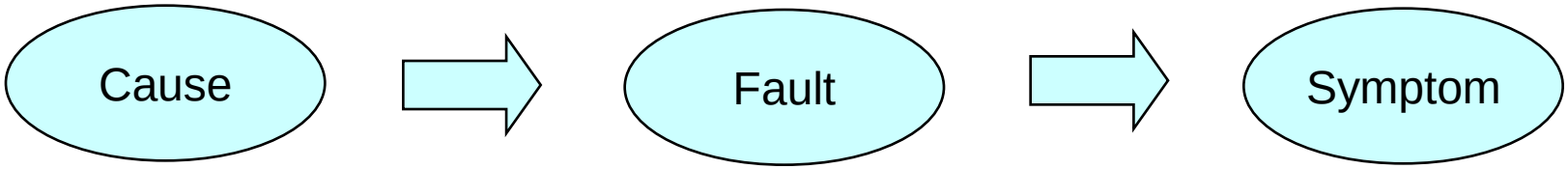
DIAGNOSTIC TECHNIQUES

SYMPTOMS, FAULTS & CAUSES

“A high wind blew down a tree which was rotten with Dutch Elm disease”



(Dutch Elm disease)

(Rot in the tree)

(Tree blew down)

SYMPTOMS AND FAULTS

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pump bearing temperature is too high

a fuse has blown

a light isn’t working

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loose wire is causing a short circuit

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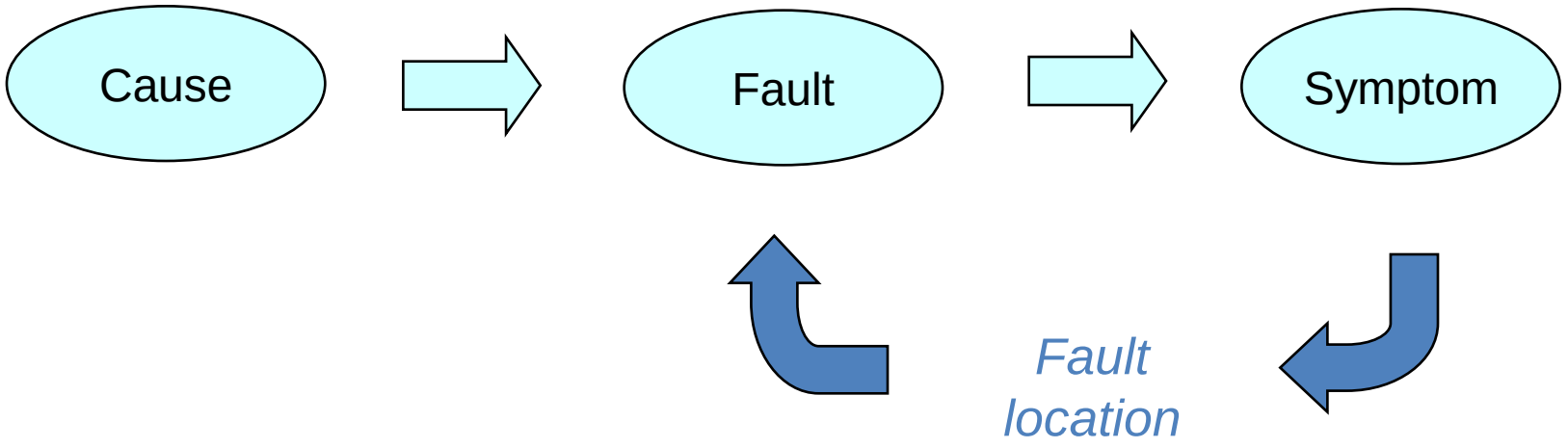
FAULT LOCATION

Fault location is the process of finding a fault from its observed symptoms



FAULT LOCATION

It is important to consider only those symptoms that are attributable to the fault:

