



Republic of Rwanda  
Ministry of Education



**RTB** | RWANDA  
TVET BOARD

## HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) SYSTEM INSTALLATION

**ELTAC401**

### INSTALL HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) SYSTEM

#### Competence

**RQF Level: 4**

**Learning Hours**



**Credits: 7**

**Sector: Energy**

**Trade: Electrical technology**

**Module Type: Specific**

**Curriculum: ENGELT4001-TVET Level 4 in Electrical Technology**

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**Issue Date: May, 2023**

<b>Purpose statement</b>	This module describes the knowledge, skills and attitude required to effectively install HVAC system. At the end of this module the learner will be equipped with necessary skills to install, fix and inspect an HVAC system in addition he/she offers guidance to HVAC equipment distributors and dealers basing on HVAC components 's quality and durability.					
<b>Learning assumed to be in place</b>	Inorganic chemistry, Mechanics and property of matters physics					
<b>Delivery modality</b>	<b>Training delivery</b>		<b>100%</b>	<b>Assessment</b>		<b>Total 100%</b>
	Theoretical content		30%	Formative assessment	30%	50%
	Practical work:		70%		70%	
	• Group work and presentation	30%				
	• Individual work	40%				
			Summative Assessment		50%	

## Elements of Competency and Performance Criteria

Elements of competency	Performance criteria
<b>1.Perform HVAC pre-installation activities</b>	1.1 Safety and security measures are effectively applied as per HVAC safety standards
	1.2 Equipment, tools and materials are properly selected in line with types of HVAC
	1.3 Power and control diagram of HVAC is correctly drawn based on HVAC drawing symbols

<b>2. Carryout HVAC assembling operations.</b>	2.1 Block diagram is correctly revised according to the type of HVAC installation required data
	2.2 Power and control diagram of HVAC are correctly implemented according to HVAC installation techniques
	2.3 HVAC system is correctly inspected in line with HVAC functionality and performance factors
<b>3. Conduct HVAC post-assembling activities.</b>	3.1 The workplace is properly cleaned according to safety rules and wastes disposal procedures
	3.2 HVAC installed system is properly documented in accordance to future reference and troubleshooting technics
	3.3 The system is handed over according to HVAC system handover procedures

## Intend Knowledge, Skills and Attitude

Knowledge	Skills	Attitudes
<ul style="list-style-type: none"> <li>✓ Types of drawing tools</li> <li>✓ Safety precautions, and security</li> <li>✓ Technical Symbols and diagrams</li> <li>✓ Interpret drawing</li> <li>✓ Schematic diagrams</li> <li>✓ Wiring diagrams</li> <li>✓ Circuit diagrams</li> <li>✓ Industrial codes and standards</li> <li>✓ Basic of chemistry</li> <li>✓ Basic of physics</li> </ul>	<ul style="list-style-type: none"> <li>✓ Computer skills</li> <li>✓ Proper use of measurement tools</li> <li>✓ Hand-drawing skills</li> <li>✓ Computer-aided design</li> <li>✓ Industrial drawing standards</li> <li>✓ Creating technical drawings</li> <li>✓ Analytical skills</li> <li>✓ Diagnostic skills</li> <li>✓ Communication skills</li> <li>✓ Collaborative skills</li> <li>✓ Task management skills</li> </ul>	<ul style="list-style-type: none"> <li>✓ Honest</li> <li>✓ Accountability</li> <li>✓ Self-motivated</li> <li>✓ Gender sensitive</li> <li>✓ Customer care oriented</li> <li>✓ Decisive</li> <li>✓ Time management</li> <li>✓ Humble</li> <li>✓ Creative</li> <li>✓ Patient</li> <li>✓ Responsible</li> <li>✓ Innovative</li> <li>✓ Flexible</li> <li>✓ integrity</li> </ul>

		<ul style="list-style-type: none"> <li>✓ Goal oriented</li> <li>✓ Self-confident</li> <li>✓ Motivated</li> <li>✓ Good common sense</li> <li>✓ Self-confident</li> <li>✓ Task oriented</li> <li>✓ Honest</li> <li>✓ Customer focused</li> <li>✓ Energetic</li> <li>✓ Able to work independently</li> <li>✓ Integrity</li> <li>✓ Strong moral character</li> <li>✓ Personal hygiene/grooming</li> <li>✓ Time management</li> <li>✓ Open minded</li> <li>✓ Organized</li> <li>✓ Maintain health</li> <li>✓ Positive work ethics</li> <li>✓ Gender sensitivity</li> <li>✓ Flexible</li> <li>✓ Problem solver</li> <li>✓ Goals oriented</li> <li>✓ Teamwork and Collaboration</li> <li>✓ Professionalism</li> <li>✓ Strong Work Ethic</li> </ul>
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		✓ Adaptability ✓ Safety Consciousness ✓ Customer Service Orientation
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## Course content

