U-3ARC
TRAINING WEBINAR N°40

PRECISION AIR CONDITIONING SYSTEMS

(DATA CENTER COOLING)

TRAINER:

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PRECISION AIR CONDITIONING SYSTEMS (DATA CENTER COOLING)

TRAINING OBJECTIVES

- Introduction to PAC systems / close control units
- Benefits of PAC to data centers and server rooms.
- How PAC system works
- PAC systems designs
- Humidity control in PAC systems
- PAC system layout
- PAC systems installation scenarios
- PAC system pipe installation requirements
- precautions for brazing
- precautions for cooling circuit pressure testing
- precautions for cooling circuit vacuum drying
- precautions for charging the cooling circuit
- common faults, possible causes and remedies

Introduction to PAC systems

- The precision air conditioners, also known as a CCU (close control units) or CRAC (computer room air conditioner).
- Precision air conditioning is a specialized cooling technology designed explicitly for critical environments, such as data centers.
- Unlike traditional air conditioning systems used for general comfort cooling, precision AC provides precise control over temperature, humidity, and airflow.

Benefits of PAC to Data Center and Server Rooms

- Precise and quick processor-based temperature controller.
- Both low/high humidity control levels can be impeded.
- Designed for 24 x 7, 365 days continuous operation.
- Demonstrate better air distribution across server and data centers.
- Deploy new features or enhance existing ones as their software/ firmware is regularly updated.
- It also assists to remotely monitor/troubleshoot
- redundancy operation / standby operation

How PAC system works

A PAC system is designed to provide precise control over temperature and humidity, making it ideal for environments like data centers, server rooms, and laboratories where maintaining specific conditions is crucial.

➢ **cooling mechanism**

PAC systems use evaporator coils to lower the air temperature. these coils are often designed with microchannel technology for high heat transfer efficiency.

➢ **air distribuiton**

fans distribute the cooled air evenly throughout the room, ensuring consistent temperature and humidity levels

➢ **humidity control**

PAC systems include humidifiers or dehumidifiers to maintain the desired humidity levels. This is important to prevent static electricity and other issues that affect sensitive electronic equipment

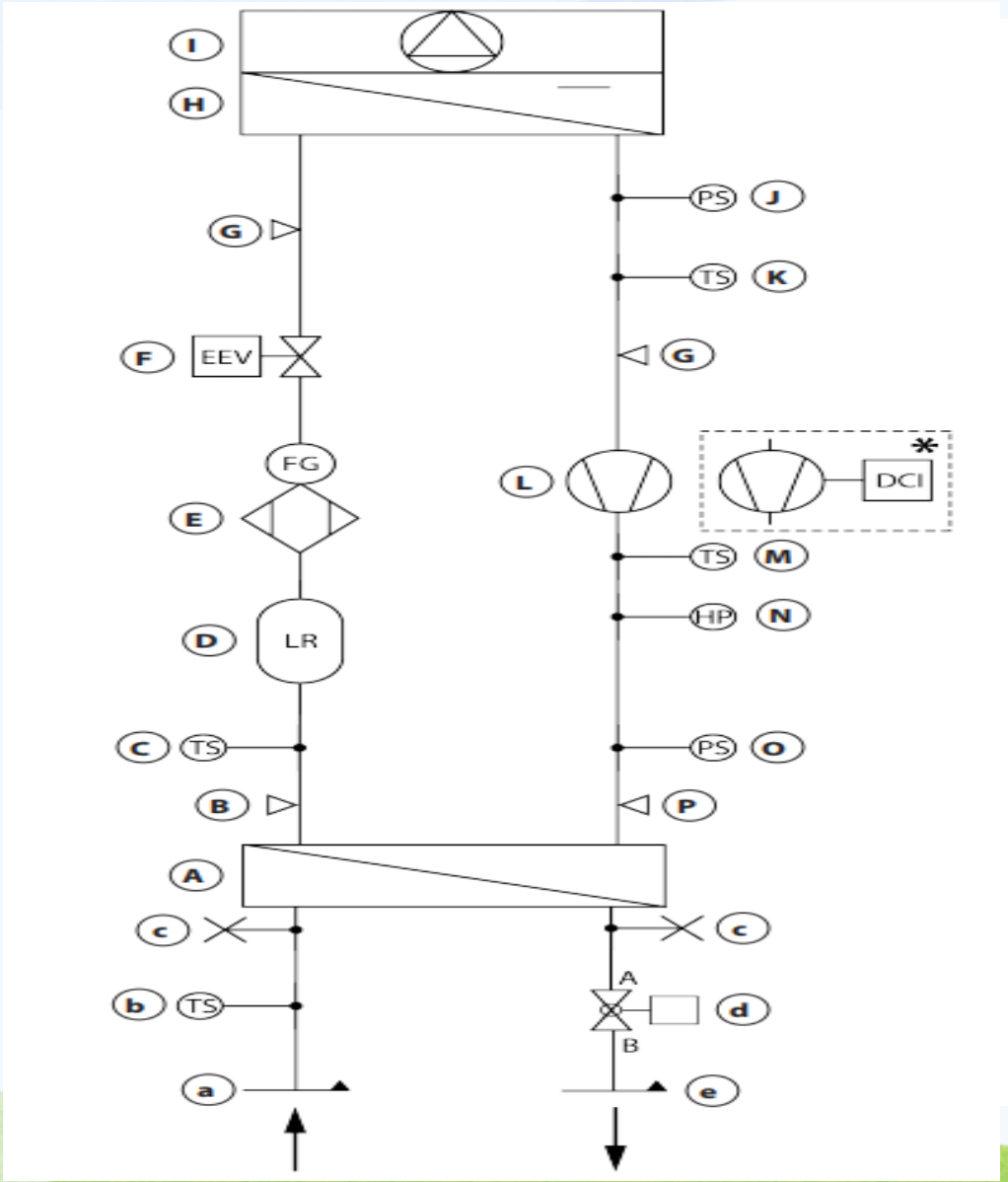
➢ **Air filtration**

high efficiency air filters remove dust and other particles from the air, ensuring a clean environment for the equipment

➢ **microprocessor control**

Advanced microprocessors controllers monitor and adjust the system in real-time to maintain precise conditions.

schematic for a cooling circuit of single compresso and air cooled condenser



Cooling circuit:

Liquid line (HP: PS 41 Bar - TS 64 °C):

- **A** Water-cooled condenser
- **B** Pressure intake SAE 5/16" male flare
- **C** Liquid temperature probe
- **D** Liquid receiver
- **E** Dehydrator filter with liquid sight glass
- **F** Electronic expansion valve

Suction line (LP: PS 22 Bar - TS 38 °C):

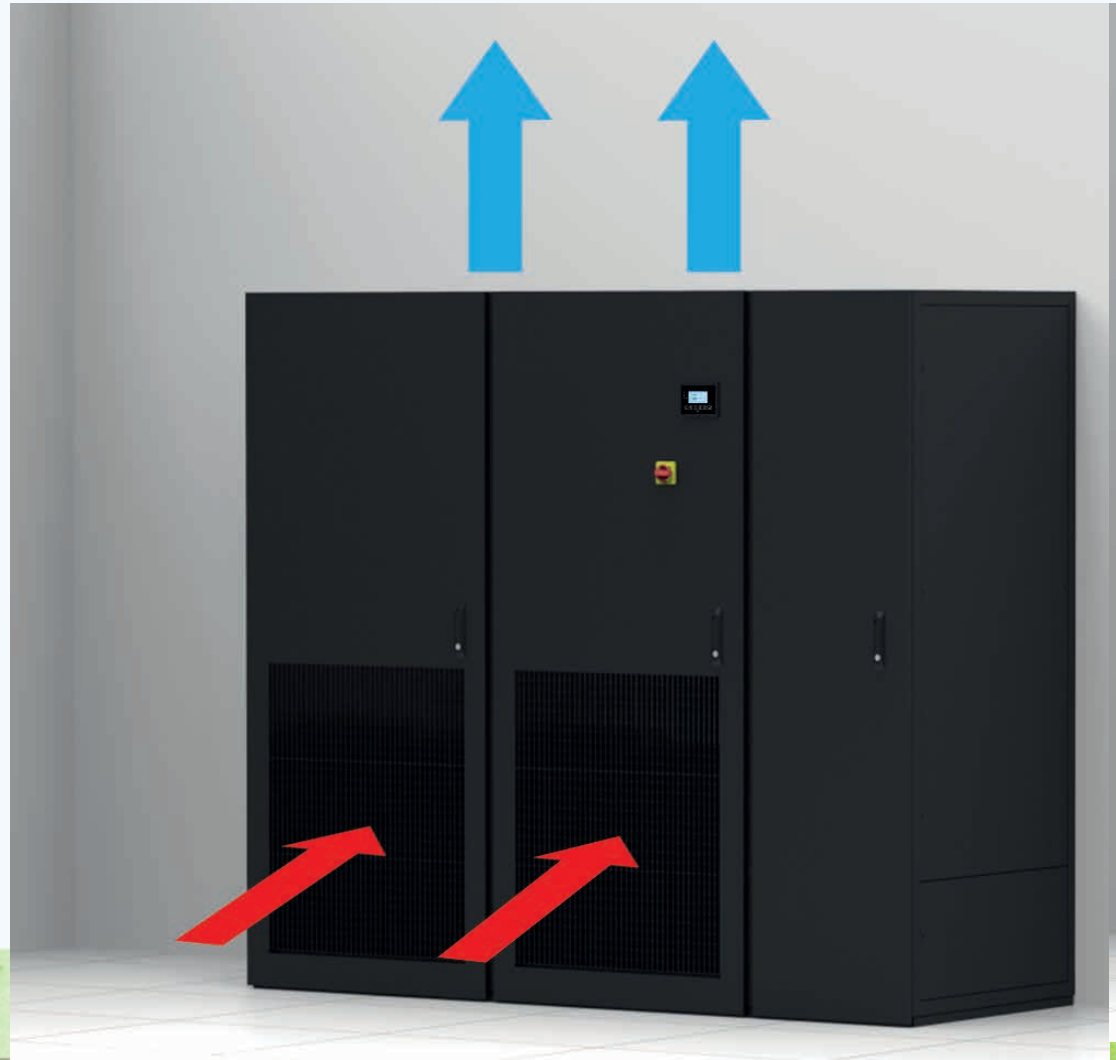
- **G** Pressure intake SAE 5/16" male flare (for refrigerant charging)
- **H** Direct expansion coil
- **I** Fan
- **J** Evaporation pressure probe
- **K** Suction temperature probe

