TTE Training Ltd.

Phase 2
Electrical Course Notes

E2-CN-006

Fault Diagnosis Techniques

Six Point Technique

1. Firstly, collect the evidence

- Do not approach a fault with a preconceived idea of what it is.
- Before changing or moving anything **STOP, LOOK, LISTEN and LEARN.**
- The quantity of information collected is unimportant.
- The information must be relevant to the fault you are looking for. If in doubt include it and discard it later if irrelevant.
- Listen to what the user has to say about the problem.
- Check the system as it is running, if possible.
- Refer to documentation such as maintenance records, log cards, maintenance manuals etc.
- If using test equipment, check the equipment on a known point to check calibration or setting.

2. Analyse the evidence

- Once you have collected evidence, think about what it tells you
- Separate the various symptoms and try and work out the significance of each one. This step tells you if you need to collect more evidence
- Does the evidence lead you to previously recorded faults or your own experience of faults?
- Don’t collect more evidence till you have completed this step.

3. Locate the fault

- Use the analysis step to guide you to the correct area of the fault.
- Use all resources available to you, test equipment, fault finding aids, computer error logging etc.
- Wherever possible, locate the fault to component level.
- Do not assume anything, if you locate a faulty component by a system check, remove and test the component.

4. Determine and remove the root cause

- Before making any repair, you must ask yourself ‘why did the fault occur?’
- You must find and remove the root cause – otherwise the fault will reappear. The root is as far back as you can practically check.
- Beware – the cause may not be on the equipment you are working on.

5. Rectify the fault

- Adjustment, repair or replacement should only be done after identifying and removing the root cause of the problem.
- It may be a simple or major task but must be based on the earlier findings.
- Always use correct parts.
- Temporary repairs are only to keep the system running for a short period of time.
- It may be necessary to do extra work (i.e. cleaning or adjusting a component).

6. Test the system

It is important to ensure the machine, equipment or system is functioning normally after a fault has been repaired. Simply putting the machine back into service is not acceptable

Some equipment may need re-setting or fine-tuning after a fault is repaired.

Fault Location Techniques

You may often need to use other techniques to identify and remove faults.

These can include using one or more of: -

- Function testing
- Unit substitution
- Input to output
- Half-split technique
- Emergent problem sequence
- Equipment self-diagnostics

Function Testing

There is normally a specification for the operation of an electrical component, equipment or system. By ensuring the outputs are connected correctly and the correct input is applied, the operation or the function of the electrical equipment can be measured against the specification. Does it do what it is designed to do within given parameters? If not, then it is faulty.

Unit Substitution

Many faults are more easily located by replacing the unit or component with a new or proven one and checking the system within given parameters. This is normally used when components are easily changed and are inexpensive. If the fault is in the system and not the unit or component, then the replacement could also be damaged.

Input to Output

Done by working from a known point or input and checking a system or circuit in a logical sequence until the abnormal condition is located.

Half-Split Technique

To reduce diagnosis time, choose a test point which is as near as possible halfway in the area of search. If the first check shows an abnormal condition, then the fault is between the input and your test point. If normal conditions apply, then the fault is between your test point and the output. Physical or environmental conditions and experience of the system may mean your test point is not exactly at halfway. By checking the output of a controller, you can establish whether the problem is control or field equipment.

Emergent Problem Sequence

This is searching for changed factors that have happened in the past which have caused a deviation from expected standard or fault to occur. A brief but concise problem statement, free from assumptions needs to be recorded. This statement should include: -

- What is the defect or variance on the system or equipment?
- Where geographically is the problem or where was it first observed?
- When did the problem occur or when was the fault first observed?
- What is the magnitude of the problem? How much, how many, how big?