<b>Learning outcomes</b>	At the end of the module the learner will be able to:  1.Perform HVAC pre-installation activities  2. Carryout HVAC assembling operations.  3.Conduct HVAC post-assembling activities.
<b>Learning outcome 1: Perform HVAC pre-installation activities</b>	<b>Learning hours: 15</b>
<b>Indicative content</b>	

- **Introduction to HVAC system**
- **Description of safety standard and precautions**
  - ✓ Standards and guidelines related to HVAC system safety
  - ✓ Electrical safety
  - ✓ Combustion safety
  - ✓ Refrigerant safety
  - ✓ Fire and smoke safety
  - ✓ Workplace safety
- **Classification of HVAC system**
  - ✓ Classes of HVAC system
    - ✚ Heating system
    - ✚ Ventilation system
    - ✚ Air condition system
    - ✚ Refrigeration system
  - ✓ Types of HVAC system
    - ✚ central air conditioning
    - ✚ heat pump
    - ✚ split system
  - ✓ Factors to select HVAC system
- **Identification of equipment, tools and material used in HVAC**
  - ✓ Electromechanical based
  - ✓ Electronic based
- **Description of HVAC system's diagrams**
  - ✓ Equipment layout diagram
  - ✓ Flow diagram
  - ✓ Piping and instrumentation diagram (P&ID)
  - ✓ Block diagram and schematic diagrams.
- **Application of HVAC system simulator software**
  - ✓ SOLIDWORKS
  - ✓ AUTOCAD

**Resources required for the learning outcome**

<b>Equipment</b>	<ul style="list-style-type: none"> <li>Thermometer, Manifold gauges, Digital refrigeration gauges, digital hvac multimeter, RMS HVAC clamp meter, Digital insulation tester, Cordless drill, cordless saws, Air blower, Soldering station, Glue gun, Computer, Personal protective equipment (PPE) kit, Oscilloscope, thermal imaging tools, leak detectors.</li> </ul>
<b>Materials</b>	Tool bag, tape measure, level, extension cord, flushing solvent, refrigeration gauges hoses, Electronic passive components, Electronic active components, Integrated circuits (IC), thermostat, air filter, ducts, vents, boilers, condensers, fans, motors
<b>Tools</b>	HVAC panduit strap gun, Plumbing PVC pipe cutters, Caulking gun, ladder, hand seamer (tong), folding bar, Drill bits, wire cutter, pipe wrench, tin snips, utility knife, Drawing tool kit, HVAC Computer software, Tweezer, Technician Knife / punching tool, Crimping tool, Electrician toolbox, Pliers set, Screwdriver set, Precision screwdriver set, Magnifying glass, coil fin straightener, pipe calipers, nitrogen regulator, tubing cutters, metal shears, tin snips, wire strippers.
<b>Facilitation techniques</b>	<ul style="list-style-type: none"> <li>Lectures</li> <li>Demonstration and simulation</li> <li>group discussion</li> <li>Practical exercise</li> </ul>
<b>Formative assessment methods / (CAT)</b>	<ul style="list-style-type: none"> <li>Written assessment</li> <li>Oral presentation</li> </ul>

<b>Learning outcome 2: Carryout HVAC assembling operations.</b>	<b>Learning hours: 50</b>
<b>Indicative content</b>	

- **conducting a comprehensive HVAC site survey**
  - ✓ Purposes of HVAC site survey
  - ✓ HVAC site survey key aspects
  - ✓ key data requirements for HVAC installation:
- **Description of commonly HVAC system main parts and functions**
  - ✓ Thermostat
  - ✓ Furnace/Boiler
  - ✓ Heat Exchanger
  - ✓ Evaporator Coil
  - ✓ Condenser Coil
  - ✓ Compressor
  - ✓ Blower/Fan
  - ✓ Air Filters
  - ✓ Ductwork
  - ✓ Expansion Valve/Thermal Expansion Valve (TXV):
  - ✓ Vents/Registers
  - ✓ Condensate Drain Pan and Drain Line
  - ✓ Control Board/Control Panel
- **Reading and interpreting a block diagram method**
  - ✓ Read Labels and Annotations
  - ✓ Identify the system's Components
  - ✓ Understand the Connections and flow
- **Implementation HVAC power and control system**
  - ✓ Equipment installation methods
    - ✚ Placement techniques
    - ✚ Mounting techniques
    - ✚ Refrigerant piping
  - ✓ HVAC system wiring, calibrating labouring and routing
- **Commissioning and Testing of HVAC system**
  - ✓ Commissioning and testing steps
  - ✓ Inspecting the final system's functionality and performance
  - ✓ HVAC key performance parameters to observe
  - ✓ Specialized instruments and equipment used in HVAC installation
  - ✓ Commonly used HVAC functionality and performance assessment methods