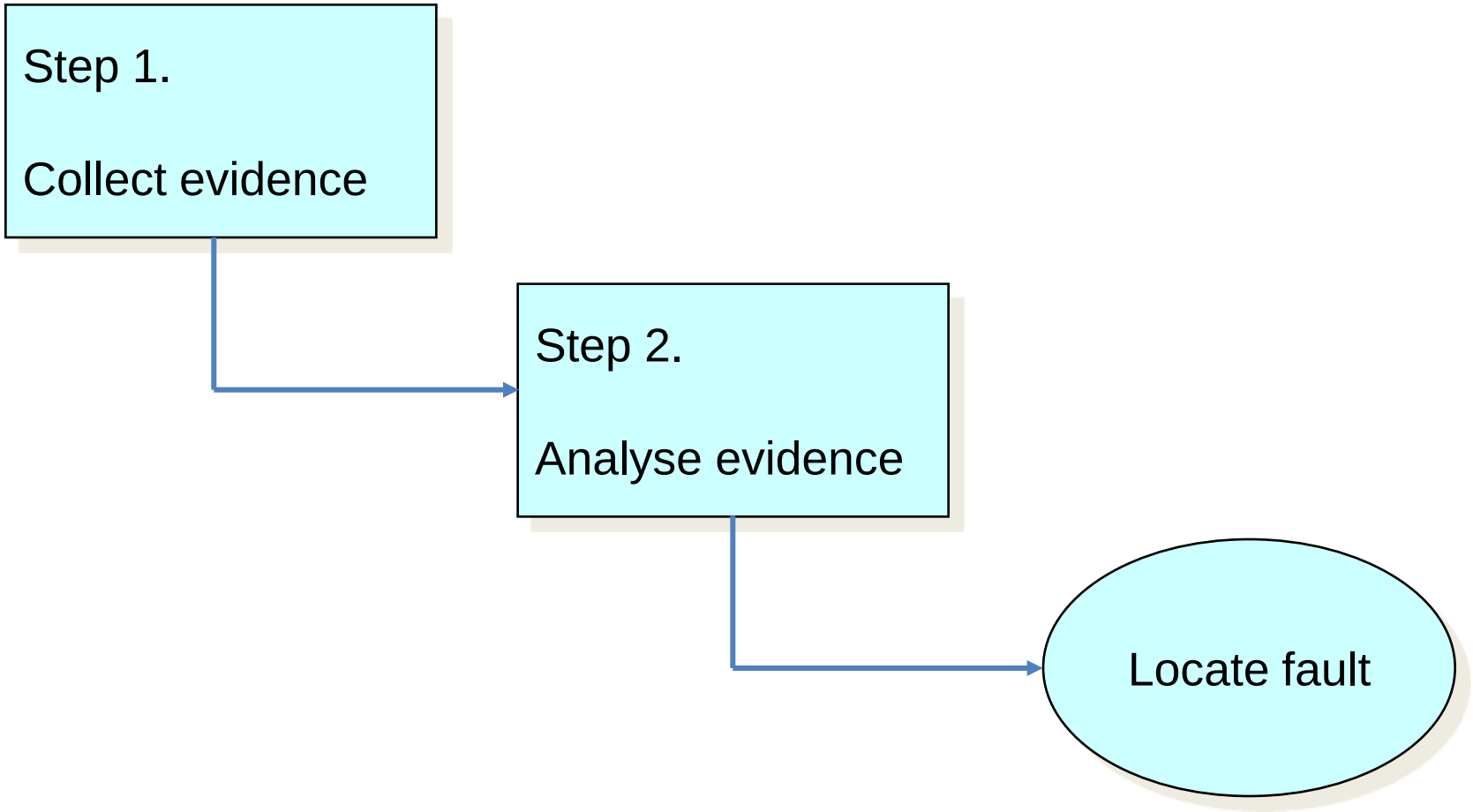
- this is easier said than done,
- it is not always certain which symptoms are relevant,
- a practical approach is first to gather evidence.

EXAMPLE OF GATHERING EVIDENCE

Consider if your car has recently developed an oil leak. A week prior to observing the leak, the car had been serviced and a new clutch release bearing had been fitted:

- the service is not a symptom,
- but it is evidence and it must be considered.

