COMPETENCY STANDARDS

OF

HEATING VENTILATION AIR CONDITIONING & REFRIGERATION (HVARC) TECHNOLOGY

(Level- 3)

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1. INTRODUCTION

The HVACR Industry is a worldwide enterprise, having role including operation, maintenance, system design, construction, equipment manufacturing, sales, education and research. The HVACR industry is being regulated by the manufacturers of HVACR equipment, but organizations such as HARDI, ASHRAE, SMACNA, ACCA, etc. have been established to support the industry and to encourage high standards of achievements.

HVACR is a necessity of the day for personal comfort, medical health, food preservation, water supply and work productivity. In fact, all human activities rely on HVACR in one way or the other. This industry produces thousands of jobs in the market for its products.

The HVACR experts plan, install and maintain the climate control system that makes our environment more comfortable and functional. The areas mentioned above continuously upgrading existing system for economical cost and environment efficiency.

The HVACR field also offers variety of jobs and opportunities to grow for obtaining better bread and butter and its professionals can use their skills at any place in the world.

Homes, Office Buildings, Industries such as Chemical, Food Preservation, Medical & Textile, Airplanes, Railways, Vehicles, Mobile Refrigerating Units and Electronic Equipment, all rely on HVACR systems for their better working. Hence the HVACR technology/industry provides huge employment opportunities for HVACR professionals in the field of Designing, Manufacturing, Erection, Operation & Maintenance throughout Pakistan and abroad.

2. PURPOSE OF THE QUALIFICATION

The purpose of this qualification is to set high professional standards for HVACR industry. The specific objectives for developing this qualification are as under:

- Improve the professional competence of the trainees
- Provide opportunities for the recognition of skills attained by a person through ~~non-~~ formal or informal pathways
- Improve the quality & effectiveness of training and assessment for HVACR industry
- Enable the existing workforce to capacitate themselves in new techniques and methods

3. DATE OF VALIDATION

These national qualifications have been validated by the Qualifications Validation Committee (QVC) on May 20-22, 2019

4. DATE OF REVIEW

These national qualifications may be reviewed in May 2021

5. CODE OF QUALIFICATION

The International Standard Classification of Education (ISCED) is a framework for assembling, compiling, and analyzing cross-nationally comparable statistics on education and training, ISCED codes for these qualifications as assigned as follow:

Qualification Title	Code
National Vocational qualification Level-3 in	0000000000
National Vocational qualification Level -3 in	0000000000
National Vocational qualification Level -4 in	0000000000
National Vocational qualification Level -5	0000000000

6. QUALIFICATION DEVELOPMENT COMMITTEE

The following members participated in the qualifications' development workshop 31st December 2018 to 4th January 2019 at Hospitality Inn, Lahore:

S. No.	Name & Designation	Organization
1.	**Mr. Amjad Mehmood Baloch**, Deputy Manager (Operations) / DACUM Facilitator	Punjab TEVTA
2.	**Engr. Zamir Ul Hassan Gardezi,** MEP Manager	MIDJAC Construction Pvt. Ltd, Islamabad
3.	**Mr. Syed Shabbir Haider,** HVAC Expert	Haier, Lahore Pakistan
4.	**Mr. Muhammad Haroon,** Senior Instructor HVAC	Govt. College of Technology, Railway Road, Lahore
5.	**Mr. Muhammad Shahid Saeed,** HVAC Expert	Govt. ATC, Township, Lahore
6.	**Mr. Azhar Waheed,** Instructor HVAC	PVTC, Islamabad
7.	**Mr. Muhammad Aslam,** HVAC Expert	Textronics, Phase-,1 Pakistan Town Islamabad
8.	**Mr. Asad Masood,** HVAC Supervisor	Climate Control, Lahore
9.	**Mr. Muhammad Atif Latif,** Sr. Technician HVAC	Pakistan Railway, Lahore.
10.	**Mr. Muhammad Awais Arshad,** HVAC Supervisor	Climate Solution, Lahore
11.	**Mr. Farooq Saeed,** Incharge HVAC	Greaves Air-Conditioning, Lahore
12.	**Mr. Muhammad Shahbaz,** Senior Instructor HVAC	Govt. College of Technology, Railway Road, Lahore
13.	**Mr. Shehzad Yousaf,** HVAC Expert	Cool Care, Shalimar Garden, Lahore
14.	**Mr. Yasir Ali,** Senior Instructor HVAC	Govt. College of Technology, Railway Road, Lahore