### Resources required for the learning outcome

<b>Equipment</b>	Thermometer, Manifold gauges, Digital refrigeration gauges, digital HVAC Multimeter, RMS HVAC clamp meter, Digital insulation tester, Cordless drill, cordless saws, Air blower, Soldering station, Glue gun, Computer, Personal protective equipment (PPE) kit, Oscilloscope, thermal imaging tools, leak
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	detectors.
<b>Materials</b>	Tool bag, tape measure, level, extension cord, flushing solvent, refrigeration gauges hoses, Electronic passive components, Electronic active components, Integrated circuits (IC), thermostat, air filter, ducts, vents, boilers, condensers, fans, motors
<b>Tools</b>	HVAC Panduit strap gun, Plumbing PVC pipe cutters, Caulking gun, ladder, hand seamer (tong) ,folding bar, Drill bits, wire cutter ,pipe wrench, tin snips, utility knife, Drawing tool kit, HVAC Computer software, , Tweezers, Technician Knife krone / punching tool, Crimping tool, Electrician toolbox, Pliers set, Screwdriver set, Precision screwdriver set, Magnifying glass, coil fin strengthener, pipe calipers, nitrogen regulator ,tubing cutters, metal shears, tin strips, wire strippers.
<b>Facilitation techniques</b>	<ul style="list-style-type: none"> <li>▪ Lectures</li> <li>▪ Demonstration and simulation</li> <li>▪ Individual and group work,</li> <li>▪ Practical exercise</li> </ul>
<b>Formative assessment methods /(CAT)</b>	<ul style="list-style-type: none"> <li>▪ Written assessment</li> <li>▪ Oral presentation</li> <li>▪ Product based assessment</li> </ul>

<b>Learning outcome 3: Conduct HVAC post-assembling activities</b>	<b>Learning hours: 5</b>
<b>Indicative content</b>	
<ul style="list-style-type: none"> <li>• <b>Description of the methods of managing HVAC waste materials</b> <ul style="list-style-type: none"> <li>✓ Reduce and reuse</li> <li>✓ Recycling</li> <li>✓ Proper storage</li> <li>✓ Hazardous waste material</li> <li>✓ Refrigerant recovery</li> <li>✓ Proper disposal</li> <li>✓ Compliance with regulations</li> </ul> </li> </ul>	

- **Classification of HVAC waste materials**
  - ✓ Solid waste
  - ✓ Hazardous waste
  - ✓ Refrigerants and refrigerant materials
  - ✓ Electronic waste(E-waste)
- **Description of HVAC waste material types**
  - ✓ Filters
  - ✓ Refrigerants
  - ✓ Hazardous materials
  - ✓ Packaging and materials
  - ✓ Electronic waste
  - ✓ Compressors and components
  - ✓ Insulation
- **Identification of HVAC documentation roles**
- **Description of HVAC documentation types**
  - ✓ Equipment manuals
  - ✓ System drawings and schematics
  - ✓ Maintenance and service records
- **Description HVAC handover key steps**
  - ✓ Completion of Installation or Maintenance
  - ✓ Functional Testing and Commissioning
  - ✓ System Performance Verification
  - ✓ Warranty and Service Contracts
  - ✓ Documentation Handover
  - ✓ Follow-Up and Support

### Resources required for the learning outcome

<b>Equipment</b>	Thermometer, Manifold gauges, Digital refrigeration gauges, digital HVAC Multimeter, RMS HVAC clamp meter, Digital insulation tester, Cordless drill, cordless saws, Air blower, Soldering station, Glue gun, Computer, Personal protective equipment (PPE) kit, Oscilloscope, thermal imaging tools, leak detectors.
<b>Materials</b>	Tool bag, tape measure, level, extension cord, flushing solvent, refrigeration

	gauges hoses, Electronic components, thermostat, air filter, ducts, vents, boilers, condensers, fans, motors, water, switches, gas valve, transformer, Bi-metal disc
<b>Tools</b>	HVAC Panduit strap gun, Plumbing PVC pipe cutters, Caulking gun, ladder, hand seamer (tong), folding bar, Drill bits, wire cutter, pipe wrench, tin snips, utility knife, Drawing tool kit, HVAC Computer software, Tweezers, Technician Knife krone / punching tool, Crimping tool, Electrician toolbox, Pliers set, Screwdriver set, Precision screwdriver set, Magnifying glass, coil fin strengthener, pipe calipers, nitrogen regulator, tubing cutters, metal shears, tin strips, wire strippers.
<b>Facilitation techniques</b>	<ul style="list-style-type: none"> <li>▪ Lectures</li> <li>▪ Individual and group work</li> <li>▪ Practical exercise</li> </ul>
<b>Formative assessment methods /(CAT)</b>	<ul style="list-style-type: none"> <li>▪ Written assessment</li> <li>▪ Oral presentation</li> </ul>