FAULT FINDING USING RELEVANT EVIDENCE



COLLECTING EVIDENCE

- all sources must be considered,
- include those detected by visual inspections and the use of other senses, e.g. smell,
- where appropriate analyse computer print out's and chart readings,
- maintenance and calibration records as well as shift logs should also be taken into account,
- a valuable source is often other peoples observations ,
- but be careful to differentiate between facts and opinions

ANALYSIS OF EVIDENCE

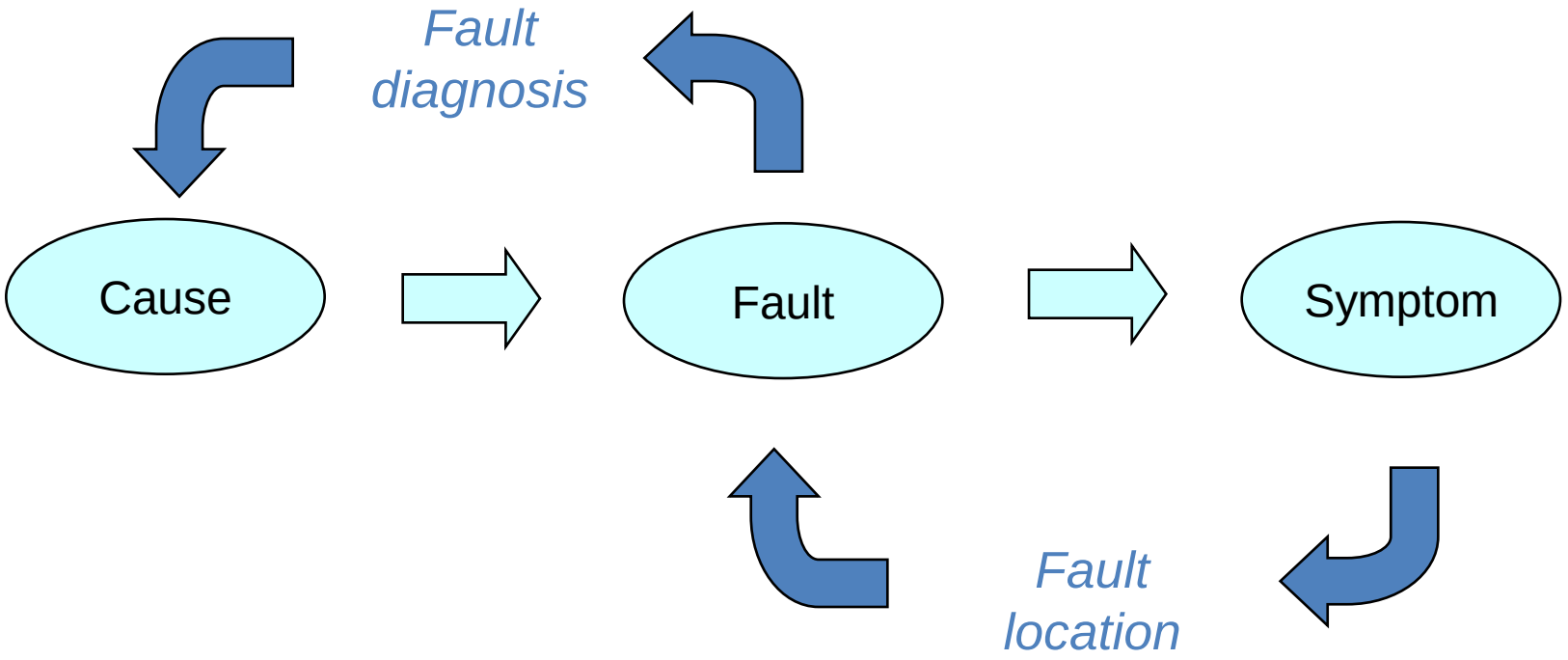
- ensure you separate relevant facts from those that are not,
- frequently people lack precise knowledge of the working of machines or equipment,
- where possible use fault finding aids to overcome this problem.

TYPICAL FAULT FINDING AID

No standby light	*Is your TV plugged in?*	Plug your TV into mains socket (AC outlet)
	Is the main power switch on the front of your TV off?	Press the power button.
	Has the fuse in the mains plug blown?	Replace fuse in mains plug.
TV doesn't work even though standby light is on	*Has sleep timer switched TV off?*	Press a numbered button on the remote control and cancel the sleep timer feature.
No picture, no sound	*Is your TV plugged in?*	Plug your TV into mains socket (AC outlet)
	Is the aerial connection cable broken or damaged?	Check all aerial connections for broken or damaged wires. If necessary replace with new cables.
	Possibly station trouble	Move the aerial away from possible source of interference. If you live in a known poor reception area try using a booster to improve the quality of broadcast signal.
	Is the main power switch on the front of your TV off?	Press the power button.
	Have you pressed the mute button or have you set the volume at minimum?	Press mute button again or increase the volume using the volume control
Unable to playback video tapes	*During automatic tuning of your TV you didn't have your VCR switched on, therefore your TV was unable to find the signal.*	Before starting the automatic tuning operation make sure your VCR is switched on displaying it's test signal, see page 8 for details.

