ELECTRO MECHANICAL EQUIPMENT OPERATION AND MAINTENANCE

NTQF Level III

Learning Guide #32

Unit of Competence: Install Electro Mechanical Machine and drives

Module Title: Installing Electro Mechanical Machine and drives

LG Code: EIS EME3 M03 LO3-32

TTLM Code: EIS EME3 TTLM 0219v1

LO 3: Test installed electrical machines and drives

Instruction Sheet	Learning Guide 32

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Testing Electrical machines and drives
- Final inspections of installed electrical machines and drives
- Reporting on installation and testing of equipment

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Test electrical machines and drives in accordance with manufacturer's instruction
- Inspect to ensure that the installed electrical machines and drives conform to manufacturer's instruction.
- Report on installation and testing of equipment is prepared according to company's procedures/policies.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 13.
3. Read the information written in the "Information Sheets 1". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the "Self-check 1" in page .
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).

6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.
8. Read the information written in the “Information Sheet 2”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
9. Accomplish the “Self-check 2” in page .
10. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 2).
11. Read the information written in the “Information Sheets 3“ . Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
12. Accomplish the “Self-check 3” in page .
13. Do the “LAP test” in page __ (if you are ready). Request your teacher to evaluate your performance and outputs. Your teacher will give you feedback and the evaluation will be either satisfactory or unsatisfactory. If unsatisfactory, your teacher shall advice you on additional work. But if satisfactory you can proceed to Learning Guide #33.

Information Sheet 1	Testing Electrical machines and drives

Introduction

Electrical machines such as motor, generator, and transformer are tested to evaluate their performance characteristics such as their efficiency, voltage regulation etc. These tests requires loading of electrical machines using passive elements such as resistance, inductance and capacitance. During testing of any machine, huge amount of energy consumption take place especially when machine needs to be kept under test for a long duration of time. Hence the energy cost associated is also high for testing large rated machine.

Objectives of Testing Installed Electrical Machine

I. To verify proper functioning of the equipment/system after installation;
II. To verify that the performance of the installed equipment/systems meet with the specified design intent through a series of tests and adjustments;
III. To capture and record performance data of the whole Installation as the baseline for future operation and maintenance

Functional Performance Test

The purpose of functional performance tests is to demonstrate that the installations can meet the functional and performance requirements as specified in the General Specification and/or Particular Specification. Functional performance tests should proceed from the testing of individual components to the testing of different systems in the Installations.

1.1 Testing Generators

Testing your generator system should be part of a standard planned maintenance program for all systems. The main reason to test your system under load is to make sure the generator will perform as designed, when it is needed most. This is the only true way to check the performance of the generator. A load test will allow verification that the generator system will produce and maintain full load without overheating and shutting down. It also allows testing of all components of the system, to ensure all work

together as designed and intended and can help identify any potential weaknesses in controlled conditions.

The only way to evaluate the health of a generator is to test it. Periodic testing let's you know that you are prepared for power failure, and that your emergency generator system will work.

1. Generator test is performed

(a) Visual inspection on engine, alternator, radiator, and various systems of the generating set

(b) Full operating test

(c) Control function test

(d) Circuit & engine protection tests

(e) Fuel consumption test

(f) Step load acceptance test

2. How to Test Generator

Don't be intimidated by a generator system. Conducting periodic testing is simple. Unlike a portable generator, a residential standby generator connect directly to a fuel source like propane or natural gas. The generator then connects to a mainline circuit breaker. This main utility line in to your home is may be in a box outside your home, or in the garage or basement.

1. Flip the mainline breaker OFF**:-** Flipping the main utility disconnect will cut power from the incoming utility line and force the standby generator to turn on.
2. Listen for generator to turn on and the transfer switch to click:- The transfer switch is the most common installation for distributing power from incoming utility or generated power throughout the house. The generator may run for a few seconds to a minute before the transfer switch clicks and power is distributed. This is because the transfer switch is waiting to make sure that the incoming generated power is stable.