### Integrated/Summative assessment

#### Integrated situation

Bank of Kigali branch located in Kicukiro district, Kigali city needs to hire a qualified HVAC technician that will be able to install smart air conditioning unit in one of its customer care room. The bank of Kigali bought basing on quality and noiseless factors the Daikin 9,000 btu 15 SEER Cooling Only Ductless Mini Split Air Conditioner, the hired technician needs to perform the following job activities in five (5) hours:

- ✓ Perform site inspection
- ✓ Draw the well presentable schematics
- ✓ Install the Air conditioning system
- ✓ Formulate the documentation /logs and related invoice

#### Resources

<b>Tools</b>	HVAC Panduit strap gun, Plumbing PVC pipe cutters, Caulking gun, ladder, hand seamer (tong) ,folding bar, Drill bits, wire cutter ,pipe wrench, tin snips, utility knife, Drawing tool kit, HVAC
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	Computer software, , Tweezers, Technician Knife krone / punching tool, Crimping tool, Electrician toolbox, Pliers set, Screwdriver set, Precision screwdriver set, Magnifying glass, coil fin strengthener, pipe calipers, nitrogen regulator ,tubing cutters,metal shears, tin strips, wire strippers.	
Equipment	Thermometer, Manifold gauges, Digital refrigeration gauges, digital HVAC Multimeter, RMS HVAC clamp meter, Digital insulation tester, Cordless drill, cordless saws, Air blower, Soldering station, Glue gun, Computer, Personal protective equipment (PPE) kit, Oscilloscope, thermal imaging tools, leak detectors.	
Materials/ Consumables	Tool bag, tape measure, level, extension cord, flushing solvent, refrigeration gauges hoses, Electronic passive components, Electronic active components, Integrated circuits (IC), thermostat, air filter, ducts, vents, boilers, condensers, fans, motors.	

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	
1. Perform Air Conditioning pre-installation activities	Safety and security measures are effectively applied as per AC safety standards	Security measures tools is appropriately applied			2
		PPE is effectively won basing on safety standard			3
	Equipment, tools and materials are properly selected in line with types of AC	Selection of tools is properly performed according to AC components			5
		Tools and equipment are properly separated and			5

		placed in line with air conditioning system types			
	Power and control diagram of AC is correctly drawn based on AC drawing symbols	Schematic diagram /block diagram is drawn			5
		System's symbol is clearly shown basing on drawing standards			5
<b>2. Carryout Air Conditioning assembling operations</b>	Block diagram is correctly revised according to the type of AC installation required data	Diagram /user manual is well interpreted refer to system			5
		Diagram is clearly and easy to implement			5
		Arrangements of pre-installation tools is well conducted			5
	Power and control diagram of AC are correctly implemented according to AC installation techniques	Piping is well performed according to installation techniques			6
		Air conditioning components are well fixed according to installation techniques			5
		AC components are correctly interconnected basing on user manual and block diagram			5
		System is supplied appropriately refer to power and wiring standards			5

	AC system is correctly inspected in line with AC functionality and performance factors	AC system's components are inspected to check its performance			5
		Remote controlling is effectively working to set the new system			5
		The room condition parameter efficiently changes basing on user's needs			4
3.Conduct Air Conditioning post-assembling activities	The workplace is properly cleaned according to safety rules and wastes disposal procedures	Unused wastes are properly arranged			4
		The site is well cleaned			3
		Used waste are stored in appropriate place			3
	AC installed system is properly documented in accordance to future reference and troubleshooting techniques	Repair report is clearly written			3
		Recommendation to future re-install			3
		Formulated invoice is well performed and presented			3
	The system is handed over according to AC system handover procedures	User is well trained and guided on new system uses and functionality			3
		Information on spare parts inventory is well			3
Total marks		.....100			
Percentage Weightage		100%			
Minimum Passing line % (Aggregate):		70%			

## List of abbreviations

1. **HVAC:** Heating Ventilation, and Air conditioning
2. **AC:** Air conditioning
3. **TXV:** Thermal Expansion Valve
4. **RMS:** Root mean square
5. **PPE:** Personal protective equipment
6. **P&ID:** Piping and instrumentation diagram
7. **PVC:** Poly Vinyl Chloride
8. **E-waste:** Electronic waste
9. **BMS:** Building Management System
10. **EER:** Energy Efficiency Ratio
11. **COP:** Coefficient of Performance
12. **IAQP:** Indoor Air Quality Parameters
13. **MERV:** Minimum Efficiency Reporting Value (for air filters)
14. **ASHRAE:** American Society of Heating, Refrigerating and Air-Conditioning Engineers
15. **IC.** Integrated circuit
16. **UPS:** Uninterruptible Power Supply

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## Glossary

**Air:** Air is the mixture of gases that surrounds the Earth and is essential for sustaining life. In real-life applications, air plays a crucial role in HVAC systems for providing ventilation, facilitating the exchange of fresh air, and maintaining indoor air quality. Air is also used as a medium for heat transfer in processes such as cooling, heating, and air conditioning.