FAULT DIAGNOSIS

In the same way that fault location works back from symptoms to the fault, *fault diagnosis* looks first at the fault before moving to identify the cause:



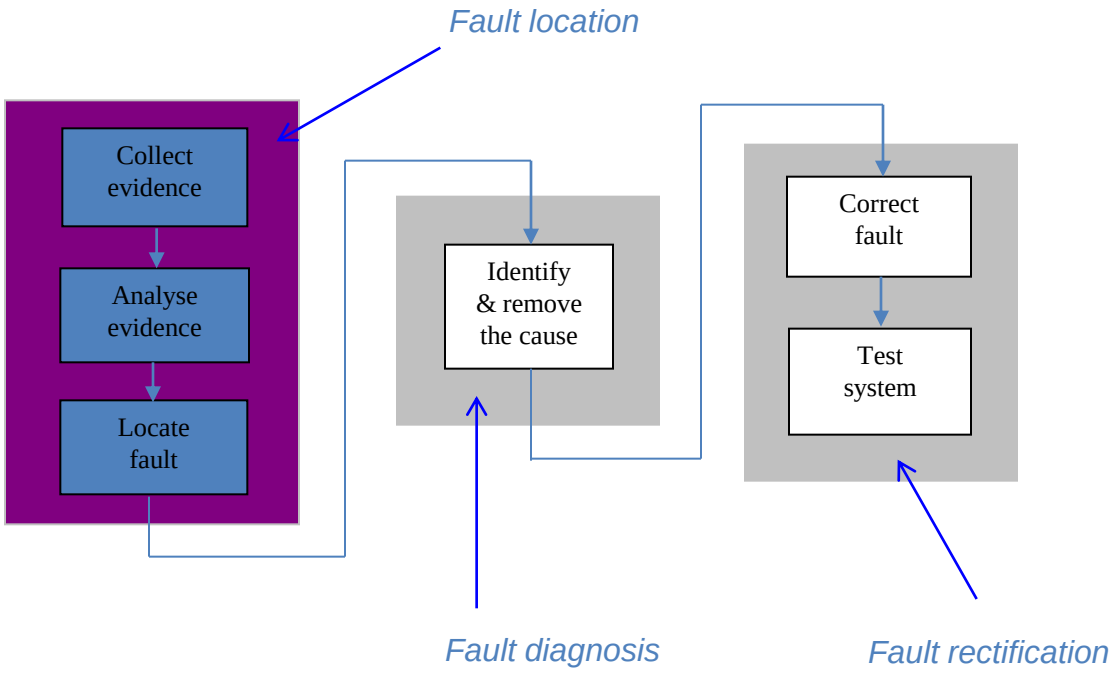
FAULT RECTIFICATION

Although the previous diagram is valid, an additional step must be included to ensure that the cause has been correctly identified:

- this can only be achieved by including a rectification step,
- where, after diagnosis, the fault is corrected,
- then the system must be checked or tested,
- if this stage is neglected, undesirable side effects introduced as part of the correction process may go unnoticed.

FAULT CORRECTION

The six steps which form a logical approach to fault correction are.



USE OF THE SIX STEPS

(EXAMPLE)

Consider a table lamp which shares a double socket with a television set. The lamp was accidentally knocked from the table during routine dusting and when replaced did not work, i.e. the bulb did not illuminate when the lamp was switched on. On your return home from work you are told “the bulb’ gone”, so you replace the bulb only to find the lamp still does not light.

To illustrate the application of the six step fault correction process, we can assume the cause of the fault is a loose wire in the lamp switch which has caused a short circuit and blown a fuse in the plug.

STEP 1

Step	Comments/actions
1. Collect evidence	(a) check and confirm all other lights in house are working. (b) check and confirm that the TV is working. (c) a replacement bulb didn't solve the problem. (d) the lamp worked until it was knocked over.