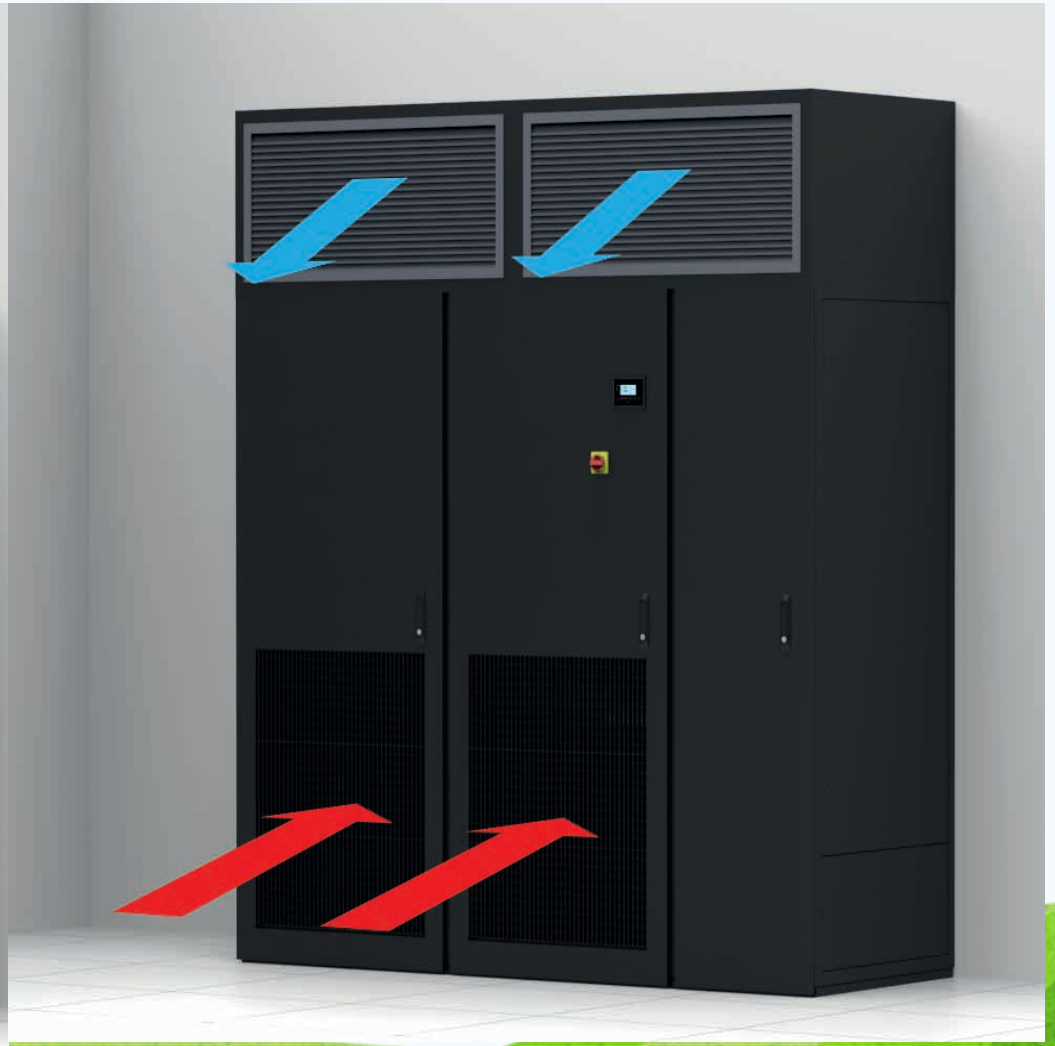
Hot gas line (HP: PS 41 Bar - TS 64 °C):

- **L** Compressor
- **M** Discharge temperature probe
- **N** High pressure switch with manual reset (41 Bar)
- **O** Condensation pressure probe
- **P** Pressure intake SAE 5/16" male flare

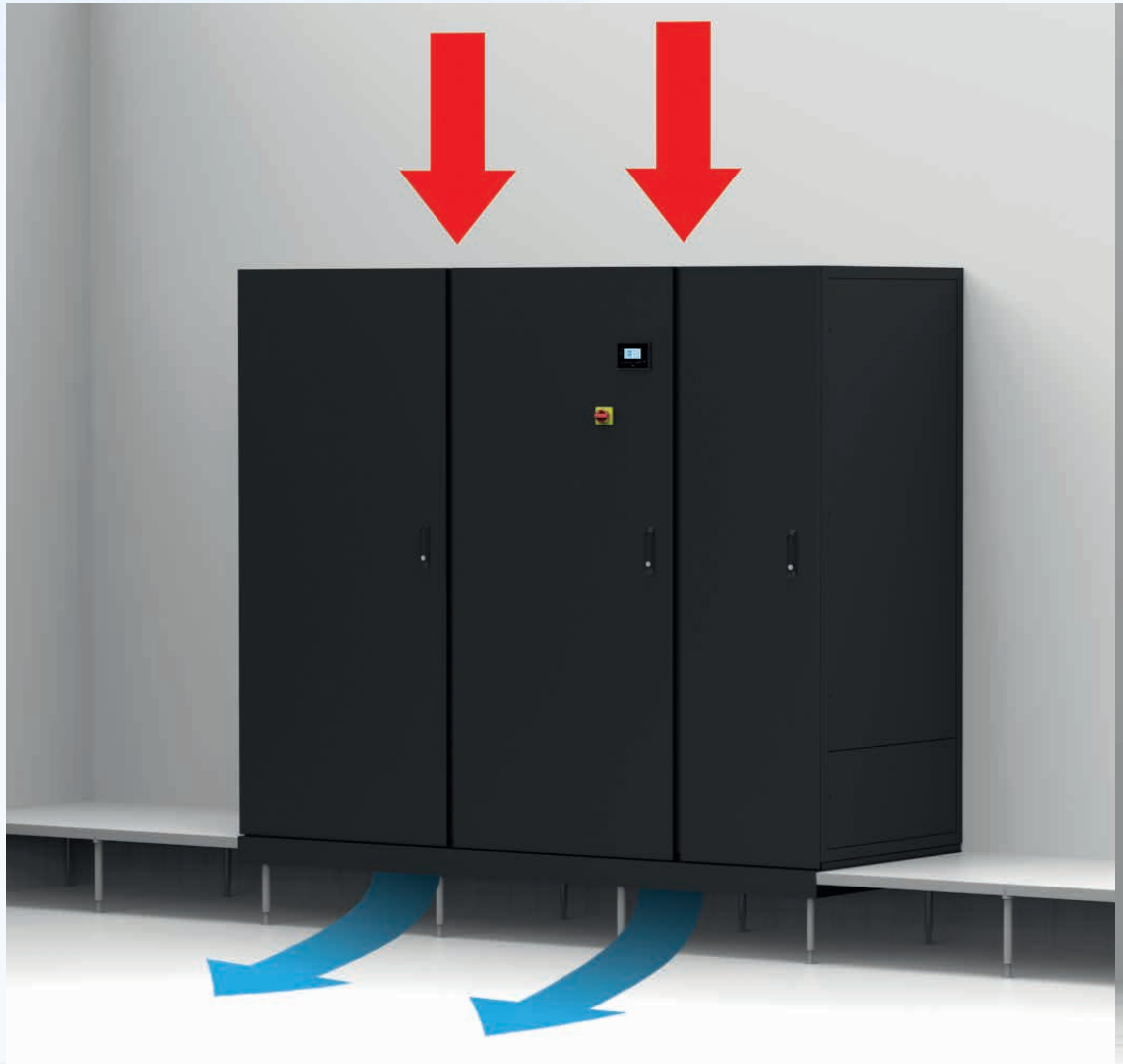
*** DC inverter compressor (accessory)**

PAC systems supply from above





PAC system supply from below



Air cooled condensing unit

Horizontal installation

Vertical installation

Humidity control in PAC systems

Humidity control in PAC is crucial for maintaining optimal conditions, especially in environments with sensitive electronic equipment.

1. Humidifiers and dehumidifiers

PAC systems are equipped with both humidifers and dehumidifiers. humidifiers add moisture to the air when the humidity is too low, while dehumidifers remove excess moisture when the humidity is too high

2. Humidity sensors

these sensors continously monitor the humidity levels in the environment. they provide real-time data to the system’s microprocessor control.