**Air Handler:** A device that circulates and conditions air within a building. It typically includes a blower, heating or cooling elements, filters, and dampers.

**Gas:** **Gas** is a state of matter characterized by molecules that are widely spaced and have little interaction. In real-life applications, various gases are used for different purposes. For example, natural gas is commonly used as a fuel source for heating, cooking, and electricity generation. In HVAC systems, refrigerants such as R-410A or R-22 are used to transfer heat and provide cooling.

**Temperature:** Temperature refers to the measure of the average kinetic energy of particles in a substance, indicating its hotness or coldness. In real-life applications, temperature is a fundamental parameter used for various purposes. HVAC systems utilize temperature control to regulate the thermal conditions of indoor spaces, ensuring comfort and maintaining desired temperature levels.

**Heat:** Heat is the transfer of thermal energy from one object or substance to another due to a temperature difference. In real-life applications, heat is essential for numerous processes. HVAC systems use heat to provide warmth during cold weather by using furnaces, heat pumps, or boilers. Heat is also removed from indoor spaces to provide cooling through air conditioners or refrigeration systems.

**Combustible:** Combustible refers to materials that can burn or undergo combustion when exposed to heat or flames. In real-life applications, combustible materials are present in various forms, including solid, liquid, or gas. It is important to handle and store combustible materials safely and ensure proper ventilation and fire safety measures in buildings to minimize the risk of fire incidents.

**Piping:** Piping in HVAC systems refers to the network of pipes or tubes that carry fluids, such as refrigerants, water, or air, throughout the system. Piping is used for transporting and distributing these fluids to various components, such as air handlers, coils, heat exchangers, and chillers. Proper design, sizing, and installation of piping are essential for efficient and effective operation of the HVAC system.

**Flow:** Flow in HVAC refers to the movement of air or fluids through the system. It can refer to the flow of air through ductwork or the flow of refrigerant, water, or other fluids through pipes or coils. Proper flow control and balancing are critical for achieving optimal performance, temperature control, and energy efficiency in HVAC systems.

**Sensor:** A sensor is a device used to detect and measure physical or environmental conditions in HVAC systems. Sensors can include temperature sensors, humidity sensors, pressure sensors, occupancy sensors, and airflow sensors, among others. These sensors provide feedback and data to the HVAC system, allowing it to adjust and optimize its operation based on the measured parameters.

**Survey:** In the context of this module, a survey refers to an assessment or inspection of a building or space to gather information about its system needs, conditions, or requirements. A survey may

involve evaluating the existing equipment, assessing air quality, measuring temperatures, analyzing energy usage, or identifying potential areas for improvement. The information collected from a survey helps in designing, sizing, or optimizing HVAC systems for maximum efficiency and performance.

**Power Conversion:** Power conversion in HVAC refers to the process of transforming electrical power from one form to another to enable the operation of various HVAC equipment. It involves converting the incoming electrical power supply to different voltage levels, frequencies, or phases as required by the HVAC system components, such as motors, compressors, or control systems. Power conversion is essential for the efficient and reliable functioning of HVAC systems.

**User Manual:** A user manual is a document or guide provided by the manufacturer or supplier of HVAC equipment that provides instructions, information, and guidelines on how to safely and effectively operate, install, and maintain the equipment. It typically includes step-by-step procedures, diagrams, safety precautions, troubleshooting tips, and other relevant information to assist users in correctly using the HVAC equipment.

**Logs:** Logs in HVAC systems refer to records or written documentation that capture important information about the operation, maintenance, and performance of the HVAC equipment or system. Logs can include data such as temperature readings, pressure measurements, equipment running hours, maintenance activities performed, and any issues or abnormalities observed. Keeping accurate logs helps in monitoring system performance, identifying trends, diagnosing problems, and maintaining a historical record of the HVAC system's operation.

**Catalogue :** A catalogue in HVAC is a comprehensive document or publication provided by equipment manufacturers or suppliers that lists and describes their products, components, or systems. HVAC catalogs typically include detailed specifications, technical data, performance characteristics, model numbers, dimensions, and other relevant information about the available HVAC equipment or components. Catalogs serve as a reference for selecting and procuring the appropriate HVAC equipment or components for specific applications.