S. No.	Name & Designation	Organization
15.	**Dr. Zulfiqar Ali Cheema,** Deputy Director (VT)	NAVTTC HQ, Islamabad

7. QUALIFICATION VALIDATION COMMITTEE

The following members participated in the qualifications Validation workshop w.e.f. 20th May 2019 to 22nd May 2019 at Park Lane Hotel, Lahore:

S. No.	Name & Designation	Organization
1.	**Mr. Amjad Mehmood Baloch**, Deputy Manager (Operations) / DACUM Facilitator	Punjab TEVTA
2.	**Mr. Muhammad Haroon,** Senior Instructor HVAC	Govt. College of Technology, Railway Road, Lahore
3.	**Mr. Muhammad Shahid Saeed,** HVAC Expert	Govt. ATC, Township, Lahore
4.	**Engr. Asad Mehmood Butt,**	Representative from P. TEVTA, Lahore
5.	**Mr. Ghulam Rasool Rajput,**	Representative from S. TEVTA, Karachi
6.	**Mr. Shoukat Ali,**	Representative From KPK. TEVTA, Bannu
7.	**Mr. Saulat Saeed,** CEO (HVACR Expert)	Air Comfort, Lahore.
8.	**Engr. Liaqat Ali Jamro,** Director Acad & Training	S. TEVTA, Karachi
9.	**Mr. Saddam Anwar Rana** Research Officer	PBTE, Lahore
10.	**Dr. Zulfiqar Ali Cheema,** Deputy Director (VT)	NAVTTC HQ, Islamabad

8. ENTRY REQUIREMENTS

Entry requirements of this qualification is Matriculation

9. REGULATIONS FOR THE QUALIFICATION AND SCHEDULE OF UNITS

Summary of Competency Standards

Applied Thermodynamics in HVAC&R Systems (HVAC-223)					
CS.24	Analyze Thermodynamics performance of HVAC system	3	40	4	Technical
CS.25	Prepare Boiler for Smooth Operation	3	45	4.5	Technical
Advance Refrigeration (HVAC-243)					
CS.27	Service and Maintain Transport Refrigeration Units	3	20	2	Technical
CS.28	Apply Principles of Refrigeration in Cold Storage Technology	3	20	2	Technical
HVAC&R Workshop Practice-II (HVAC-253)					
CS.31	Perform refrigerant recovery	3	10	1	Technical
CS.32	Install Residential Air conditioner	3	40	4	Technical
CS.33	Repair refrigerator, deep freezer, display unit, bottle cooler and Water cooler	3	70	7	Technical
CS.34	Repair and Service Residential Air conditioner	3	60	6	Technical
CS.35	Overhaul the compressors	3	20	2	Technical
CS.36	Repair and Service Residential Refrigeration Units	3	30	3	Technical
CS.37	Test, Recover, evacuate and charge refrigeration system	3	60	6	Technical
Principle of Air Conditioning (HVAC-214)					
CS.39	Calculate Psychrometric Process of Air	3	60	6	Technical
Engr. Architectural and Computer Aided Drawing (HVAC-233)					
CS.42	Develop Geometrical Solids	3	60	6	Technical
CS.43	Draw Projection of Pipes	3	30	3	Technical
Basic Electronics Applied to HVACR Systems (ELR-311)					

CS.61	Make Circuit using Electronic Components	3	20	2	Technical

Digital Skills					
CS.135	Use digital devices	3	5	0.5	Generic
CS.139	Perform writing and editing tasks	3	5	0.5	Generic
CS.140	Write and Edit Copy	3	5	0.5	Generic

Analyse Thermodynamic performance of HVACR System

Overview

This Competency Standard identifies the competencies required to analyze the thermodynamic performance of HVAC systems. Students will be expected to analyze the thermodynamic performance according to the nature of work at workplace. His underpinning knowledge regarding thermodynamic performance will be sufficient to provide the basis for his work.