3. Microprocessor control

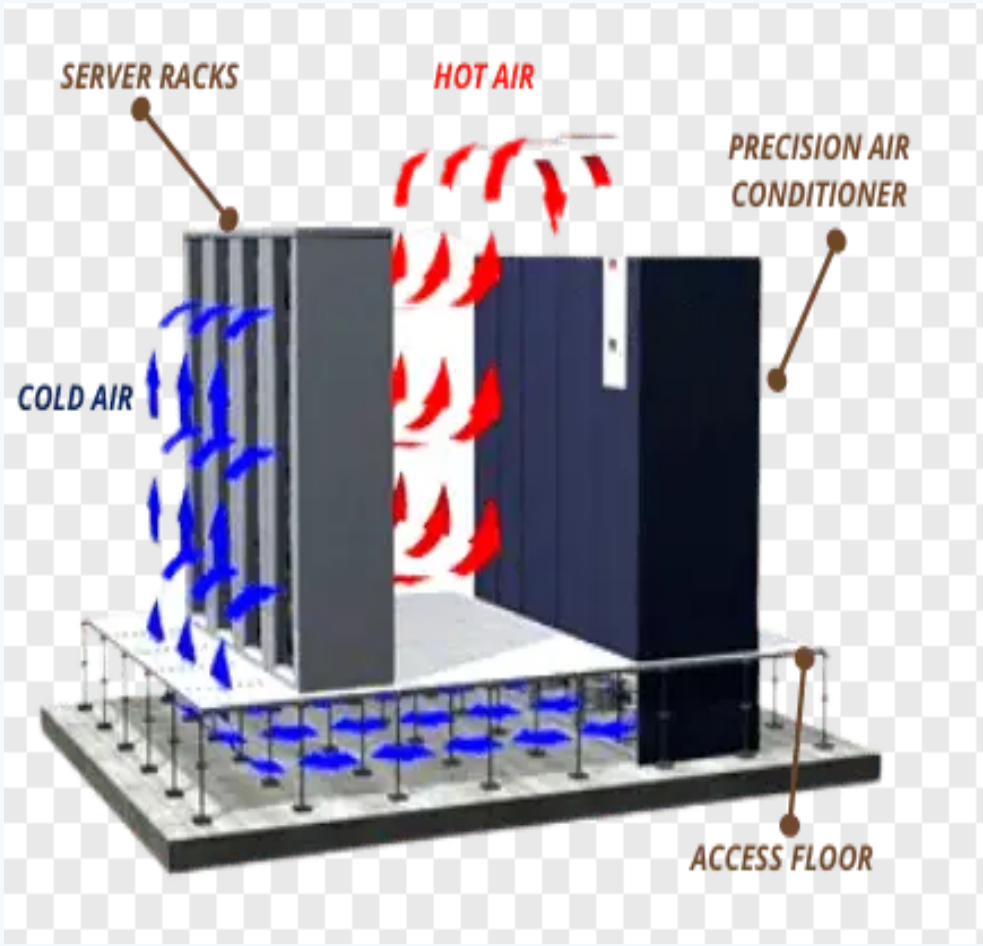
the controller processes the data from the humidity sensors and adjust the operationof the humidif or dehumidifier accordingly to maintain the desired humidity levels.

humidity sensor

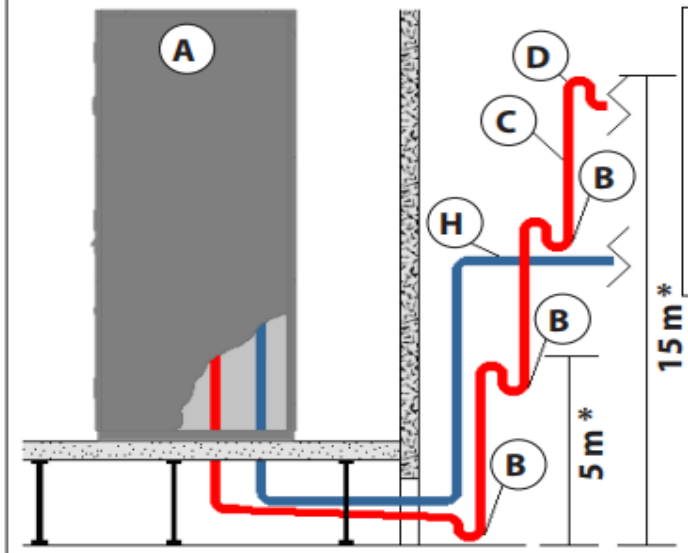
micro processor

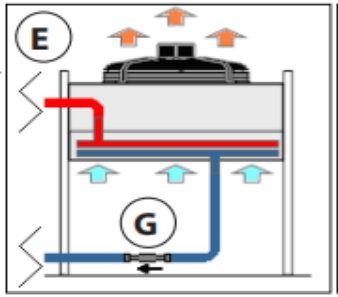
humidifer bottle

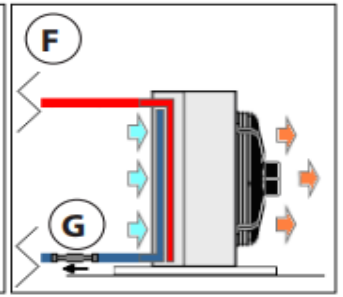
PAC system layout


SERVER RACKS
HOT AIR
PRECISION AIR CONDITIONER
COLD AIR
ACCESS FLOOR

PAC installation with condenser up high





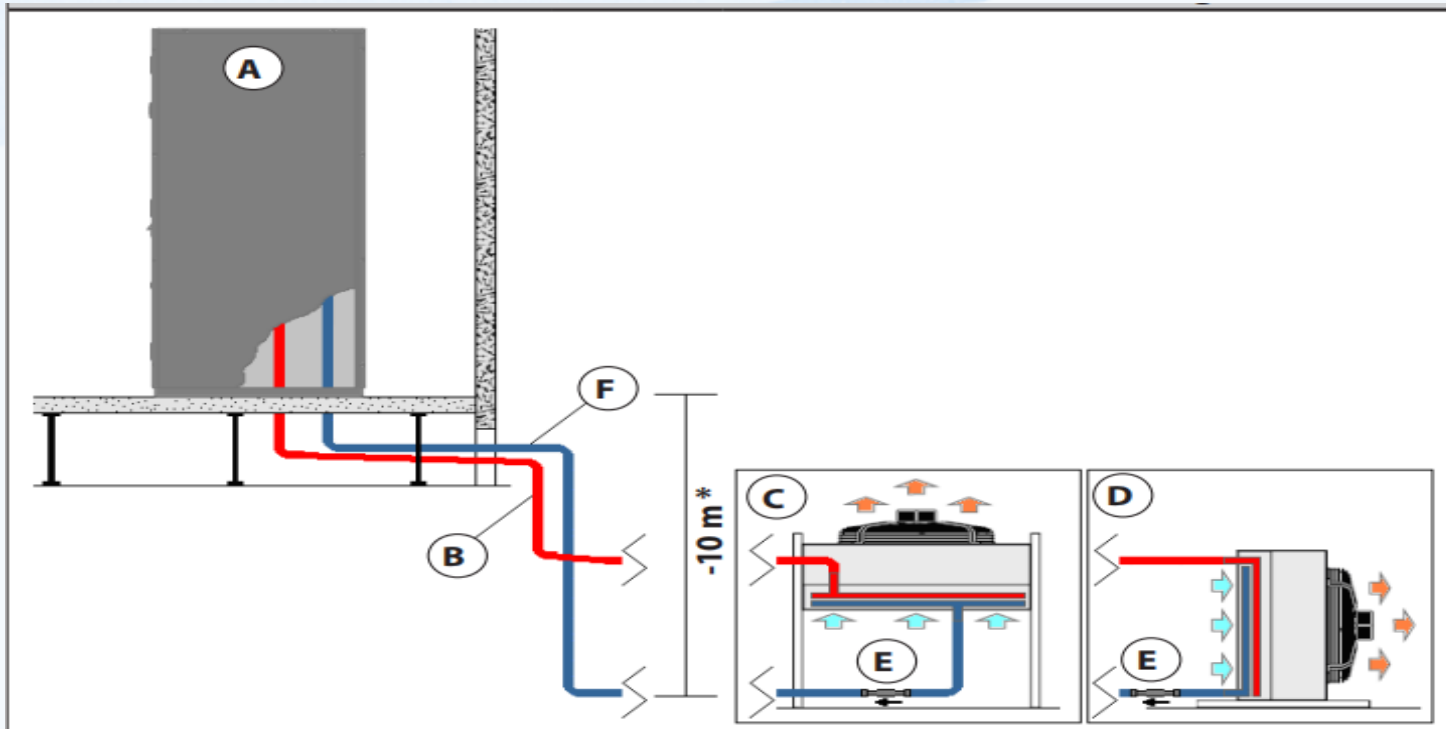


A Unit
B Oil traps (Siphons)
C Supply line
D Back-siphon
E Air-cooled condenser (horizontal installation)
F Air-cooled condenser (vertical installation)
G Check valve
H Liquid line

* **Suggested maximum vertical height difference**

Suggested maximum vertical height difference		15 m
Supply pipe precautions		Ensure a gradient of 2% along the horizontal sections toward the condenser
		Insert oil traps (siphons) at the start of each vertical climbing section
		Insert oil traps (siphons) every 5 metres of vertical climbing section
		Insert a back-siphon on the supply pipes at the end of the vertical section
Supply pipe insulation	**Internal**	Required
	External	For aesthetic reasons only, or in the event of risk of contact with people
Liquid pipe precautions		Install the check valve as close as possible to the air-cooled condenser
Liquid pipe insulation	**Internal**	Required
	External	Only if exposed to the sun, for aesthetic reasons only, or in the event of risk of contact with people

PAC installation with condenser down low



A Unit
B Supply line
C Air-cooled condenser (horizontal installation)
D Air-cooled condenser (vertical installation)
E Check valve
F Liquid line

* Suggested maximum vertical height difference

Suggested maximum vertical height difference		-10 m
Supply pipe precautions		Ensure a gradient of 2% along the horizontal sections toward the condenser
Supply pipe insulation	**Internal**	Required
	External	For aesthetic reasons only, or in the event of risk of contact with people
Liquid pipe precautions		Install the check valve as close as possible to the air-cooled condenser
Liquid pipe insulation	**Internal**	Required
	External	Only if exposed to the sun, for aesthetic reasons only, or in the event of risk of contact with people

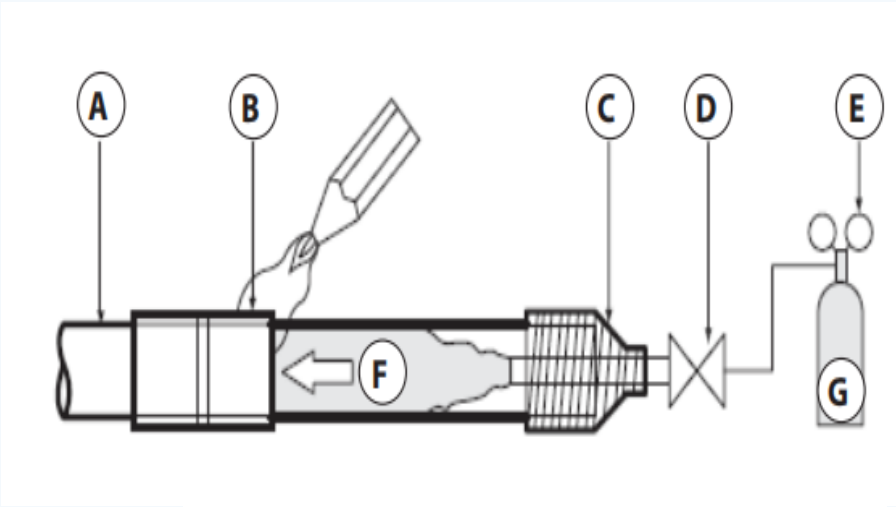
PAC system piping installation requirements

- The pipes must be made of copper that is suitable for direct expansion cooling circuits as required by standard EN 12735-1.
- Annealed copper coils may be used (diameters up to 7/8"), as well as hard-drawn copper bars.
- In conformity with the EN14276-1 and EN14276-2 standards, the minimum recommend thickness for gas supply line piping,
- in particular where there are curves, for air condensed units using R410a refrigerant, it must be equal to values present in the table

External diameter Ø		Minimum pipe thickness
De		t
Inches	mm	mm
3/8"	10	0.8
1/2"	12	0.8
5/8"	16	1
3/4"	18	1
7/8"	22	1
1-1/8"	28	1.2

Precautions for brazing

- Check the nitrogen flow during brazing.
- If brazing is performed without using nitrogen, a strong layer of rust will develop inside the pipes, which may damage the valves and compressor and hinder the unit from operating correctly.
- When performing brazing while feeding nitrogen into the pipe, the nitrogen must be regulated with a pressure reduction valve at 0.2 Bar (20 kPa) (just sufficient to be felt on the skin).