**Equipment :**In HVAC, equipment refers to the physical devices, machinery, or components used in heating, ventilation, air conditioning, and refrigeration systems. HVAC equipment can include furnaces, air conditioners, heat pumps, boilers, chillers, air handlers, fans, filters, compressors, control panels, sensors, and various other devices. Each equipment type serves a specific function within the HVAC system and contributes to maintaining indoor comfort and air quality.

**Tools:** Tools in HVAC are instruments or devices used by HVAC technicians or installers to perform tasks such as installation, repair, maintenance, or troubleshooting of HVAC systems. HVAC tools can include hand tools (screwdrivers, wrenches, pliers), power tools (drills, saws), specialized HVAC instruments (gauges, thermometers, leak detectors), electrical testing equipment, and more. The use of appropriate tools is crucial for ensuring safe and accurate HVAC work.

**Material:** In HVAC, material refers to the various components, supplies, or substances used in the construction, installation, or repair of HVAC systems. It can include items such as ductwork (metal sheets, insulation), piping (pipes, fittings), insulation materials, refrigerants, wiring, fasteners, gaskets, seals, filters, and other

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miscellaneous items required for HVAC system installation or maintenance.

**System Drawing:** A system drawing in HVAC refers to a graphical representation or diagram that illustrates the layout, components, and connections of a heating, ventilation, and air conditioning (HVAC) system. System drawings provide a visual depiction of the system's design, including equipment placement, ductwork routing, piping arrangements, control points, and other relevant details. These drawings are essential for planning, installation, and maintenance of HVAC systems.

**E-waste:** E-waste, short for electronic waste, refers to discarded electronic devices and equipment. In the context of HVAC, e-waste can include old or obsolete electronic components, control boards, thermostats, sensors, or other electronic equipment associated with heating, ventilation, and air conditioning systems. Proper disposal and recycling of e-waste are important to prevent environmental pollution and recover valuable resources.

**Hybrid:** In HVAC, hybrid refers to a system or technology that combines multiple sources or methods for heating, cooling, or energy management. For example, a hybrid HVAC system might incorporate both a conventional furnace and a heat pump, allowing the system to switch between different heating methods based on efficiency and outdoor conditions. Hybrid systems aim to optimize energy usage, comfort, and cost-effectiveness by leveraging the advantages of different technologies.

**Electromechanical:** Electromechanical refers to systems or devices that involve both electrical and mechanical components and processes. In HVAC, electromechanical systems often refer to equipment that uses electrical power to control mechanical actions or functions. Examples of

electromechanical devices in HVAC include motors, fans, compressors, valves, and dampers, which rely on the interaction between electrical and mechanical components to perform their intended functions.

**Thermostat:** A thermostat is a device used in HVAC systems to control and regulate the temperature of a space. It measures the current temperature and compares it to a desired setpoint. Based on this comparison, the thermostat sends signals to the HVAC equipment to activate or deactivate heating or cooling as needed. Modern thermostats may also include advanced features such as programmable schedules, remote control capabilities, and smart home integration.

**Thermodynamics:** Thermodynamics is a branch of physics that deals with the relationships between heat, energy, and work. In HVAC, thermodynamics is fundamental to understanding the principles of heat transfer, energy conversion, and the behavior of fluids and gases in heating and cooling processes. It provides the theoretical framework for concepts such as refrigeration cycles, heat pumps, and the laws governing energy conservation and entropy.

#### **Gas Property:**

Gas properties refer to the characteristics or attributes of a gas that define its behavior and properties. In the context of HVAC, gas properties can include parameters such as pressure, temperature, density, specific heat capacity, thermal conductivity, and molecular composition. Understanding gas properties is essential in HVAC design and analysis, especially in areas like combustion, refrigeration, and gas flow calculations.

**Warranty:** A warranty is a formal guarantee provided by the manufacturer or supplier of a product, typically specifying that the

product will be free from defects in materials or workmanship for a certain period of time. In HVAC, warranties are commonly offered for HVAC equipment such as air conditioners, furnaces, heat pumps, and other components. The warranty outlines the terms and conditions under which repairs, replacements, or other remedies will be provided if the equipment fails within the warranty period.

**Lectures Method:** The term "lectures method" does not have a specific meaning in the context of HVAC. It is possible that there was a misunderstanding or miscommunication. If you provide more context or clarify the intended meaning, I would be happy to assist you further.

**Parameters:** Parameters are measurable or controllable factors that define the characteristics or behavior of a system or process. In HVAC, parameters can include variables such as temperature, pressure, humidity, airflow rate, energy consumption, noise level, and air quality measurements. Monitoring and controlling these parameters are crucial for maintaining optimal performance and comfort in HVAC systems.

