATER COOLERS**

- Remove filter access cover.
- Cover hole inside base of cooler to prevent dirt or tools falling into motor.
- Undo filter clamps.
- Remove filter panel for renewal.
- Use vacuum cleaner to remove all dust from inside the cooler.
- Re-fit new filter panel and clamp into position.
- Remove the cover used to prevent dirt or tools falling into motor.
- Ensure that the inside of the cooler is thoroughly clean.
- Re-fit filter access cover unto cooler.

19. MOTOR PROBLEMS - QUICK CHECKLIST

SYMPTOM:	POSSIBLE CAUSE:
<p><b><u>MECH.</u></b></p> <p>Bearing overheats:</p> <p>Bearing knocks:</p> <p>Bearing whistles:</p> <p>Bearing requires early Renewal:</p>	<p>Excessive grease in bearing. Dirt in bearings. Bearing clearance too small. Lubrication failure. Incorrect grease used. Misalignment. Excessive belt tension.</p> <p>Dirt in bearing. Bearing clearance too large. Defect in bearing surface. Bearing wrongly fitted</p> <p>Bearing clearance too small.</p> <p>Dirt in bearing. Defect in bearing surface. Bearing wrongly fitted. Lubrication failure. Misalignment. Excessive belt tension.</p>
<p><b><u>ELECTRICAL:</u></b></p> <p>Motor will not start:</p> <p>Motor only just starts:</p> <p>Motor runs too fast or too slow:</p> <p>Motor overheats:</p>	<p>Brushes making bad contact. Break in armature supply. Fault in field supply.</p> <p>Short circuit on armature winding. Fault in field circuit.</p> <p>Brush position wrong. Fault in field supply. Short circuit on field winding.</p> <p>Overloading. Ventilation obstruction. External or internal air circuit filter blocked. Ventilation failure. Short circuit on armature winding.</p>

**MOTOR PROBLEMS - QUICK CHECKLIST**

SYMPTOM:	POSSIBLE CAUSE:
<p><b><u>COMMUTATION</u></b></p> <p>Sparking:</p> <p>Sparking and noisy operation of brushes on commutator:</p> <p>Sparking, rough commutator surface, fine lines in brush track:</p> <p>Rapid commutator or brush wear:</p> <p>Blackening of commutator at certain spots:</p>	<p>Overloading.  Broken brush(es)  Brush sticking in holder.  Brush position wrong.  Dirty or corroded commutator.  Commutator surface contaminated by oil, oil-mist, or other ambient factors.  Low commutator temperature.  High mica.  Loss of brush spring tension.  Short circuit on armature winding.  Short circuit on Interpole winding.</p> <p>Short circuit between adjacent commutator segments.  High resistance connection at commutator.  High mica.  Loose commutator.</p> <p>Low average current density in brushes due to light motor loading.  Commutator surface contaminated by oil, oil-mist, or other ambient factors.  Low humidity.  Commutator operating temperature too low.  Loss of brush spring tension.</p> <p>Abrasive material under brush.  Brush grade too abrasive.  Low average current density in brushes due to light motor loading.</p> <p>Commutator segment short circuit.  Motor being stalled.  Mechanical vibration.</p>

**20. MOTOR PRE-COMMISSIONING REPORT**

Customer: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 Tel/Fax No.: \_\_\_\_\_  
 Contact: \_\_\_\_\_  
 Reference: \_\_\_\_\_

MOTOR DETAILS			
Frame Size		Armature Voltage	
Serial No.		Armature Current	
Output (kW)		Field Voltage	
Speed (min <sup>-1</sup> )		Field Current	

INSULATION TESTS			
IR to Ground at 1000V		IR between windings at 1000V	
Armature Circuit		Arm-Field Circuits	
Field Circuit		Arm Circuit-Protect'n	
Thermistors		Arm Circuit - Heaters	
Thermostats			
Heaters		Field - Protection	
Cooling Motor		Field - Heaters	

Circuit Resistances		Visual Checks	
Armature Circuit		Visible Damage	
Field Circuit		Brush Gear	
Thermistors		Terminal Connections	
Thermostats		Terminal Box Sealing	
Heaters		Covers	
		Heat Exchanger	
		Water Circuit	
		Filters	

Engineer's signature: \_\_\_\_\_

Engineer's name: \_\_\_\_\_ (please print)

Date initiated: \_\_\_\_\_

Date completed: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_



**MOTOR COMMISSIONING REPORT**

Customer: \_\_\_\_\_

Tel/Fax No.: \_\_\_\_\_

Contact: \_\_\_\_\_

Reference: \_\_\_\_\_

MOTOR DETAILS			
Frame Size		Armature Voltage	
Serial No.		Armature Current	
Output (kW)		Field Voltage	
Speed (min <sup>-1</sup> )		Field Current	

PRE RUNNING	
Alignment	
Bolted down	
Connections	
Covers fitted	

RUNNING OFF LOAD	
Cooling motor direction	
Cooling motor current	
Field voltage	
Field current	
Armature voltage	
Armature current	
Speed (min <sup>-1</sup> )	
Direction (from DE)	
Vibration level	

RUNNING ON LOAD	
Field voltage	
Field current	
Armature voltage	
Armature current	
Speed (min <sup>-1</sup> )	
Vibration level	

Engineer's signature: \_\_\_\_\_

Engineer's name: \_\_\_\_\_ (please print)

Date initiated: \_\_\_\_\_

Date completed: \_\_\_\_\_

Comments: \_\_\_\_\_



**MOTOR MAINTENANCE REPORT**

Customer: \_\_\_\_\_

Address: \_\_\_\_\_

Tel/Fax No.: \_\_\_\_\_

Contact: \_\_\_\_\_

Reference: \_\_\_\_\_

MOTOR DETAILS			
Frame Size		Armature Voltage	
Serial No.		Armature Current	
Output (kW)		Field Voltage	
Speed (min <sup>-1</sup> )		Field Current	

INSULATION TESTS			
IR to Ground at 1000V		IR between windings at 1000V	
Armature Circuit		Arm-Field Circuits	
Field Circuit		Arm Circuit-Protect'n	
Thermistors		Arm Circuit - Heaters	
Thermostats			
Heaters		Field - Protection	
Cooling Motor		Field - Heaters	

Brush Grade:	Brush arm numbering: Top = 1, number CW viewed at Comm-End
	Brush holder numbering: Riser = 1, number towards endshield

BRUSH LENGTH RECORD CHART									
Date	Brush Arm	Brush Holder							Comments
		1	2	3	4	5	6	7	
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								

BRUSH LENGTH RECORD CHART									
Date	Brush Arm	Brush Holder							Comments
		1	2	3	4	5	6	7	
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								