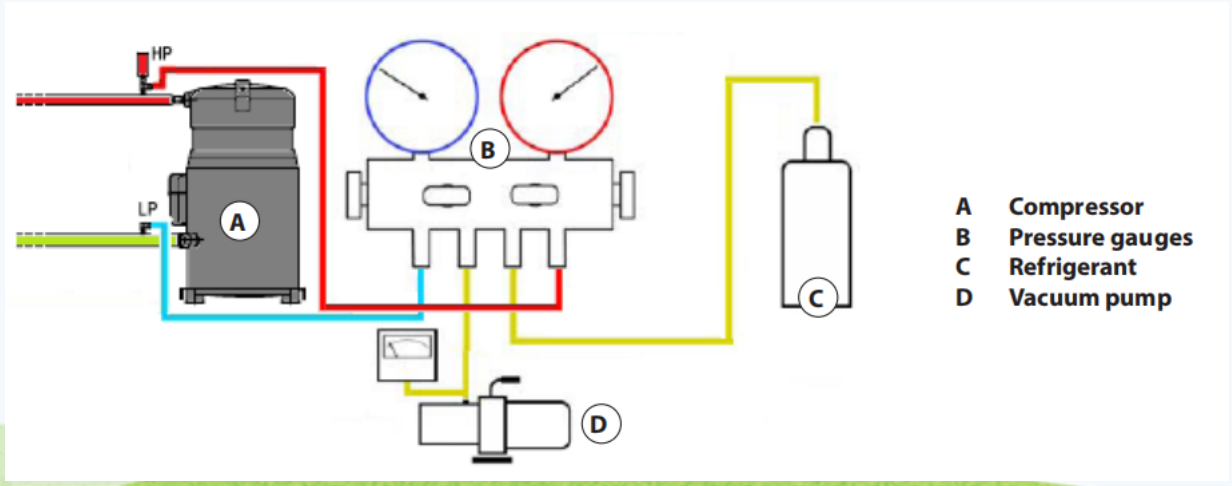
A	Cooling lines
B	Spot requiring brazing
C	Insulating tape
D	Manual valve
E	Pressure reduction valve
F	Nitrogen
G	Nitrogen cylinder

Precautions for cooling circuit pressure testing

- Once the cooling circuit is completed, a verification of soldered joints and union fittings by way of nitrogen pressurisation is recommended.
- Open the nitrogen delivery valve. Reach test pressure for R410a systems, shown on the suitable kit pressure gauge. The recommended pressure is between 40 and 42 Bar (4 - 4.2 MPa):
- If the pressure does not reach this value, this means that there is a leak in the circuit.
- If it reaches the recommended pressure, maintain it for upto atleast 24 hours. The test is considered a success if, in such a period of time, there is no decrease in pressure. Otherwise, it means there is a leak in the circuit.
- Should a leak be found, proceed with the repair and repeat the previous operations, otherwise proceed with vacuum drying operations of the cooling circuit.

Precautions for cooling circuit vacuum drying

- Connect the pressure gauges to the cooling circuit as shown below. Connect the vacuum pump and refrigerant tank to the pressure gauges.
- Power the machine (but not the compressors) to heat the possible crankcase oil heater.
- Verify that all circuit cocks are open.
- Bring the pressure gauges in position for operation in vacuum phase (carry out the vacuum simultaneously from both the liquid side and the gas side).
- Start the vacuum pump. The correct vacuum that can be achieved at the installation site is approximately - 1 BarG (1 mBarA). Leave the pump running for a few hours (min. 2 hours):



- If, within two hours, the pump is unable to reach approximately - 1 BarG (1 mBarA), this means that there are still traces of humidity or there is a leak.
- If a vacuum of approximately - 1 BarG (1 mBarA) is reached,Close the pressure gauges and switch off the pump. maintain it for at least one hour.
- The test is considered a success if, in such a period of time, there is no increase in pressure. If otherwise, it means that there is still humidity inside the pipes, or there is a leak.
- Should there be a leak, proceed with repairing it and repeat the previous operation, otherwise:
- Disconnect the pump and move on to refrigerant charging operations.

Precautions for charging the cooling circuit

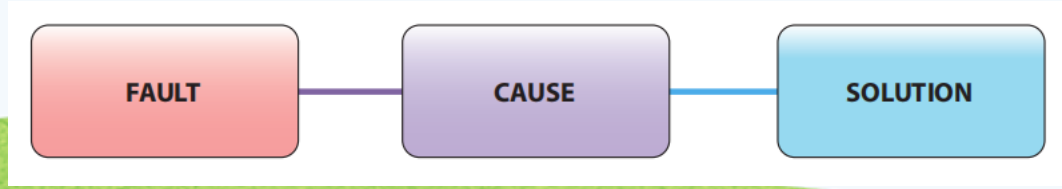
- Check that the pressure gauges are compatible with the pressure of the refrigerant used
- Check that the refrigerant cylinder is the type of refrigerant used.
- Place the refrigerant cylinder on the calibrated scales.
- Open the HIGH PRESSURE SIDE filling valve to insert refrigerant until it approximately reaches 2/3 of the calculated quantity.
- Open the recharging valve on the LOW PRESSURE SIDE, adding enough refrigerant to eliminate the empty condition.
- Load any amount of top up oil through the provided valve placed on the compressor (if oil topup is required)
- Feed the unit and wait for a few minutes.
- Place the unit on ON, starting up the fans.
- Start the compressor, being especially careful with double circuit units.

COMMON FAULTS, POSSIBLE CAUSES AND REMEDIES

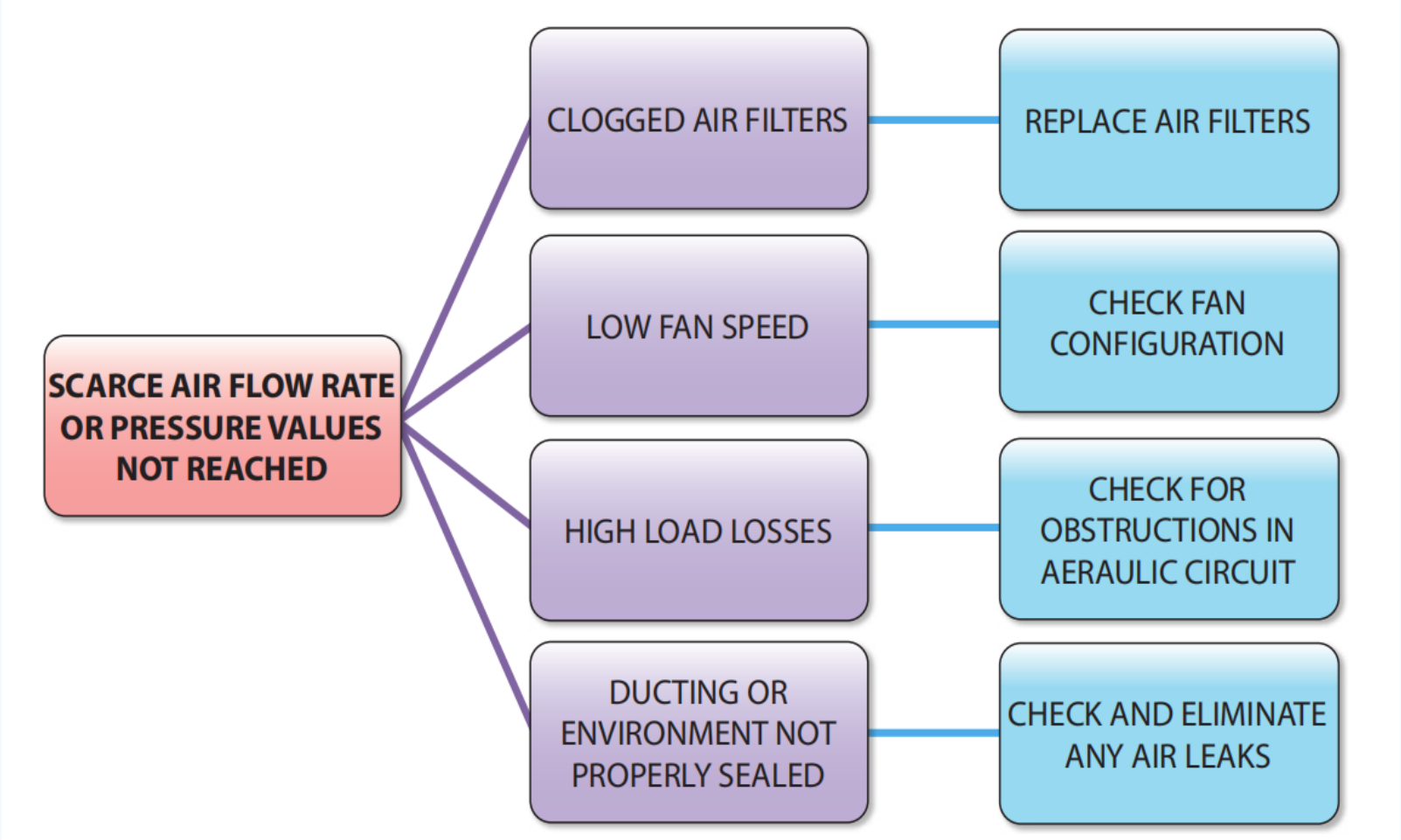
Most common faults;

These are classified as either relating to ventilation, direct expansion or humidification.