3. Let your generator run for about 10 minutes:- Give your generator time to warm up and “exercise.” This is a good time to walk through your home and check to see that power is restored fully.
4. After running a test, be sure to turn the mainline breaker ON:- and wait again for the transfer switch click and the generator to return back to standby.

1.2 Testing Pumps

A pump test is a procedure carried out by a pump manufacturer, supplier, installer, or owner to confirm one or more aspects of pump design or performance.

Pump tests are conducted to confirm that the pump meets the performance, design, and construction standards required by the project specifications and data sheets. The most common types of pump tests include:

- Pump performance tests: A performance test is used to determine that the head and flow produced by a pump as well as the power required to operate a pump match the project requirements.
- Hydrostatic pressure tests: A hydrostatic pressure test, or hydro test, involves putting the pump casing under pressure that is considerably greater than the actual operating pressure to ensure that the casing is strong enough to withstand operating pressures.
- Field tests: Most field tests are simple procedures used to demonstrate that the pump operates without excessive vibration and noise or high bearing temperatures as installed in the field.

Pump test may be conducted either in the pump factory or in the field. Factory tests are typically much more detailed than field tests.

To assist in defining these five pump categories, follow definitions for several specific characteristics of the five pumps categories for which the test procedure is applicable—namely rotodynamic pump, single-axis flow pump, and end suction pump:

Rotodynamic pump means a pump in which energy is continuously imparted to the pumped fluid by means of a rotating impeller, propeller, or rotor.

Single axis flow pump means a pump in which the liquid inlet of the bare pump is on the same axis as the liquid discharge of the bare pump.

End suction pump means a rotodynamic pump that is single-stage and in which the liquid enters the bare pump in a direction parallel to the impeller shaft and on the end opposite the bare pump's driver-end.

Pump Testing Procedure

This procedure will also cover testing that determines if the system is safe to operate. It ensures there is no damage to the pump system or lung model and no injury to the operators. The following parameters will be tested to guarantee the safety of equipment and researchers:

1) Pressure does not exceed the rated pressure of the system components

2) Pressure supplied by the pump does not exceed critical value at pressure sensor This procedure will ensure the following specifications are met:

3) Experimental flow rate is determined within 10% of expected flow rate

4) There is no leakage from the system

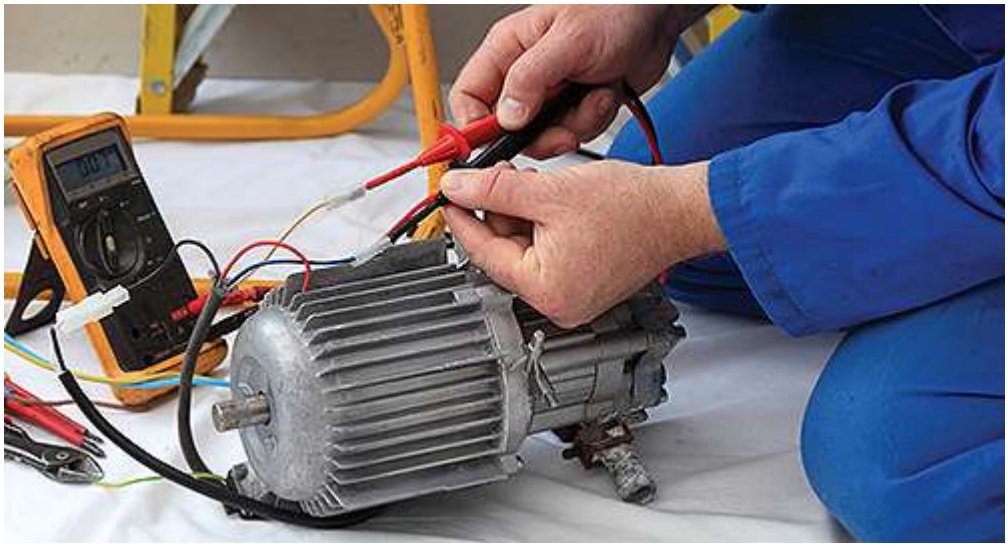
5) Flow direction is able to be reversed

This procedure will also be used to verify the correctness of an assumption.