**Technical Factors:** Technical factors refer to various aspects, considerations, or elements that have an impact on the technical performance, design, or operation of a system or process. In HVAC, technical factors can include factors such as equipment sizing, load calculations, airflow distribution, duct design, control strategies, energy efficiency, system compatibility, and safety standards. Considering and addressing these technical factors are essential for achieving effective and reliable HVAC system operation.

**Furnace:** A furnace is a type of heating equipment used in HVAC systems to generate and distribute heat within a building or space. Furnaces are typically fueled by gas, oil, or electricity and can be

used for residential, commercial, or industrial heating applications. They work by heating air or water and then distributing the heated medium through ductwork or pipes to provide warmth and maintain desired indoor temperatures.

**Key Aspect:** In HVAC, a key aspect refers to an important or critical element or factor that significantly influences the performance, efficiency, or functionality of the HVAC system. Key aspects can include aspects such as proper equipment sizing, airflow design, temperature control, humidity management, energy efficiency, ventilation requirements, and adherence to safety codes and regulations. Understanding and addressing key aspects are essential for achieving optimal HVAC system operation.

**Calibrating:** Calibrating in HVAC refers to the process of adjusting or fine-tuning a measurement or control device to ensure its accuracy and reliability. HVAC systems utilize various sensors, thermostats, pressure gauges, flow meters, and other instruments that require calibration. Calibrating involves comparing the readings or output of a device to a known standard or reference and making necessary adjustments to align the device's measurements with the standard.

**Setting:** Setting in HVAC refers to configuring or adjusting the controls, parameters, or operational settings of HVAC equipment or systems. It involves specifying values or conditions for temperature setpoints, fan speeds, airflow rates, humidity levels, time schedules, and other relevant parameters. Proper settings are crucial for achieving desired comfort levels, energy efficiency, and system performance based on the specific requirements and conditions of the building or space.

**Configure:** Configuring in HVAC refers to the process of setting up or arranging the components, controls, or software of an

HVAC system to operate as intended. It involves selecting appropriate options, programming controllers or thermostats, connecting devices, and ensuring proper communication and coordination among system components. Configuring ensures that the HVAC system functions correctly and optimally based on the desired operational parameters and control strategies.

**Maintain:** Maintenance in HVAC refers to the ongoing activities and procedures performed to keep the HVAC system in good operating condition and prevent deterioration or failure. HVAC maintenance includes tasks such as cleaning or replacing air filters, inspecting and lubricating equipment, checking electrical connections, testing safety controls, verifying refrigerant levels, and performing routine inspections and preventive maintenance procedures. Regular maintenance helps prolong the life of HVAC equipment, ensure efficient operation, and minimize unexpected breakdowns.

**Fix:** In HVAC, fixing refers to the process of repairing or resolving issues, malfunctions, or failures in the HVAC system or its components. When a problem arises, such as a malfunctioning compressor, a leak in the refrigerant system, or a faulty control board, a qualified HVAC technician performs troubleshooting to identify the root cause and then carries out the necessary repairs or replacements to restore proper system functionality.

**Component process:** A process defined for the deployment of components.

**Component:** A representation of deployable items and the user-defined processes that operate on them, usually by deploying them.

**Control processor:** The processor in a processor array machine that issues the instructions to be executed by all the processors in the processor array. Alternatively, the control processor may perform tasks in which the processors in the array are not involved, e.g., I/O operations or serial operations.

**HVAC:** Stands for Heating, Ventilation, and Air Conditioning. It refers to the technology used for indoor environmental comfort.

**Heat Pump:** A device that transfers heat from one place to another using refrigeration principles. It can provide both heating and cooling by reversing the refrigeration cycle.

**Boiler:** A device that heats water or generates steam to provide heating for a building. It can use various fuel sources, such as natural gas, oil, or electricity.

**Chiller:** A machine that removes heat from a liquid (typically water) to provide cooling. It is commonly used in larger buildings and industrial applications.

**Thermostat:** A device used to control the temperature of a space. It can activate heating or cooling systems based on the desired temperature settings.

**A control panel:** in the context of HVAC refers to a centralized unit or interface that allows users to monitor and control various aspects of an HVAC system. It is typically a physical or digital panel that houses control devices, switches, displays, and indicators to manage the operation of the HVAC equipment.

**Ductwork:** A network of channels used for distributing conditioned air throughout a building. It carries heated or cooled air from the HVAC system to different rooms.

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**Ventilation:** The process of exchanging indoor air with fresh outdoor air to maintain air quality and control moisture levels. It helps remove contaminants, odors, and excessive humidity.