Competency Units	*Performance Criteria*
1. Prepare to analyze the thermodynamic performance of HVACR systems	**P1.** Calculate thermodynamic properties of air **P2.** Calculate specific heat of air at constant pressure and at constant volume **P3.** Calculate enthalpy of air / gasses **P4.** Calculate internal energy of air / gasses **P5.** Calculate specific gravity of different liquids **P6.** Calculate density of air / liquids **P7.** Calculate rate of discharge of fluids
2. Analyze the thermodynamic performance of HVACR systems	**P1.** Apply thermodynamic principles to analytical solutions on refrigeration and air conditioning systems. **P2.** Obtain Parameters, specifications and performance requirements in relation to refrigeration and air conditioning systems in accordance with established procedures. **P3.** Carry out approaches to analyze thermodynamic parameters to provide the most effective solution.
3. Make report and act on the results of thermodynamic performance analysis	**P1.** Evaluate to determine the effectiveness of solutions for thermodynamic issues and modify where necessary. **P2.** Make report of the analysis including details of all findings, calculations and assumptions.

	P3. Take actions regarding equipment, documents for inclusion in work/project or development records in accordance with professional standards and manufacturer's specifications.

Knowledge and Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Thermodynamic performance issues
- Forming effective strategies for analyzing refrigeration and air conditioning systems performance
- Obtaining thermodynamic performance parameters, specifications and performance requirements appropriate to each situation
- Evaluating the results of the analysis
- Documenting analysis details of all findings, calculations and assumptions
- Record keeping and reporting

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Apply thermodynamic principles to analytical solutions on HVACR systems
- Analyze the thermodynamic performance of HVAC/R systems
- Take action on the results of different thermodynamic performance analysis
- Make report thermodynamic performance analysis

List of Tools, Equipment and Machinery

Sr. No	*Description*
1	Personal Protective Equipment
2	Basic Measuring tools
3	Basic Hand tools
4	Basic Cutting tools
5	Basic Power tools

6	Basic Marking tools
7	Basic Electrical and Electronics tools

Prepare Low Pressure Boiler for Smooth Operation

Overview

This competency standard identifies the competencies required to prepare boiler for smooth operation. Students will be expected to prepare boiler for smooth operation according to the nature of work at workplace. His underpinning knowledge regarding boiler operation will be enough to provide the basis for his work.

Competency Units	*Performance Criteria*
1. Prepare the low-pressure boiler for operation	**P1.** Review operational order and check appropriate / designated / concerned / competent person where required **P2.** Identify and report health and safety hazards / maintenance requirements to appropriate personnel according to workplace reporting procedures **P3.** Identify and set quantity of steam to be generated for allocated Process **P4.** Purge the boiler according to workplace procedure **P5.** Perform pre-operational checks to confirm operational status of boiler and related equipment
2. Operate and monitor boiler	**P1.** Use equipment in line with organizational safety procedures, manufacturer's instructions and environmental protection practices. **P2.** Apply complete pre-operational safety and pre start-up checks to ensure operational effectiveness. **P3.** Start boiler and bring safely online; communicate recent performance to appropriate personnel. **P4.** Monitor boiler operation, diagnose status and adjust to maintain safe and efficient operation.
3. Shut down and store boiler	**P1.** Shut down boiler according to workplace procedures and manufacturer's recommendations **P2.** Clean boiler internally and externally according to workplace procedures and manufacturer's recommendations **P3.** Remove valves and fittings in preparation for maintenance **P4.** Store the boiler in the appropriate storage mode according to workplace procedures and manufacturer's recommendations

	P5. Store and record boiler house chemicals, in line with safety procedures and environmental protection practices. **P6.** Follow emergency shutdown procedures in cases of fire. **P7.** Complete operating log, record fuel efficiency and report to the designated personnel.
4. Analyze and respond to abnormal performance (Trouble Shooting of Boiler)	**P1.** Analyze operating data and plant operating conditions to identify causes of abnormal performance **P2.** Act correctively in accordance with workplace procedures in response to Hazards, out-of-specification test results and/or plant performance **P3.** Implement emergency procedures as required according to workplace procedures and manufacturer's recommendations and ASHRAE US Standards.

Knowledge and Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard.

This includes the knowledge of:

- Hazards that are most likely to cause harm
- Identification and use of Personal Protective Equipment (PPE)
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Different types of electric motors
- Working principles of different types of electric motors
- Pressure and pressure laws
- Temperature and its units
- Ohm meter, Voltmeter and Ampere meter use
- Record keeping and reporting

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Adopt PPE for boiler operation
- Set measured quantities of boiler
- Follow start up precautions
- Start & Operate boiler safely
- Shutdown boiler

List of Tools, Equipment and Machinery

Sr. No	*Description*
1	Personal Protective Equipment
2	Basic Measuring tools
3	Basic Hand tools
4	Basic Cutting tools
5	Basic Power tools
6	Basic Marking tools
7	Basic Electric and Electronics tools

Service and Maintain Transport / Mobile Refrigeration Units

Overview

This competency standard identifies the competencies required to service and maintain transport / mobile refrigeration units. Students will be expected to diagnose the defects and service / maintain in transport / mobile refrigeration units according to the nature of work at workplace. His underpinning knowledge regarding servicing and maintenance of transport / mobile refrigeration units will be sufficient to provide the basis for his work.