6) Temperature change of the fluid is negligible

1.3 Testing Motors

Testing electric motors doesn't have to be a mystery. Knowledge of the basics together with powerful new test equipment vastly simplifies the job. Electric motors have had a reputation for being a mix of science and magic. So when a motor fails to operate it may not be obvious what the problem is. Knowing some basic methods and techniques along with having a few test instruments handy helps detect and diagnose problems with ease.



When an electric motor fails to start, runs intermittently or hot, or continually trips its over current device, there may be a variety of causes. Sometimes the trouble lies within the power supply, including branch circuit conductors or a motor controller. Another possibility is that the driven load is jammed, binding or mismatched. If the motor itself has developed a fault, the fault may be a burnt wire or connection, a winding failure including insulation deterioration, or a deteriorating bearing.

A number of diagnostic tools, such as clamp-on ammeters, temperature sensors, a Megger or oscilloscope, can help illuminate the problem. Preliminary tests generally are done using the ubiquitous multi meter. This tester is capable of providing diagnostic information for all kinds of motors.

Test Methods for various common tests performed on motors

Many of these tests require a mechanical load to be applied to the motor so the motor has something to “push” against. Such loads are often either a mechanical brake, which converts the motor output energy to frictional heat loss, or a generator, which converts the mechanical energy to electricity which can then be used to drive a resistor load bank (convert to heat) or other means to dump the electrical energy.

Power Usage

For AC motors, use a CT and PT to measure the current (I) and voltage (V) applied to a motor to form the instantaneous power P=I*V.

For DC motors, rather than a CT, you measure the current with a shunt, and compute power as I*V.

The amount of power is somewhat proportional to the motor load so tests typically automatically ramp the load to form a curve of input electrical power to output mechanical power. The “no load” and “full load” (or “blocked”) conditions are often of interest because fundamental parameters of motor operation can be obtained. For example, the “no load” phase angle between current and voltage in each phase of an AC induction motors is of interest for equivalent circuit parameters.

Condition of Windings

Testing the resistance of each winding can be measured with a standard DMM. These tests help determine issues such as shorts to ground, shorts between phases, and broken windings. A high-pot tester can check for winding insulation breakdown.

Component Temperature

Sensors used are listed in the table above and applied to various components used to construct the motor, such as the housing, heat sink fins, bearings, and so on. The type

of sensor to use is usually chosen based on the required accuracy, with RTDs being the best. Careful calibration and precision signal conditioning is important to get the highest accuracy from temperature sensors due to their small signal output.

Bearing and Unbalance Vibration

For rotating motors, applying an accelerometer to a motor bearing mount can assess the mechanical integrity of the bearing. Excessive vibration indicates bearing failure and the frequencies of those vibrations are indicative of the types of faults, such as bad roller bearing elements or overall looseness due to worn out elements.

When two axes are measured simultaneously, say vertical and horizontal as defined by gravity, an overall mount movement can be detected if either the bearing or the mount is moving. These frequencies occur at rotational speed and the harmonics, caused either by shaft misalignment or motor unbalance. Asymmetric windings, whether mechanical or electrical, also cause rotational forces.

Shaft Alignment

For rotating motors, placing an accelerometer in the direction of the motor shaft can detect looseness and misalignment in the shaft.

A more typical means of detecting motion of the shaft, due to run out or looseness, uses a proximity sensor. This type of sensor detects the distance between the sensor and the shaft and are almost always non-contact sensors, although some ride on the shaft surface. Non-contact version of these sensors usually use either eddy current or laser displacement methods, and one method may perform better that the other depending on the shaft material and condition. For example, the eddy current method will not work on a carbon fiber composite shaft.