- scarce air flow rate
- noisy fan
- flow sensor triggered
- fan thermal cut-off
- low super heat
- noisy fan
- flow sensor triggered
- fan thermal cut-off
- low sub cooling
- noisy compressor
- compressor not working
- low super heat
- low / high pressure triggered



Problems with ventilation (air flow)



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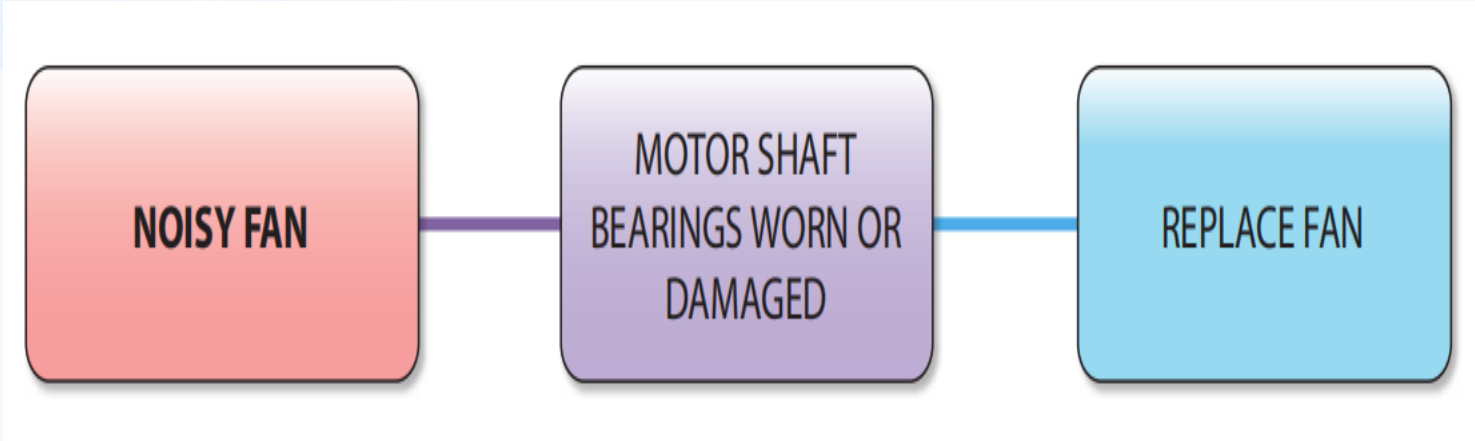