Competency Units	*Performance Criteria*
1. Check and diagnose the defect in the freezer unit	**P1.** Inspect unit and ascertain, record to the extent of repair needed. **P2.** Prepare list of material, equipment, manpower and items according to the requirement. **P3.** Check / observe all components of refrigerant circuit according to standard practices and manufactures specifications to ensure correct performance. **P4.** Check / observe all components of the refrigerant system, electrical system and accessories according to standards practices & manufactures specifications to ensure correct operation. **P5.** Test system pressure with dry nitrogen gas and locate leaks using specified equipment and recommended safety procedures.
2. Service / repair refrigerant system of the freezer unit	**P1.** Check internal and external electrical / electronic control systems for operations and repair / replace

	where necessary according to manufacturer's instructions. **P2.** Check electronic climatic controls for smooth operation and replace where necessary according to manufacturer's instructions. **P3.** Check freezer unit for specified /specific performance against manufacturer's specification

Knowledge and Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- Hazards that are most likely to cause harm
- Identification and use of Personal Protective Equipment (PPE)
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Different types of compressors and their functions
- Define pressure and temperature laws
- Define temperature and its units
- Read and interpret manufacturer's manuals, specifications etc.,
- Basic refrigeration and air conditioning principles Refrigeration Cycle
- Types of Refrigerants, their properties and applications
- Functions of the gauge manifold and color code of hoses
- Function of service valves
- Working principles of the recovery machine
- Refrigerant recovery process
- Refer to manufacturer's specifications/ instructions on service and maintenance of transport / mobile refrigeration units
- Identify the type of refrigerants
- Detection of gas leaks and repairing leaks Pressure testing in refrigerant lines Adherence to conditions of the "Environment Protection Acts "(EPA)
- Coupling manifold gauge and hoses to the refrigerant lines either by piercing or using service valves
- Safe handling and use of refrigerants, gauges, tools & equipment
- Record keeping and reporting

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

The candidate will demonstrate the following repair / service skills in a simulated environment to provide evidence of competency:

- Diagnose faults of Transport Refrigeration by using specified tools and instruments
- Repair refrigerant leak in Transport Refrigeration system
- Replace the compressor and other accessories of unit
- Recharge refrigerant
- Operate crankcase pressure regulator (KVL)

List of Tools, Equipment and Machinery

Sr. No	*Description*
1	Personal Protective Equipment
2	Basic Measuring tools
3	Basic Hand tools
4	Basic Cutting tools
5	Basic Power tools
6	Basic Electric tools
7	Gauge manifold
8	Recovery Machine with accessories
9	Vacuum pump
10	Refrigerant Charging Station
11	Oxy-acetylene welding set with accessories

Perform Refrigerant Recovery

Overview

This Competency Standard identifies the competencies required to couple the recovery unit to the equipment and recover the refrigerant. Students will be expected to recover refrigerant from the system according to the nature of work at workplace. His underpinning knowledge regarding refrigerant recovery will be sufficient to provide the basis for his work.

Competency Units	*Performance Criteria*
1. Couple the recovery unit to the equipment	**P1.** Identify type of refrigerant to be recovered according to available information. **P2.** Select appropriate system for connection of charging hoses, either with piercing valve or charging valve according to requirements. **P3.** Ensure recovery unit to be free of any other type of refrigerant. **P4.** Transfer refrigerant in unit to a separate recovery cylinder; ensure that no refrigerant escapes to atmosphere. **P5.** Connect gauge manifold to system, according to standard color codes of hoses of manifold gauge. **P6.** Couple recovery unit to equipment, following standard procedure for connections. **P7.** Connect overfill protection device and ensure safety of operation.
2. Recover Refrigerant	**P1.** Start recovery unit, monitor process and ensure full recovery of Refrigerant. **P2.** Stop recovery unit **P3.** Disconnect system according to standard procedure **P4.** Ensure no refrigerant escapes to atmosphere