Pull-in Current

A high-bandwidth CT or shunt measures the time response of current draw by the motor when first powered. Since the motor is not moving initially, the power source is driving a very low resistance due almost exclusively to the resistance of the windings. The current in-rush returns to normal levels after the motor starts moving. The shape and peak amplitude of the pull-in current can be used as a pass/fail disposition during manufacturing tests.

Run Up Time and Vibrations

The time required for a motor to reach the commanded speed can be an indication of proper motor construction. The typical sensor used for this measurement is an encoder or 1/rev (once per revolution) sensor. Motors that can be speed-controlled often have built-in encoders or 1/rev sensors which the motor controller can use to detect speed. Another method utilizes a non-contact sensor, such as a proximity or laser, to measure some aspect of the motor speed. For a prox, two notches at 180 degrees apart on the shaft (to maintain balance) can produce an oscillating signal the frequency of which is proportional to the motor speed. For a laser, a reflective yet lightweight piece of tape can produce an oscillating reflectance.

Also, since the run up to speed passes through all possible operating speeds of the motor, it is useful to monitor vibration during this run up in case any mechanical resonances are passed as the range of frequencies are invoked. In these situations, a slow run up is beneficial to allow build-up of low Q resonances.

Coast Down Time

The same test methods discussed for run up apply to coast down as well, with the one important fact that during coast down the motor is not being powered. Thus, any torque and other forces present during run up are absent in a coast down.

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What are the objective of testing installed electrical machine and device? (2 point)
2. what is the purpose of functional performance test? (2 point)
3. what is the reason to test your system under load? (2 point)
4. what are the test performed on generator ?(2 point)
5. what are the parameters will be tested to guarantee the safety of equipment and operators? (2 point)

Note: Satisfactory rating - 10 points **Unsatisfactory - below 10 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____

Information Sheet 2	Final inspections of installed electrical machines and drives

Introduction

2.1 Inspection Performed After Installation

After the basic system and equipment is installed, the following shall be performed and recorded to assure installation completeness:

1. Check installation for conformance with the design and specifications using available data (design drawings, vendor's drawings and manuals, process and instrument diagrams.)

2. Confirm suitability of electro mechanical equipment operation by:

- Checking alignment of all couplings, belts, gears, reducers, and sprockets (complete all records)
- Checking freedom of shaft rotation
- Checking tightness of seals, inspecting packing of glands, and stuffing boxes
- Checking lubrication (complete all records)

3. Perform and record required tests such as visual inspection, pressure and hydrostatic.

4. Check that all moving parts have safety guards and if not, installer shall provide acceptable field guards.

5. Check cleanliness of equipment and systems.

6. The above shall include all checks and tests which can be performed without energizing systems.

2.2. pre-operational inspection

The first operation of the equipment shall be without material, the only exception being pumps which must be run, as applicable, with water or oil. All running inspections shall consist of continuous operation until all bearing temperatures and equipment vibrations reach a steady state condition.

The following inspection shall be made:

1. Check operation of hydraulic and lubrication systems. Oil supply shall be confirmed.

2. Ensure the motor rotation has been checked before connecting motor driven equipment.

2.3. Make sure that the equipment operates with minimum vibration within limits established by the manufacturer.

1. Checks shall be made between all moving parts to be sure there is no interference and that clearances are to manufacturer's tolerances.

2. Make sure that all instrument devices, limit switches, timing devices, overload trips, alignment switches, emergency stop switches and the like, are operating properly.

3. Simulate system operation and make other adjustments as required to ensure satisfactory run-in operation.

4. It will be the Contractor's responsibility to do touch-up painting on all finished surfaces damaged or abraded during installation or left unpainted for field welding.

5. Installation person is to ensure that all chutes, material handling equipment and pipelines and ports are free from any obstruction or contamination.

6. All piping systems and vessels are to be isolated from contamination at all times, i.e. caps, plugs, covers, etc.

7. All systems are to be fully cleaned, tested, and inspected prior to first filling, flushing or introduction of processed and handled materials.