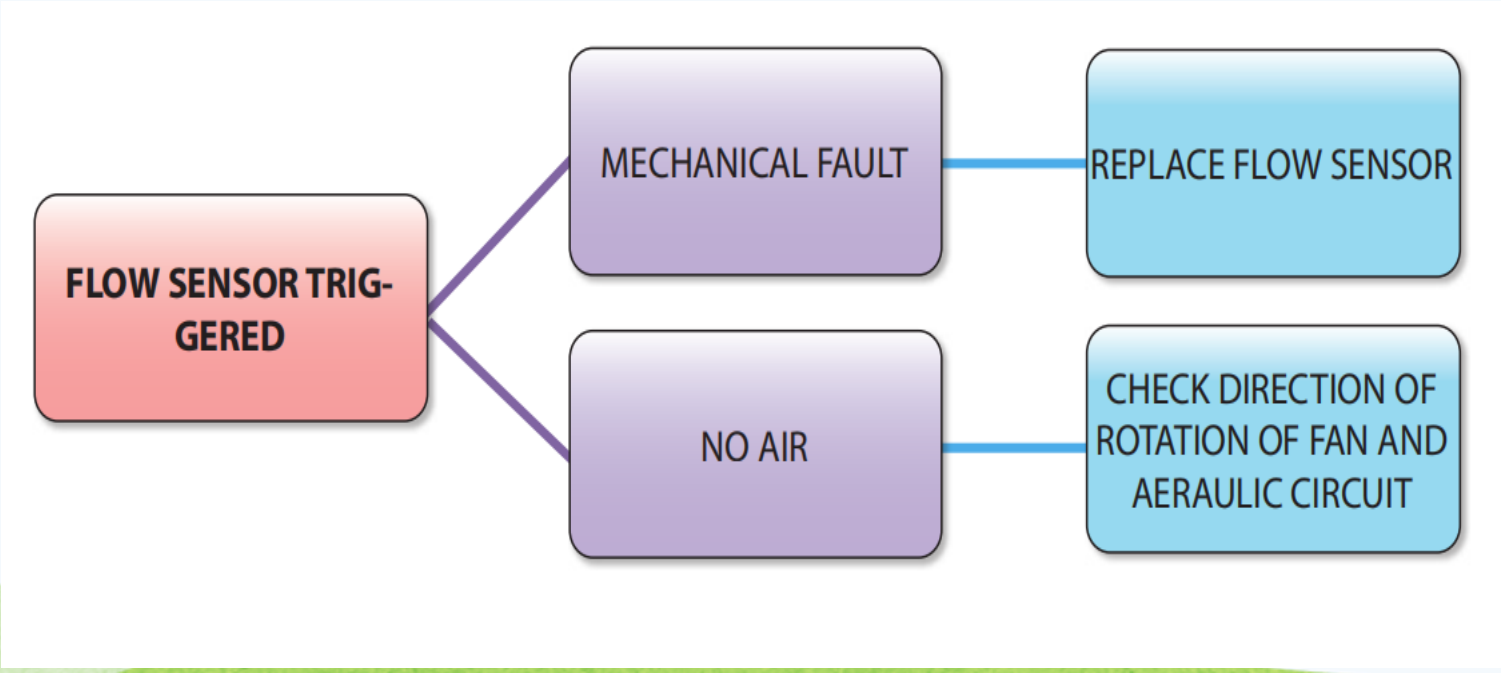

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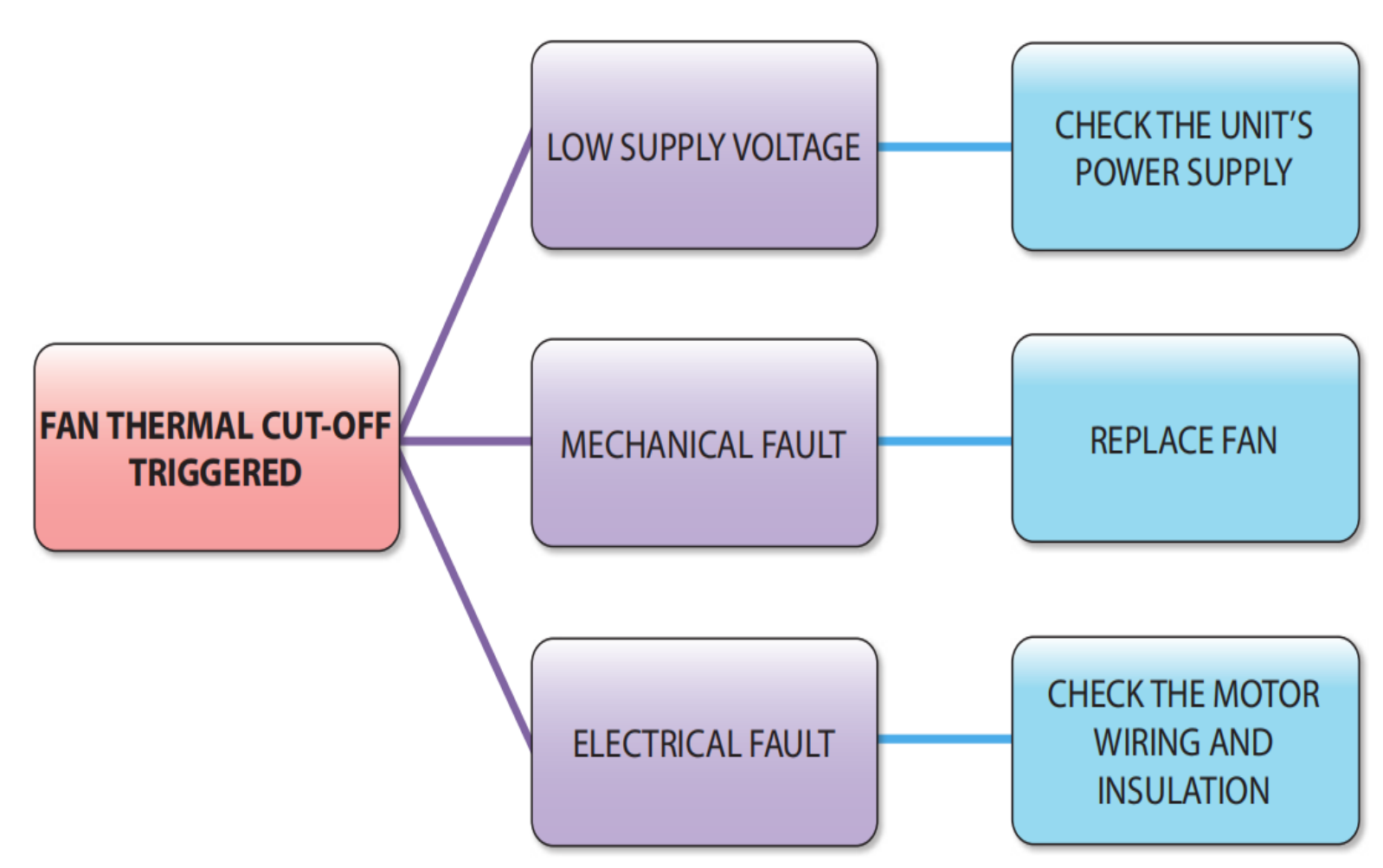
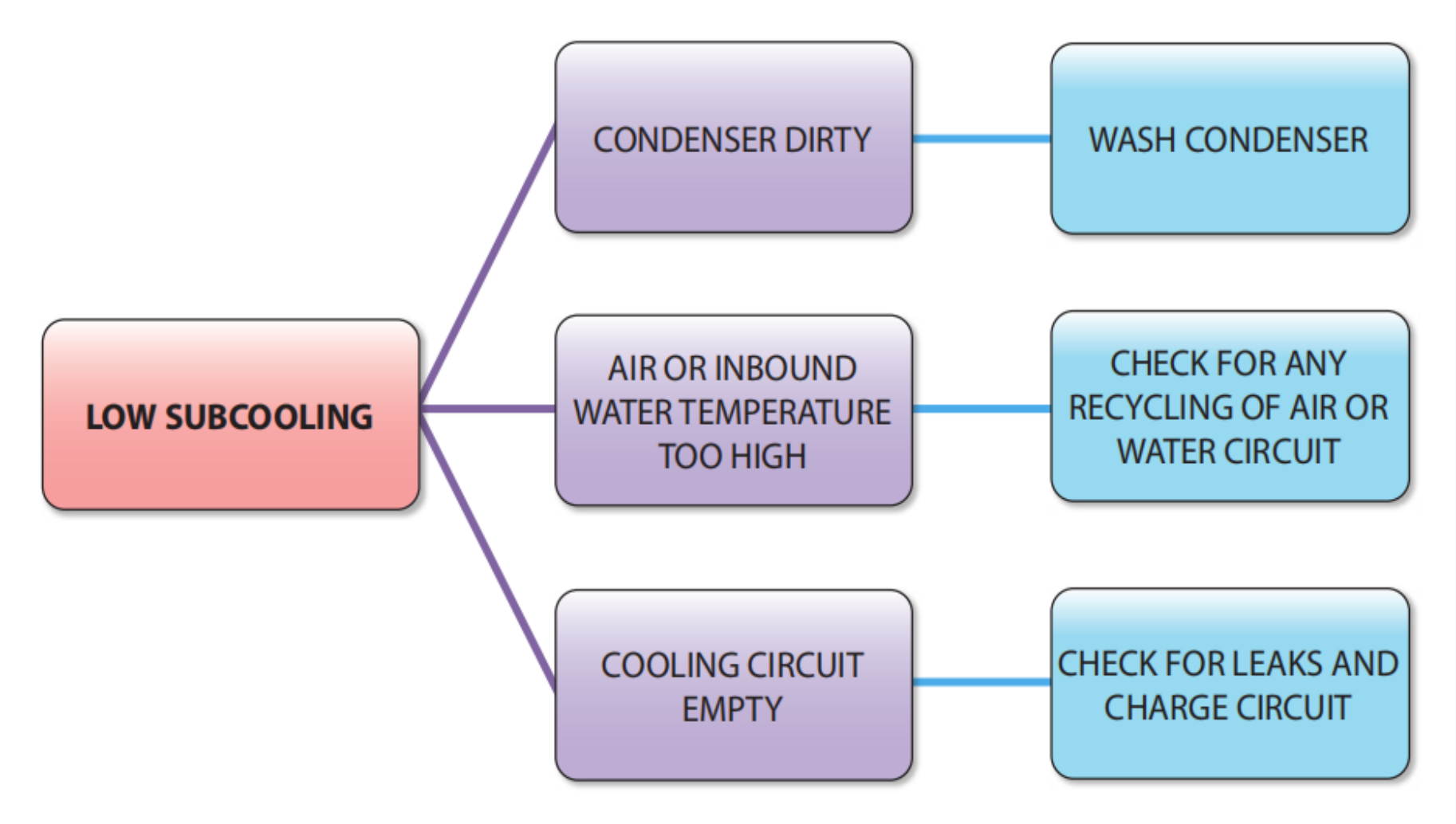
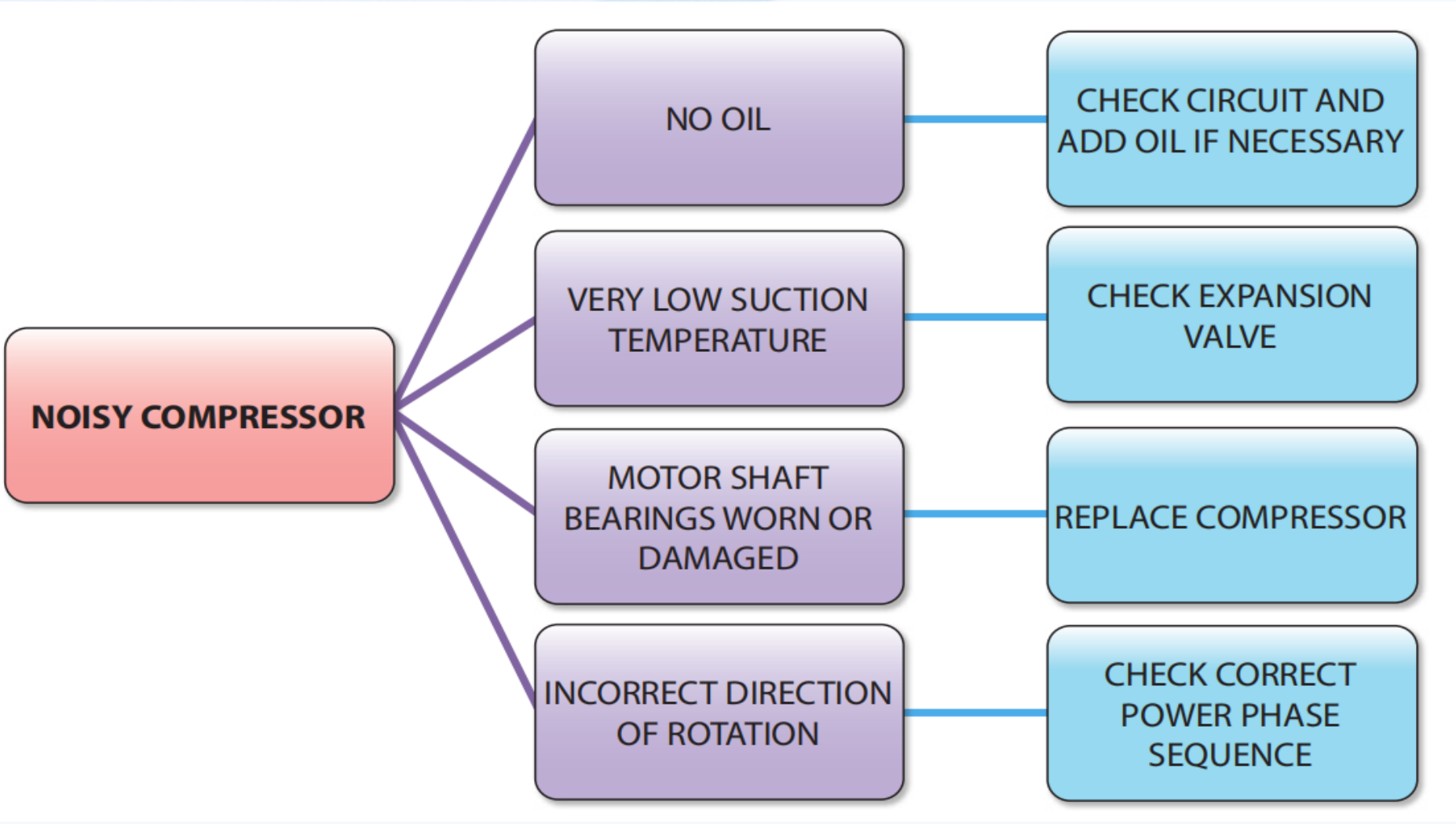


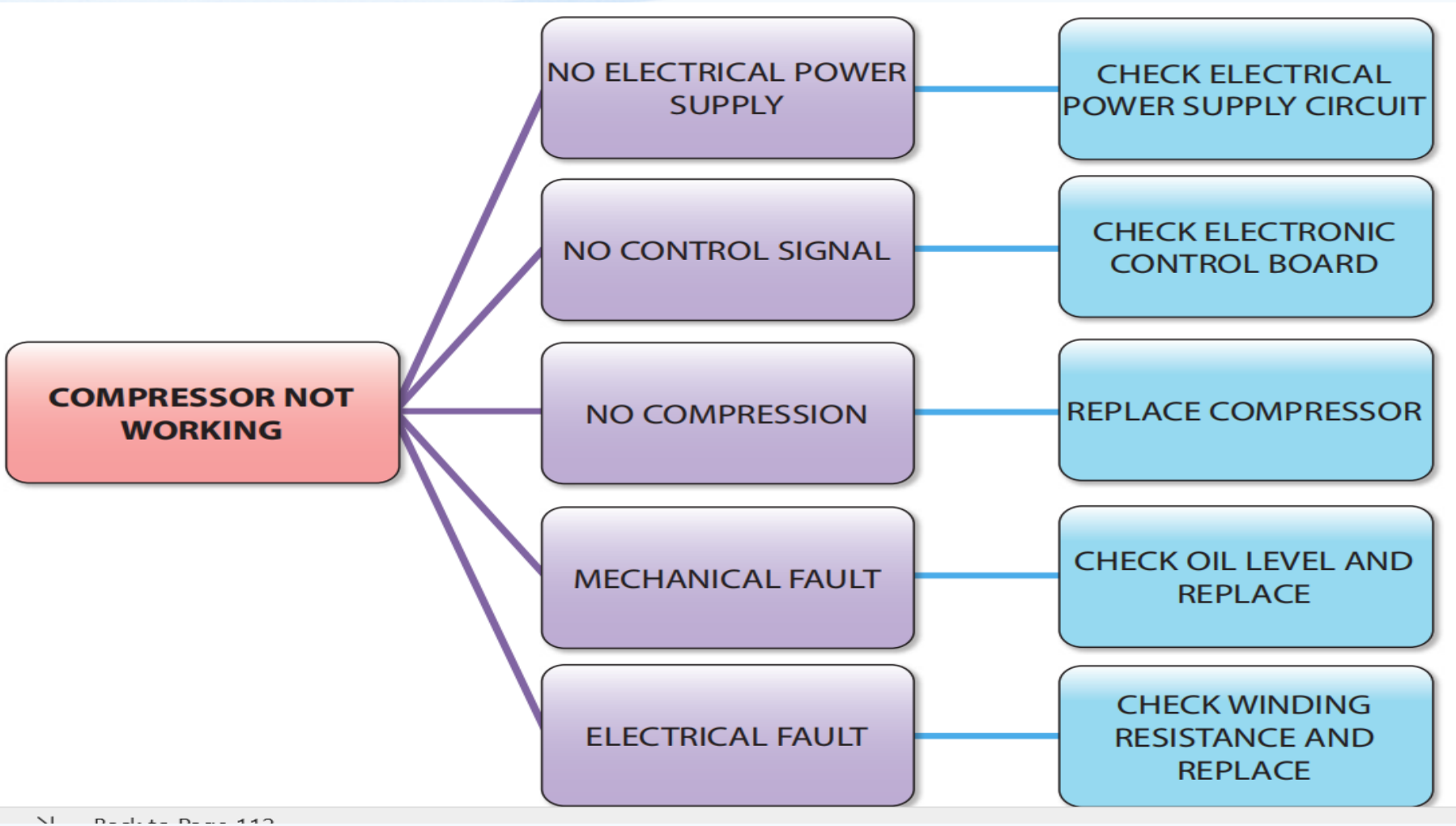
PROBLEMS WITH DIRECT EXPANSION COOLING CIRCUIT