**Humidifier:** A device that adds moisture to the air to increase humidity levels. It is used in dry climates or during winter when indoor air tends to become dry.

**Dehumidifier:** A device that removes moisture from the air to reduce humidity levels. It is used in humid climates or in areas with excess moisture.

**Air Filter:** A device used to remove airborne particles, dust, and contaminants from the air. It helps improve indoor air quality and protect HVAC system components.

**VAV System:** Stands for Variable Air Volume system. It regulates the airflow to different zones within a building based on varying temperature requirements.

**SEER:** Stands for Seasonal Energy Efficiency Ratio. It is a measurement of the cooling efficiency of an air conditioning system. Higher SEER ratings indicate higher efficiency.

**AFUE:** Stands for Annual Fuel Utilization Efficiency. It is a measurement of the heating efficiency of a furnace or boiler. Higher AFUE ratings indicate higher efficiency.

**Zoning:** The practice of dividing a building into separate areas or zones with independent temperature

**Environment:** A collection of resources that identify the components that can be deployed by the parent application and the agents that do the work.

**Initiative:** An action to take for the change occurred.

**Closed Circuit:** In HVAC, a closed circuit refers to a system in which the fluid, such as refrigerant or water, circulates within a continuous loop without any leakage or external exchange. The closed circuit ensures that the fluid remains contained within the system and circulates between the components, such as the compressor, condenser, evaporator, and expansion valve, to facilitate heat transfer and maintain system operation.

**Loop:** In HVAC, a loop refers to a closed pathway through which a fluid, such as refrigerant or water, flows within the system. It typically includes supply and return lines that connect the various components and enable the circulation of the fluid. For example, a refrigerant loop in an air conditioning system consists of the high-pressure and low-pressure sides, connecting the condenser, compressor, evaporator, and expansion valve.

**Feedback:** Feedback in HVAC refers to the process of monitoring and adjusting system performance based on the information received from sensors and devices within the system. Feedback allows the system to respond to changes in temperature, humidity, pressure, or other variables and make necessary adjustments to maintain

desired conditions. For example, a thermostat provides feedback to the HVAC system by sensing the indoor temperature and signaling the system to turn on or off to achieve the desired setpoint.

**Open Circuit:** An open circuit in HVAC refers to a situation where there is a break or interruption in the electrical or fluid flow path within the system. It means that the circuit is incomplete, and the fluid or electrical current cannot flow through the intended pathway. In HVAC systems, an open circuit can result in a malfunction or failure of components, preventing proper operation and requiring troubleshooting and **repair**.

**Refilling:** Refilling in HVAC refers to the process of replenishing a system with the necessary fluid, such as refrigerant or water, to maintain proper levels and ensure optimal performance. Refilling is typically required when there is a loss of fluid due to leaks, maintenance activities, or system adjustments. For example, refrigerant refilling is necessary in air conditioning systems to maintain the correct charge and ensure efficient cooling.

**Control Board:** The control board, also known as the circuit board or control module, is a crucial component of an HVAC system. It is responsible for controlling and coordinating the operation of various system

components, such as the compressor, blower motor, and fan. The control board receives signals from thermostats, sensors, and user inputs, and it sends commands to activate or deactivate specific system functions.

**Microprocessor:** The microprocessor is a small computer chip integrated into the control board. It processes data, executes commands, and performs calculations to control and manage the HVAC system's operation. It plays a vital role in monitoring inputs, running control algorithms, and delivering outputs based on programmed logic.

**Input/Output (I/O) Ports:** I/O ports on the control board are used to connect and interface with external devices, such as thermostats, sensors, actuators, and communication modules. The inputs provide information to the control board, while the outputs deliver control signals to activate or deactivate system components.

**Diagnostic LEDs:** Diagnostic LEDs (Light Emitting Diodes) are small indicator lights present on the control board. They provide visual feedback and help diagnose system issues by displaying error codes or status information. The specific pattern or color of the LEDs can indicate various conditions, such as normal operation, a fault, or a specific error condition.

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**Control Algorithms:** Control algorithms are software programs running on the control board that determine how the HVAC system responds to inputs and operates under different conditions. These algorithms define temperature setpoints, fan speed control, defrost cycles, energy-saving modes, and other control strategies to optimize system performance and efficiency.

**Firmware:** Firmware refers to the software or program code stored on the control board's memory. It contains the operating instructions and control logic for the HVAC system. Firmware updates may be required periodically to introduce new features,

improve performance, or address known issues.

**User Interface:** Some advanced control boards feature a user interface, such as an LCD display or touch panel, that allows users to interact with the system. The user interface provides information about system status, allows users to adjust settings, view diagnostic information, and access advanced configuration options.

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