Knowledge and Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- Hazards that are most likely to cause harm
- Identification and use of Personal Protective Equipment (PPE)
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Basic refrigeration and air conditioning Cycle
- Types of Refrigerants, their properties and applications
- Functions of the gauge manifold and color code of hoses
- Function of service valves

- Working principles of the recovery machine
- Refrigerant recovery process
- Gas leaks and repairing leaks Pressure testing in refrigerant lines Adherence to conditions of the “Environment Protection Acts “(EPA)
- Coupling manifold gauge and hoses to the refrigerant lines either by piercing or using service valves
- Recovery of refrigerants using recovery machines and allied accessories.
- Safe handling and use of refrigerants, pressure gauges, tools & equipment
- Record keeping and reporting

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Operate refrigerant recovery unit
- Connect unit with HVAC machine
- Transfer refrigerant in a cylinder

List of Tools, Equipment and Machinery

Sr. No	*Description*
1	Personal Protective Equipment
2	Basic Measuring tools
3	Basic Hand tools
4	Basic Cutting tools
5	Basic Power tools
6	Basic Electric tools
7	Gauge manifold with hoses
8	Piercing valve
9	Recovery unit

Install Residential Air Conditioner

Overview

This Competency Standard identifies the competencies required to install different types of Window type / Split type residential Air conditioners at workplace in accordance with the organization's / client's guidelines. This unit covers the knowledge regarding safety rules, Personal Protective Equipment (PPE), and international standards for installing Residential Air conditioner.

Competency Units	*Performance Criteria*
1. Install Window Air Conditioner	**P1.** Select tools, equipment and related accessories according to job requirements **P2.** Mark the location on the wall where Window Air Conditioner to be installed according to Unit specifications and client requirements **P3.** Make opening at the marked area on the wall **P4.** Fix Iron / wooden frame in the opening firmly and insert in it the Air Conditioner cover according to the instructional manual and standards **P5.** Install the Air conditioner in the framed opening with standard slope so that condensate water drops outside **P6.** Cover / Seal side air gaps of opening with insulation material **P7.** Fix the fancy wooden border / frame around the Air conditioner grill as per client's requirement **P8.** Fix the Air Conditioner condensate drainpipe and put it into main sewerage line **P9.** Install power supply with circuit breaker near the Air Conditioner **P10.** Remove all packing material - Cardboard, Styrofoam, Tape and Plastic Film from the site after the installation **P11.** Switch on the Air Conditioner and check Air Conditioner performance as per capacity and specifications
2. Install Split Air Conditioner	**P1.** Select tools, equipment and related accessories according to job requirements **P2.** Select and mark the areas on the walls where Indoor and Outdoor units are to be installed according to specifications and client requirements **P3.** Perform physical inspection of indoor and outdoor unit according to unit specifications

	P4. Make opening for the refrigerant pipes, condensate pipe and control wires to pass through **P5.** Mount the Indoor unit wall mounting plate according to manufacturer specifications and install the Indoor unit on it **P6.** Prepare base for the fixing of Outdoor unit according to manufacturer specifications and fix the Outdoor unit there **P7.** Make electric supply connection at outer unit. **P8.** Connect the refrigerant pipes amongst/ to both indoor and outdoor units, supply and control wires according to manufacturer manual **P9.** Add additional refrigerant for additional piping according to manufacturer recommendations **P10.** Make oil trap in copper pipe as per site requirement Perform leak test, evacuation procedure, charge refrigerant and open the service valves **P11.** Insulate the joints and refrigerant pipes according to standards and manufacturer installation manual **P12.** Remove all packing material - Cardboard, Styrofoam, Tape and Plastic film **P13.** Switch on the Air Conditioner and check performance as per capacity and specifications

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Ozone Protection and Synthetic Greenhouse Gas Management Act 1989Basic load calculation for cooling / heating.
- Basic load calculation for cooling / heating
- Fundamental knowledge of HVACR, Electric and Electronics
- Techniques for installation of Window / Split (DC Inverter)
- Technical Operations of all types of split air conditioners
- Electrical / HVAC layout plans/wiring diagrams.
- Types of electrical wires and cables, including underground cables, their ratings and its applications
- Methods of Copper Tube cutting / Reaming / Bending /Swaging / Flaring / Brazing / Jointing / fixing
- Basic Masonry and Carpentry applications
- Gas welding (Soldering and Brazing)