8. All equipment is to be certified complete and ready for Start-Up. All parties involved in all disciplines are to sign off on each system prior to commissioning.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What are the inspection tasks perform after installation? (2 point)
2. How can confirm suitability of electro mechanical equipment operation? (2 point)
3. what shall be made in the pre operational inspection? (2 point)
4. How can make sure that the equipment operates with minimum vibration within limits established by the manufacturer? (4 point)

Note: Satisfactory rating - 10 points **Unsatisfactory - below 10 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____

Information Sheet 3	Reporting on installation and testing of equipment

Introduction

Reporting is providing information about serious wrongdoing that you have become aware of at your workplace/ place of study. Reporting is about notifying concerning what you believe to be the discovery of breaches of laws and regulations, breaches of ethical norms or serious conditions which might harm individuals, the university, cooperative partners, or society as a whole.

Examples of situations where employees need to speak out:

- Defects or shortcomings which could lead to a danger posed to life or health
- Breaches of professional and research-oriented ethical guidelines
- When fellow students or colleagues are bullied, harassed (including sexual harassment) or discriminated against in connection with their work
- Drug use or other forms of problematic
- Environmental crime
- Activities which could damage property or infrastructure

Reporting regarding conditions which are only of internal or personal interest, for example internal personal conflicts in which the employee can be considered to be a part of the conflict, shall be dealt with in accordance with guidelines for managing work

1. Method of technical report Writing

A technical report is a formal report designed to convey technical information in a clear and easily accessible format. It is divided into sections which allow different readers to access different levels of information. This guide explains the commonly accepted format for a technical report; explains the purposes of the individual sections; and gives

hints on how to go about drafting and refining a report in order to produce an accurate, professional document.

2 Structure

A technical report should contain the following sections;

Section	Details
Title page	Must include the title of the report. Reports for assessment, where the word length has been specified, will often also require the summary word count and the main text word count
Summary	A summary of the whole report including important features, results and conclusions
Contents	Numbers and lists all section and subsection headings with page numbers
Introduction	States the objectives of the report and comments on the way the topic of the report is to be treated. Leads straight into the report itself. Must not be a copy of the introduction in a lab handout.
The sections which make up the body of the report	Divided into numbered and headed sections. These sections separate the different main ideas in a logical order
Conclusions	A short, logical summing up of the theme(s) developed in the main text
References	Details of published sources of material referred to or quoted in the text (including any lecture notes and URL addresses of any websites used.
Bibliography	Other published sources of material, including websites,

	not referred to in the text but useful for background or further reading.
Acknowledgements	List of people who helped you research or prepare the report, including your proofreaders
Appendices (if appropriate)	Any further material which is essential for full understanding of your report (e.g. large scale diagrams, computer code, raw data, specifications) but not required by a casual reader

Installation Report

The installer must include in the report after installed any machine about

- The functional performance of components
- Step by step installation process of
- Testing and inspection of process
- maintenance process
- repairing process

Self-Check 2	Written project

Name: _____ Date: _____

Direction : write complete technical report for your operation sheet 2

Operation Sheet 3	Identifying defective electrical components Techniques

Techniques to identify defective electrical components

1. Check the your multimeter functionality (turn on power)
2. Disconnect the power source before checking, servicing, repairing or installing electrical equipment and devices.
3. Turn “ON” your multimeter and set to the lowest resistance setting. The resistance settings are the ones measured in Ohms.
4. Test your multimeter is working by pressing the probes together. The multimeter screen should read 0.00 also known as short circuit (inexpensive meters may read close to this from resistance of their leads). When the probes part the screen should read 1 or OL, also known as open circuit.
5. Find the two connections where wires connect to your part.
6. Push the metal parts of your multimeter probes firmly onto these connections, one probe on each connection.
7. Keep the probes still until you get a reading on the multimeter screen. Take note of the reading.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hours.

Task 1. Identify defective components of control panel

- Prepare instruments to appropriate function switch and range switch
- Check your probe
- Turn off the power supplied to control panel
- Trace the fault.