STEP 2

Step	Comments/actions
2. Analyse evidence	Points 1 (a), 1 (b) and 1 (c) suggest that there is a fault between the plug and the bulb.

STEP 3

Step	Comments/actions
3. Locate fault	Remove plug from socket and take off top of plug to check fuse and find it is blown. *(the question to ask is “what caused the fuse to blow?”).* Unscrew lamp socket and check socket wires to find one is loose.

STEP 4

Step	Comments/actions
4. Identify and remove cause	On examination, you find whoever connected the wire into the socket cut half way through the wires when cutting back the insulation. The wire eventually broke and shorted to the socket, thereby causing a short circuit to earth which has blown the fuse.

STEP 5

Step	Comments/actions
5. Correct fault	Remake the electrical connections to the lamp socket. Replace the fuse.

STEP 6

Step	Comments/actions
6. Test system	Try out the lamp to confirm it is working once again.

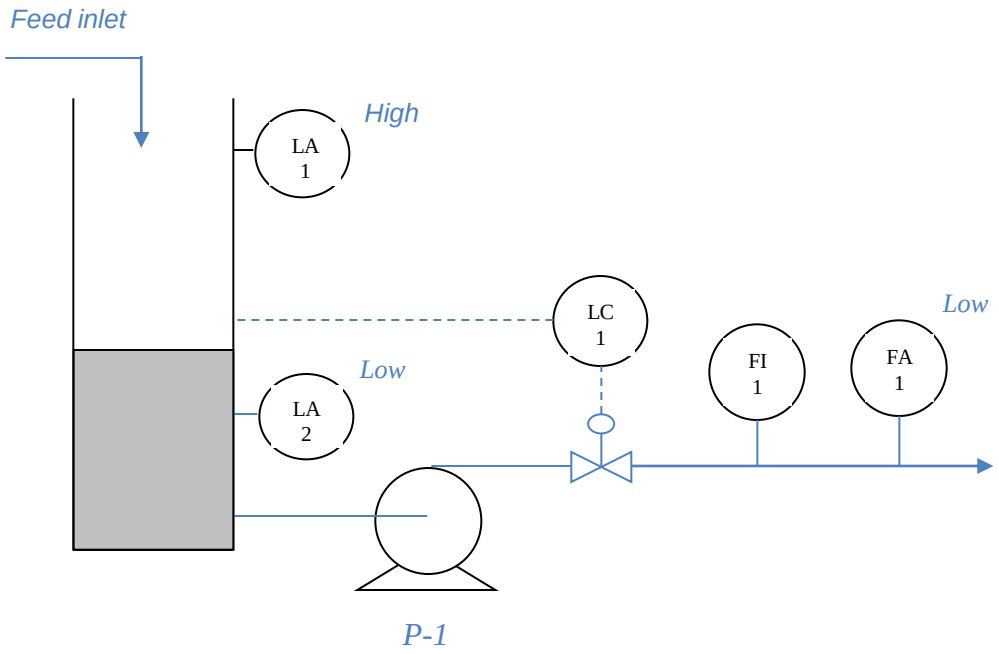
FAULT CORRECTION AIDS

(DECISION TREES)

- fault diagnosis is based on asking relevant questions at each stage of a process,
- decision trees are designed to do this in a diagrammatic form,
- it is a simple technique based on asking questions that can result in only a YES or NO answer,
- the validity of the result is still reliant on the use of a robust fault correction process,
- decision boxes are normally diamond shaped and lead either another decision box or to a rectangular action box.

PROCESS EXAMPLE

(FOR DECISION TREE)



Consider the above process. Feed enters a vessel and is pumped away by P-1 through level controller LC-1. In P-1 discharge line is a flow indicator FI-1 and a low flow alarm FA-1. The vessel has two level alarms LA-1 (high) and LA-2 (low).