- Types of Insulation and their applications
- Compressor types and applications
- Methods of Pressurizing/ Evacuation / Purging / Refrigerant charging
- Types of Refrigerant, its properties, Recycling, Recovery and Reclaiming

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

The candidate will demonstrate the following Installation skills in a simulated environment to provide evidence of competency:

- Mark location according to specifications and standards
- Perform electric connections to joint indoor unit and outdoor unit
- Prepare the base for condensing unit
- Install the indoor / outdoor unit according to HVAC standards
- Purge refrigerant and charge the unit

List of Tools, Equipment and Machinery

Sr. No	*Description*
1	Personal Protective Equipment
2	Basic Measuring tools
3	Basic Hand tools
4	Basic Cutting tools
5	Basic Power tools
6	Basic Marking tools
7	Basic Electric tools
8	AVO meter
10	Adjustable Screw Wrench
11	Combination Plier
12	Nose Plier Set
13	Locking Plier
14	Copper tube cutter
15	Electric Hand Drill Machine

Repair Refrigerator, Deep Freezer, Display Unit, Bottle Cooler and Water Cooler

Overview

This Competency Standard identifies the competencies required to repair refrigerators, deep freezers, display units, bottle coolers and water coolers. Students will be expected to repair refrigerators, deep freezers, display units, bottle coolers and water coolers according to the nature of work at workplace. His underpinning knowledge regarding repairing of refrigerators, deep freezers, display units, bottle coolers and water coolers will be sufficient to provide the basis for his work.

Competency Units	*Performance Criteria*
1. Check and identify defects in window type & split type Air Conditioners	**P1.** Check unit for the extent of repair needed ascertain and recorded. **P2.** Enlist equipment / items, material main power and accessories as required for job. **P3.** Check all components of the electrical / electronic circuit according to standard / practices and manufacturers specifications to ensure correct performance. **P4.** Check all components of the refrigerant circuit according to standard / practices and manufactures specifications to ensure correct performance. **P5.** Check all components of the Air-flow system according to standards / practices and manufactures specifications to ensure correct performance. **P6.** Check outer cover / chassis for corrosion etc. **P7.** Test system pressure with dry nitrogen and locate gas leaks by using specified equipment following safety procedures.
2. Repair window type & split type Air Conditioners	**P1.** Identify defects and repair / replace the relevant component(s). **P2.** Perform brazing and test system for leakages **P3.** Evacuate the system using vacuum pump and test according to manufacturer's specifications **P4.** Recharge refrigerant using specified type of refrigerant and recharging equipment, to required specification following safety practices.

	P5. Check filters clean / replace if necessary. **P6.** Check corrosion in outer cover / base plate and restore required conditions. **P7.** Operate and check unit to ensure satisfactory performance according to manufacturer's specifications

Knowledge and Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- Hazards that are most likely to cause harm
- Identification and use of Personal Protective Equipment (PPE)
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Fundamental knowledge of HVACR, Electric and Electronics
- Techniques for repairing of Refrigerators / Freezers / Water Coolers and Water Dispensers
- Technical Operations of Non-Frost refrigerators
- Types of electrical wires and cables, their ratings and applications
- Techniques for Diagnosing and Troubleshooting of Residential Refrigerators /
- Freezers / Water Coolers and Water Dispensers
- Types of Lubricants and their properties
- Capable to replace PCB Card
- Compressor types/ Specifications and applications
- Methods of Copper Tube Cutting / Bending /Swaging / Flaring / Brazing / Jointing /Fixing
- Gas welding (Soldering and Brazing)
- Methods of Pressurizing/ Evacuation / Purging / Refrigerant Charging
- Types of Refrigerant, its properties, recovery and reclaiming
- Record keeping and reporting

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

The candidate will demonstrate the following repair / service skills in a simulated Environment to provide evidence of competency:

- Diagnose faults of Refrigeration unit by using specified tools and instruments

- Check & Replace electrical accessories of unit
- Check & Replace the mechanical parts & accessories of the unit
- Charge the refrigerant in unit