Equipment Self Diagnosis

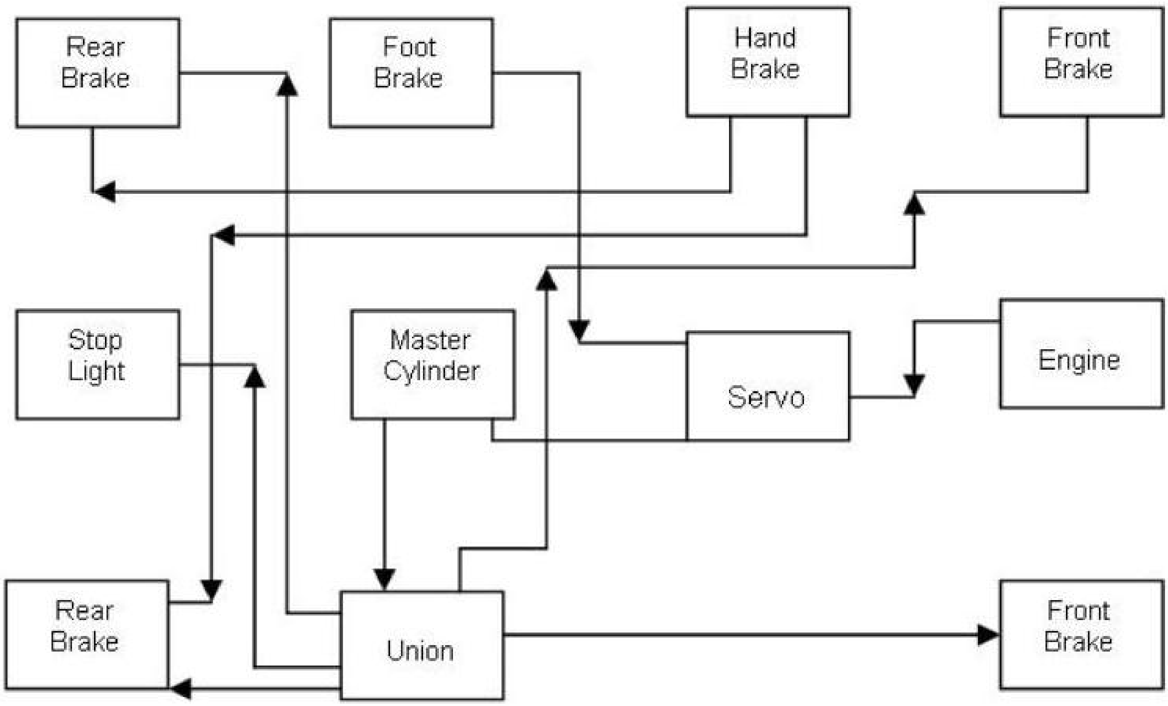
PLC’s and other microprocessor equipment or systems have as an integral part of their design a fault logging and fault code system. When a fault or abnormal condition exists, a code number or letter is displayed. The equipment or supporting documentation list these codes and give a fault description or fault location.

Fault-finding Aids

For logical fault-finding diagnosis, consider equipment or plant as a complete system. A system is a collection of inter-dependant elements or components to produce an outcome. You must know what elements make up a system and how it is supposed to work before you can successfully fault find.

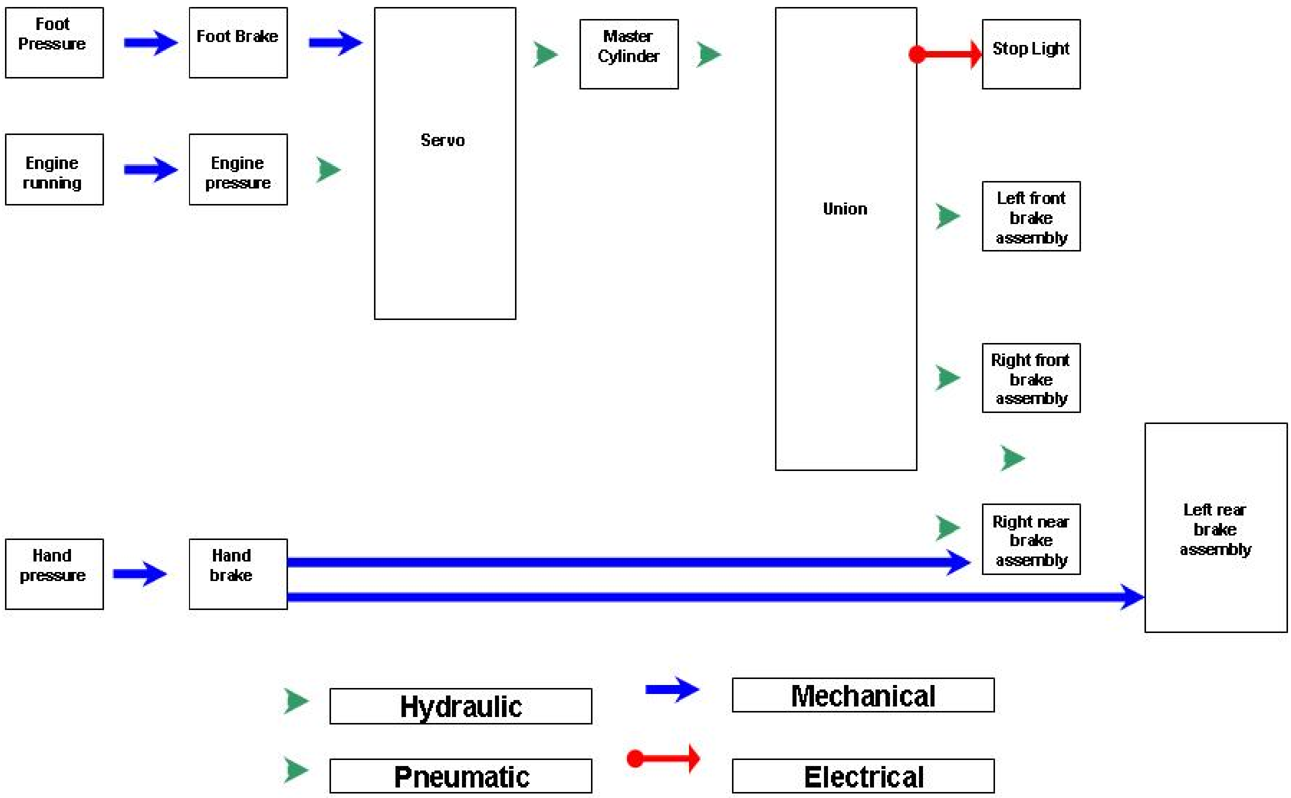
Block Diagrams

A system has three elements and in its simplest form it can be represented by a block diagram. Developing a block diagram not only shows basic understanding of the system, but also can help in locating the area of a fault by studying the inputs and outputs to each of the elements. An example of a block diagram is the one of a car braking system:



Functional Diagrams

The functional diagram shows the block diagram, but also how the elements relate to each other. The relationship between elements could be electrical, mechanical, hydraulic or pneumatic. The relationship could also be one-way or two-way. Often an element with mechanical input can produce an electrical output such as s weight transducer or flow meter. Functional diagrams go from start of process on the left to end of process on the right and they contain both series and parallel function blocks. The same car braking system is represented by this functional diagram:



Algorithms and Flowcharts

An algorithm is a sequence of logical steps to define a process or a method of fault finding. A flowchart is merely a pictorial method of representing an algorithm. Progress through an algorithm or flowchart is determined by the awareness to a series of questions. The questions are formed in such a way that the only possible answers are “yes” or “no”.

The design of an algorithm can be difficult as their usefulness depends upon the designer’s ability to anticipate and accommodate a wide range of possible thoughts. They can, however, be effectively used by persons with a limited knowledge of the system or equipment.

Fault finding Charts

Many Manufacturers’ manuals include a section which contains fault finding or trouble shooting charts covering a number of known common faults. The information contained in these charts is based upon previous experience of the equipment in service. Predicted or possible faults may also be included based upon the knowledge and experience of the design engineer.

The charts normally contain the fault (often confused with the symptom), its possible cause and remedy. In spite of confusion in terminology, these charts are a useful aid to fault diagnosis, particularly in relation to produce or process faults. Where these charts are available, they should always be used. An extract from an example faultfinding chart is shown below.

Predicted or possible faults may also be included based upon the experience or history of the equipment or system being maintained.

Fault	**Possible Cause**	**Remedy**
Product output level inaccurate but uniform for all filling heads	Leak in vacuum system	Carry out check on product bowls sealing as described in maintenance manual
	Incorrect setting of machine contained height	Readjust height. Error in level as equivalent to error in height of filling bowl
Product level inaccurate and varying	Damaged sealing rubbers	Remove filling valves at fault. Remove and examine rubber. Renew worn or damaged components
	Choked or bent air tube	Locate faulty filling valve by cyclic variation of fault. Dismantle and clean tubes or fit new tubes.
	Excess frothing of product	Inspect all unions for tightness on rubbers on product bowl outlet fittings for signs of deterioration. Check that there is an adequate level of milk in supply tank outlet pipe which should be fully submerged and no vortex forming.

Recording Fault Analysis

In a fault-finding situation it is important to collect as much evidence as is required and then to analyse that evidence in order to clarify what the problem is. It is also important to check any assumptions you might make by carrying out tests or checks and recording the results. This allows you time to think about the problem and records time and place in case you have to retrace your steps at a later date.

It is important that much of this analysis is done before taking any action, as your actions may disturb the fault. Evidence can be gained from persons involved with the equipment or system at the fault happened.

Use fault finding aids such as circuit diagram, functional diagrams to establish the location of the fault. Record the reported fault, symptom, test/check results and your deductions on a record of fault analysis.

When the fault has been traced, record the fault, the root cause and a recommendation to ensure the root cause is removed. Record the time taken to deduce the fault, sign and date the record.

These documents form a very useful aid in fault diagnosis, as they can be used to develop symptom/fault charts or faultfinding charts and be passed on to other maintenance personnel.

Example of a typical fault analysis record

	Record of Fault Analysis	
Machine No: M676		**Location:** Warehouse B
Reported Fault/Symptoms: Machine stopped and will not start.		
Symptoms	**Deduction and Possible Causes**	**Results of Inspections and/or test.**
Loss of power and over heating on normal	Friction at bearings Mechanical contact between rotor and stator Blocked air duct in cooling system	Bearings free and adequately lubricated No evidence found on inspection Air ducts found free of obstructions
Machine stopped after running a short time and failed to restart	Disconnection of one or more phases would normally prevent restarting	Motor overload tripped
Motor overload tripped	Short circuit turns in winding High resistance joints between rotor bars and rings Loss of one supply phase Intermittent continuity of number two phase conductor	Difficult to measure, remove motor to test in repair shop Static continuity test revealed nothing Running test using clamp meter to check three phases revealed excess currents in phases one and three and normal or subnormal current in phase two Repeat static continuity test while shaking lead on phase two revealed intermittent disconnection
Fault: Fractured conductor inside the insulation on motor lead phase two **Action:** Renewal of lead cleared the fault. Running test then indicated equal currents in each phase. Machine continued to run normally without overheating **Cause:** Motor cable not clamped to motor allowing excess movement **Recommendation**: New cable clamp to be fitted to this and other like motor installations		
Signature: J Morley	**Occupation**: Electrical Engineer	**Date**: 24/09/00
Time Taken:		

These records are now kept in the maintenance system can be used to apply the fault-finding aids described earlier.