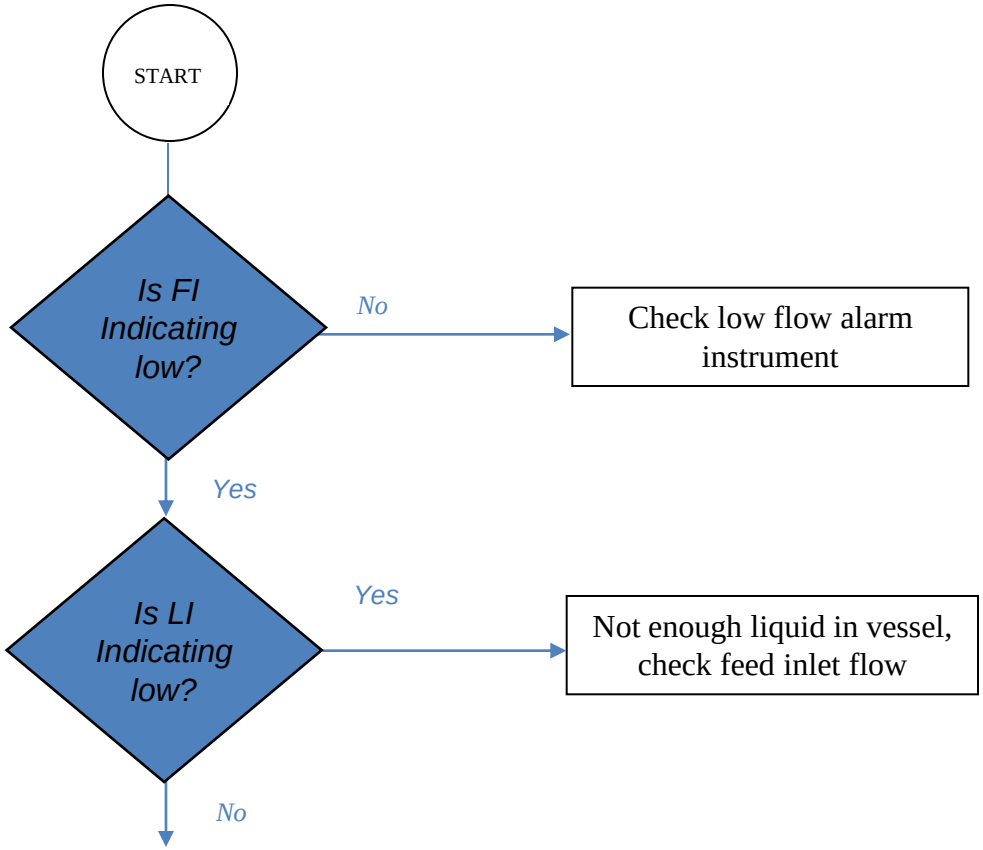
DECISION TREES

Consider the possible causes of a low flow condition as identified by FA-1:

- Pump P-1 has stopped,
- the vessel level is too low and the pump has lost suction,
- the control valve is closed - this may be a result of a low level condition in the vessel as the automatic controller closes,
- there is a fault with the low flow alarm instrument (FA-1).