Problem with cooling circuit direct expansion cont'd



Problem with cooling circuit direct expansion cont'd



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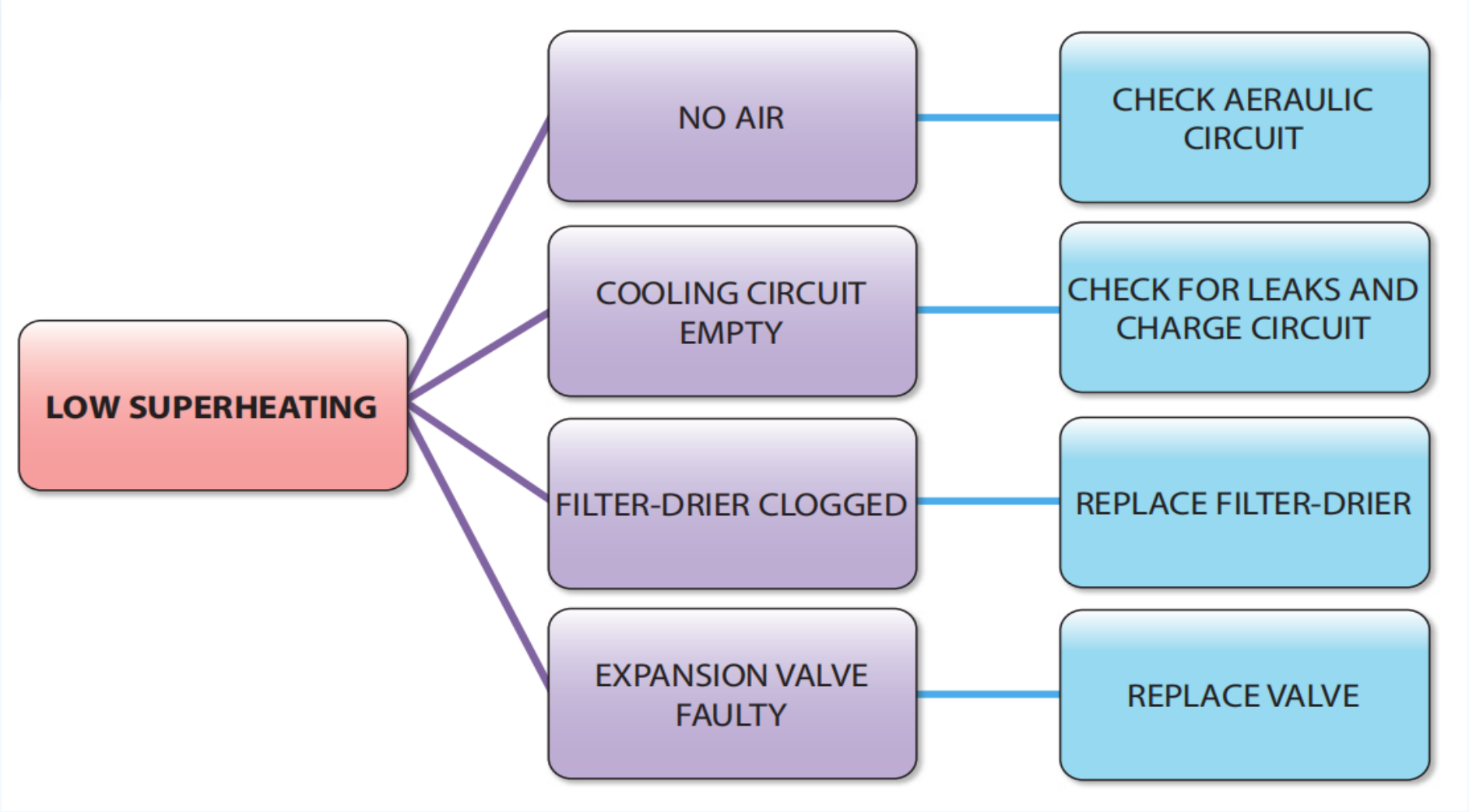

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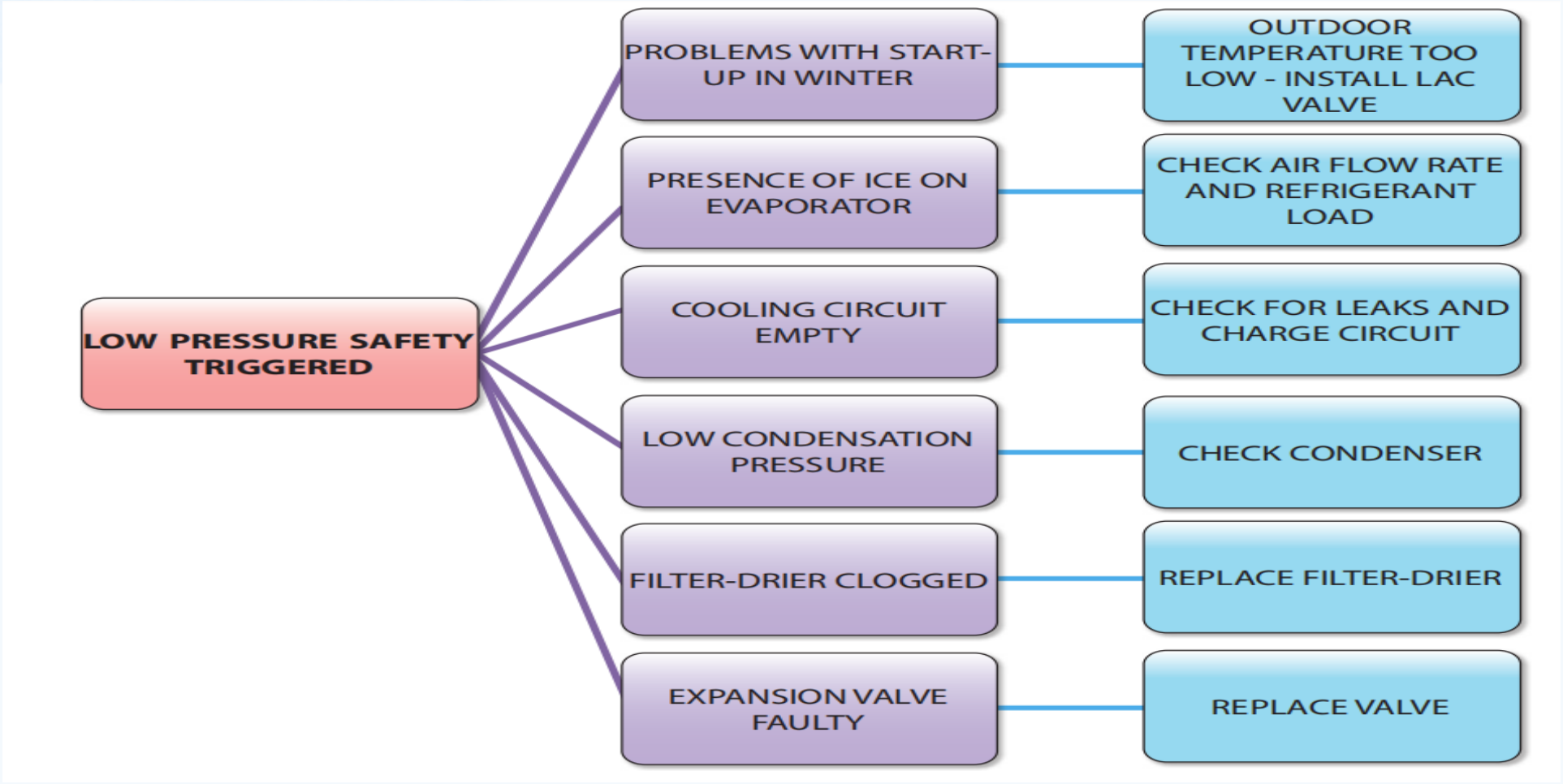