List of Tools, Equipment and Machinery

Sr. No	*Description*
1	Personal Protective Equipment
2	Basic Measuring tools
3	Basic Hand tools
4	Basic Cutting tools
5	Basic Power tools
6	Basic Marking tools
7	Basic Electric tools
8	Portable Refrigerant Charging Station
9	Digital Air Flow / Velocity Meter
10	Water Pressure Gun for Service
11	Electronic Leak Detector
12	Tube Cutter
13	Digital Optical Tachometer
14	Micron Pressure Gauge
15	Digital Pressure Gauges Set (High &Combine)
16	Pinch-Off Plier
17	Flaring and Swaging Tool Kit
18	Vacuum Pump 2-Stage, 6cfm
19	Tube Benders (Spring Type and Pulley Bender Type)
20	Megohmmeter (0 - 1000 Volts)
21	Laser Temperature Measuring Device Nose Plier Set
22	Electric Hand Grinder
23	Soldering Iron
24	Digital Clamp-On Ampere Meter
25	Digital Multi Meter
26	Electric Hand Drills
27	Hot Air Gun
28	Digital Capacitor Analyzer
29	Hand Electric Blower
30	Digital Humidity Meter
31	Digital Psychrometer (Hygrometer)
32	Pulley Wheel Puller
33	Screwdriver Set

34	Nitrogen Gas Cylinder with Hose Pipe, Regulator and Back Arrestor
35	Gas Welding Set with All Accessories
36	Allen Key Set
37	Locking Plier

Repair and Service Residential Air Conditioner

Overview

This Competency Standard covers the competencies required to diagnose / repair / service residential Air conditioners at workplace in accordance with the manufacturer's specifications / guidelines. This unit covers the knowledge regarding safety rules, personal protective equipment, and international standards for repairing / servicing of Residential Air conditioners to provide you the basis for student work.

Competency Units	*Performance Criteria*
1. Diagnose Faults in Residential Air Conditioner	**P1.** Adopt Occupational Safety and Health (OSH) procedures to avoid hazards and accidents at workplace. **P2.** Check for obvious problem to determine which component or system is causing the problem **P3.** Select tools, equipment and related accessories according to requirements and standards. **P4.** Check power supply, electric wiring, electric / electronic components and refrigerant pressure to determine the exact problem by using AVO meter / Gauge manifold / flow chart as recommended by manufacturer and record the results **P5.** Eliminate the causes of the problem according to the manufacturer's manual and standards. **P6.** Isolate and recheck the causes of the problem and rectify the fault **P7.** Start the Air conditioner and recheck the unit as specified in the manufacturer's manual and record the results
2. Repair Window / Split Air Conditioner	**P1.** Adopt Occupational Safety and Health (OSH) procedures to avoid hazards and accidents at workplace. **P2.** Select tools, equipment and related accessories according to job requirements **P3.** Disconnect the Air conditioner from electric supply and follow the manual instructions for rectification **P4.** Rectify the faults as per diagnosed, repair / replace the components, as necessary **P5.** Switch on the Air conditioner to check the performance of electrical/ electronic and mechanical components as specified in the manufacturer's manual and record the results

3. Service Window Air Conditioner	**P1.** Adopt Occupational Safety and Health (OSH) procedures to avoid hazards and accidents at workplace. **P2.** Select tools, equipment and related accessories according to job requirements **P3.** Start the Air conditioner, check and record performance by using specified test instruments **P4.** Disconnect the Air conditioner from electric supply and remove Air conditioner from the cover **P5.** Secure the electric / electronic components with polythene sheet **P6.** Clean / wash the all mechanical parts of Window Air conditioner with specified cleaning agents / detergent by using pressure pump. **P7.** Fix the Air conditioner in the cover, connect with electric supply, check and record performance
4. Service Split Air Conditioner	**P1.** Adopt Occupational Safety and Health (OSH) procedures to avoid hazards and accidents at workplace. **P2.** Select tools, equipment and related accessories according to job requirements **P3.** Start the Air conditioner, check and record performance by using specified test instruments **P4.** Pump down the split type Air conditioner and dismantle the both indoor and condensing unit **P5.** Clean the components of Air conditioner with specified cleaning agents/tools & material. **P6.** Re-Install the indoor & outdoor unit, connect with refrigerant pipes, control wires and open the service valves **P7.** Switch on the Air conditioner, check and record performance

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Ozone Protection and Synthetic Greenhouse Gas Management Act 1989
- Fundamental knowledge of HVACR, Electric and Electronics
- Techniques for repairing of Window / Split air conditioners