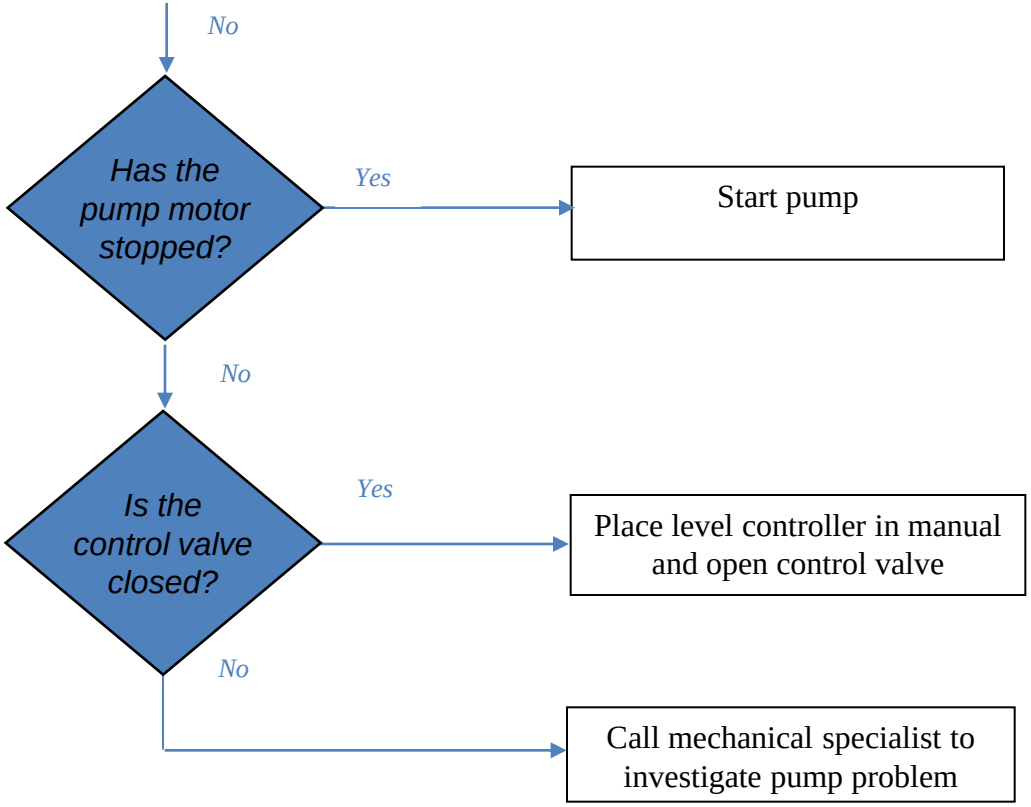
DECISION TREE

(LOW FLOW ALARM)

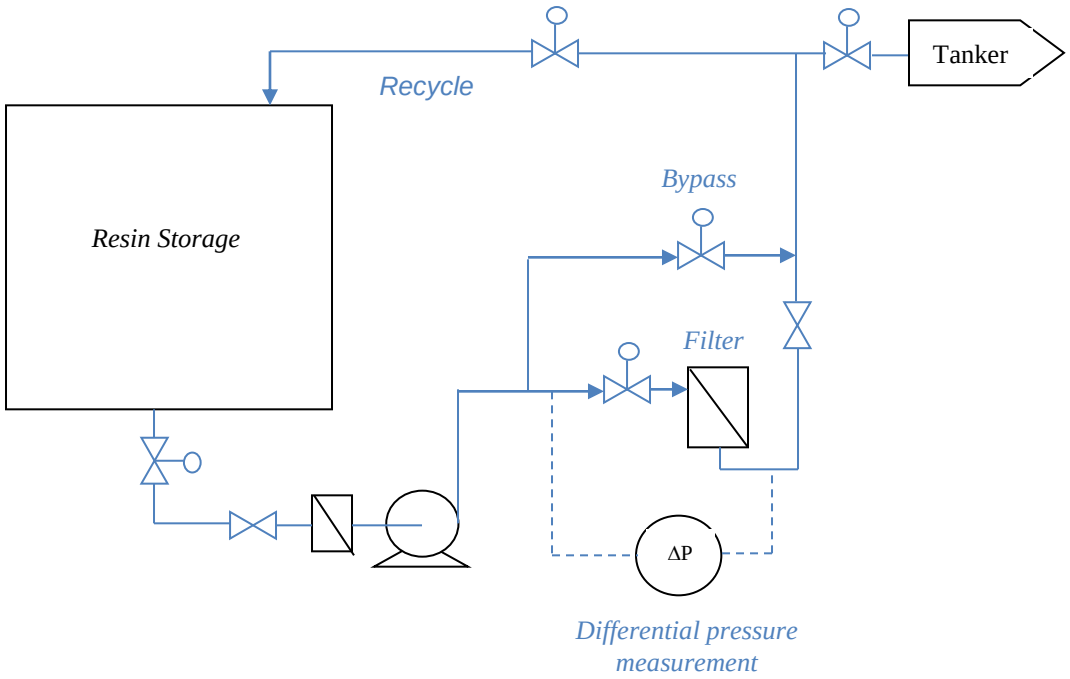


DECISION TREE

(LOW FLOW ALARM continued)



CASE STUDY


Tanker
Recycle
Resin Storage
Bypass
Filter
ΔP
Differential pressure measurement

REVIEW

(DIAGNOSTIC TECHNIQUES)

- ↗ we began by considering symptoms, faults and causes,
- ↗ fault location is the process of finding a fault from its observed symptoms,
- ↗ faults can only be assessed by gathering relevant evidence,
- ↗ ensure relevant evidence is collected and properly analysed,
- ↗ study the fault before moving to identify the cause,
- ↗ successful fault rectification relies on a thorough test/checking procedure,
- ↗ observe the six steps for a logical and robust fault correction process,
- ↗ decision trees are an example of a practical fault correction aid.