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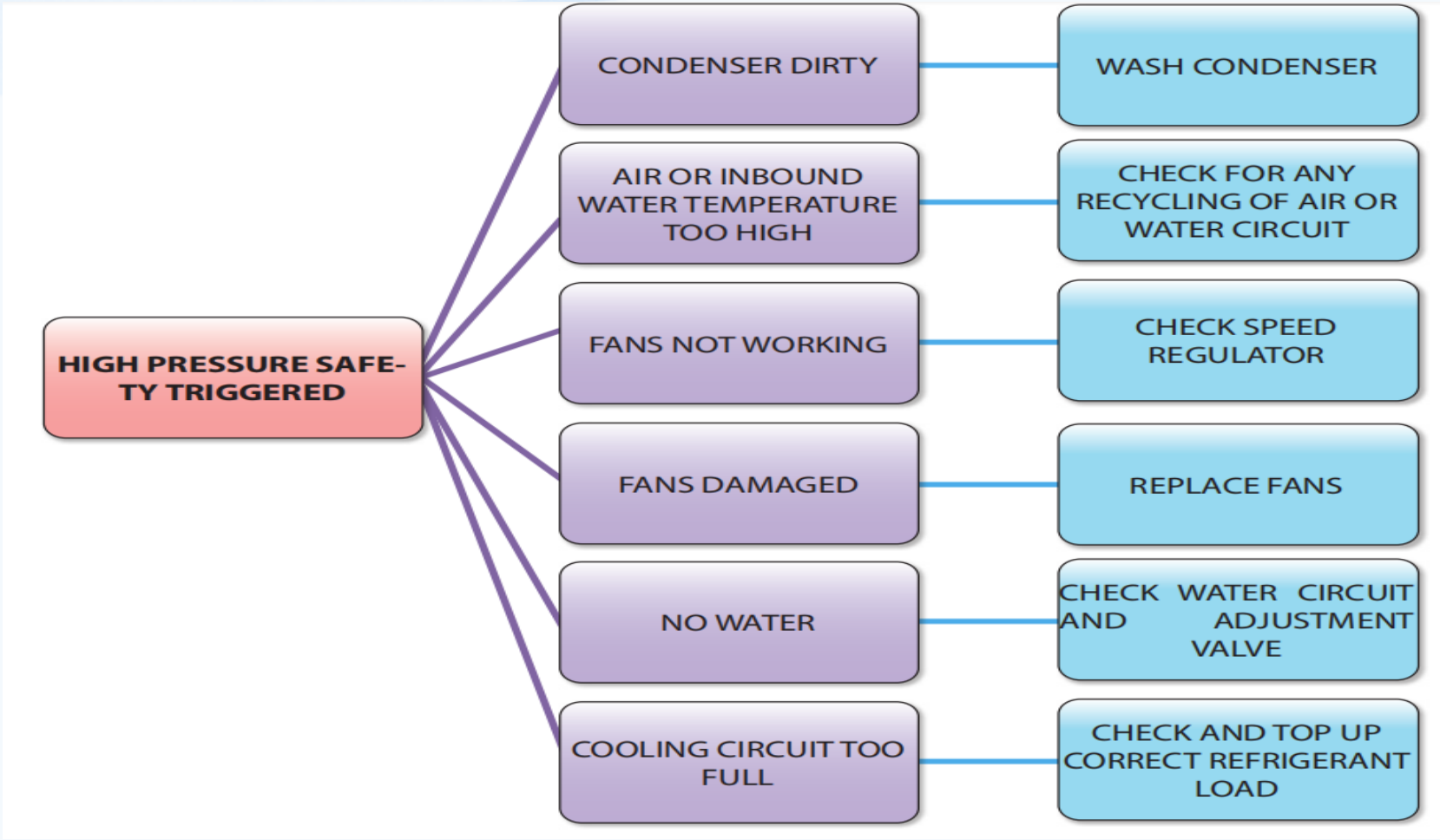
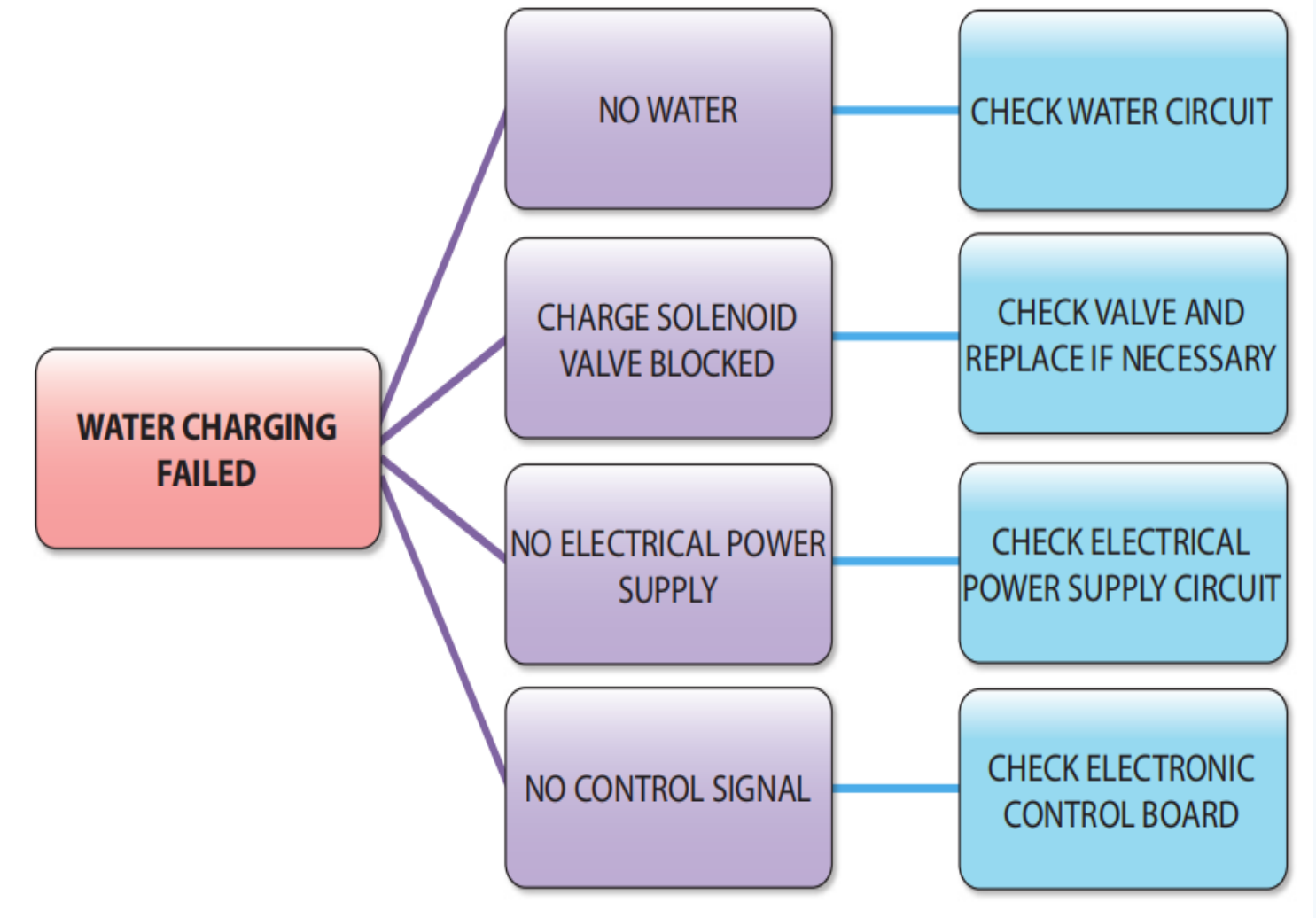
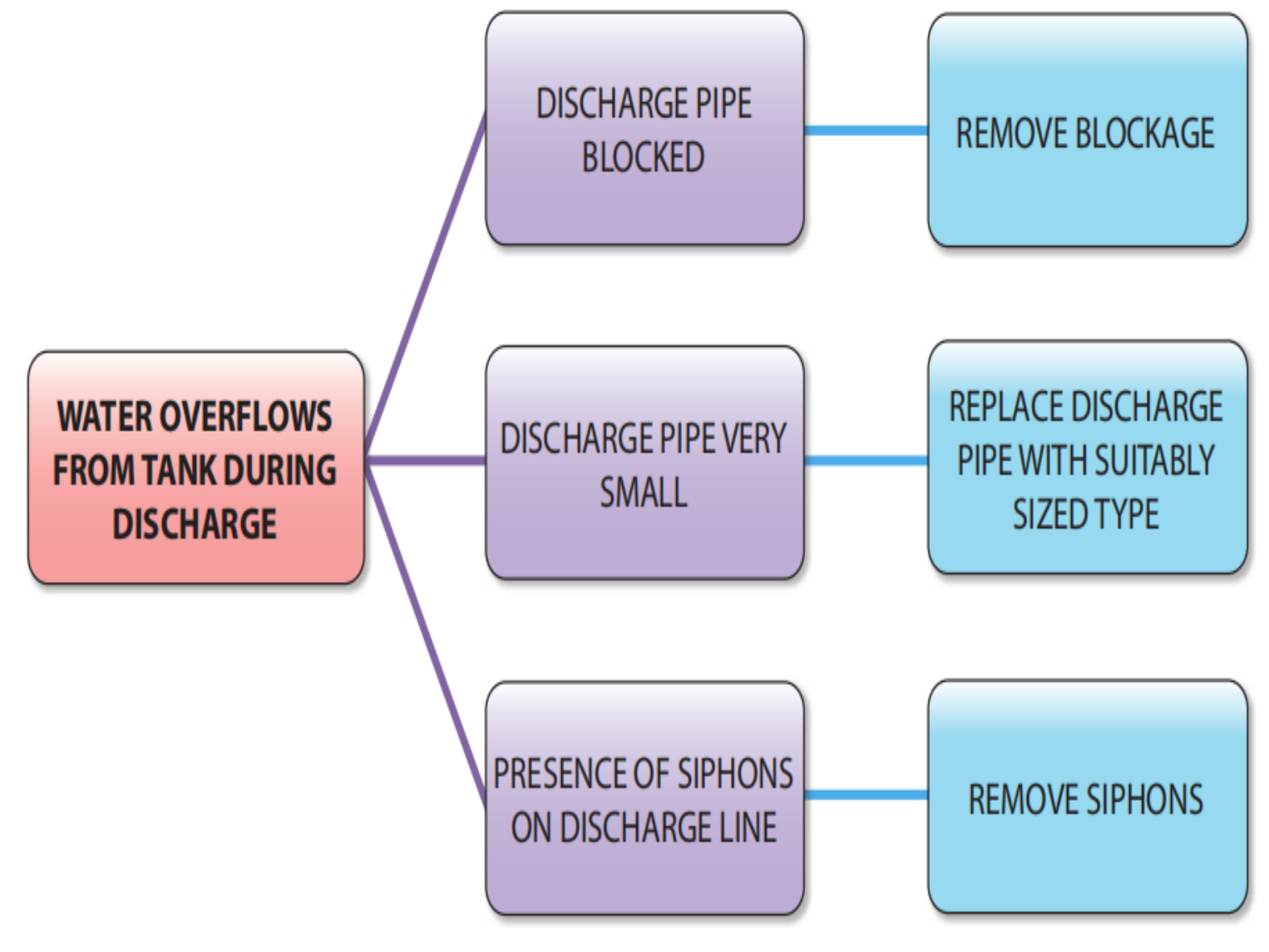


Problems with humidification



Problems with humidification cont'd



Problems with humidification cont'd