- Technical Operations of split air conditioners
- Electrical / Copper piping layout plans/wiring diagrams.
- Types of electrical wires and cables, including underground cables, their ratings and its applications
- Techniques of Diagnose and Troubleshooting of Residential Air conditioners
- Familiar with Residential Air conditioners error codes and solution
- Types of Motors used in Residential Air conditioners
- Types of Lubricants and their properties
- Capable to replace PCB Card
- Compressor types/ Specifications and applications
- Methods of Copper Tube cutting / Bending /Swaging / Flaring / Brazing / Jointing / fixing
- Gas welding (Soldering and Brazing)
- Types of Insulation and their applications
- Methods of Pressurizing/ Evacuation / Purging / Refrigerant charging
- Types of Refrigerant, its properties, recovery and reclaiming
- Record keeping and reporting

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- The candidate will demonstrate the following repair / service skills in a simulated environment to provide evidence of competency:
    - Diagnose faults of Air Conditioner by using specified tools and instruments
    - Perform pump down operation in split type air conditioner
    - Repair refrigerant leak in Air Conditioner
    - Replace the compressor of Air conditioner
    - Replace the printed circuit board (PCB) of split air conditioner

List of Tools, Equipment and Machinery

Sr. No	*Description*

1	Personal Protective Equipment
2	Basic Measuring tools
3	Basic Hand tools
4	Basic Cutting tools
5	Basic Power tools
6	Basic Marking tools
7	Basic Electric tools
8	Portable Refrigerant Charging Station
9	Digital Air Flow / Velocity Meter
10	Water Pressure Gun for Service
11	Electronic Leak Detector
12	Tube Cutter
13	Digital Optical Tachometer
14	Micron Pressure Gauge
15	Digital Pressure Gauges Set (High &Combine)
16	Pinch-Off Plier
17	Flaring and Swaging Tool Kit
18	Vacuum Pump 2-Stage, 6cfm
19	Tube Benders (Spring Type and Pulley Bender Type)
20	Megohmmeter (0 - 1000 Volts)
21	Laser Temperature Measuring Device Nose Plier Set
22	Electric Hand Grinder
23	Soldering Iron
24	Digital Clamp-On Ampere Meter
25	Digital Multi Meter
26	Electric Hand Drills
27	Hot Air Gun
28	Digital Capacitor Analyzer
29	Hand Electric Blower
30	Digital Humidity Meter
31	Digital Psychrometer (Hygrometer)
32	Pulley Wheel Puller
33	Screwdriver Set

Overhaul the compressors

Overview

This Competency Standard covers the competencies required to overhaul the compressors in accordance with the manufacturer's specifications / guidelines. This unit covers the knowledge regarding overhauling of compressors to provide you the basis for student work.

Competency Units	*Performance Criteria*
1. Prepare to dismantle compressor	**P1.** Determine job requirements from workplace instructions **P2.** Control and interpret refrigerant gases during installation, servicing or de-commissioning of air conditioners source **P3.** Source and interpret dismantling information **P4.** Analyze dismantling options and select most appropriate to the circumstances **P5.** Identify hazards associated with the work and manage the risks **P6.** Select dismantling tools and equipment and check for serviceability
2. Dismantle and evaluate compressor and components	**P1.** Dismantle compressor in a logical sequence according to manufacturer, workplace procedures, safety & environmental requirements and without affecting unnecessary damage to components or systems **P2.** Clean components for evaluation according to workplace procedures, safety and environmental requirements **P3.** Measure and Compare components with manufacturer specifications and serviceability is determine **P4.** Determine component repair methods **P5.** Identify unserviceable parts and replacement parts sourced
3. Carry out overhaul	**P1.** Source and interpret overhaul information **P2.** Analyze overhaul options and select those most appropriate to the circumstances **P3.** Select and check overhaul tools and equipment for serviceability **P4.** Machine the components repair / replace as required **P5.** Carryout adjustments according to manufacturer specifications, workplace procedures, safety and environmental requirements

4. Assemble compressor and components	**P1.** Assemble compressor according to manufacturer specifications, workplace procedures, and safety & environmental requirements **P2.** Measure tolerance and clearances against manufacturer specifications and make necessary adjustments **P3.** Complete assembly of compressor within workplace timeframes and without causing damage to other components or systems **P4.** Carryout post-assembly testing according to workplace procedures, safety & environmental requirements **P5.** Detect and rectify problem(s) as have been introduced during the assembly process
5. Complete work processes	**P1.** Ensure final inspection to make work according to workplace expectations and ready compressor for use or storage **P2.** Clean work area, dispose of waste and non-recyclable materials and collect recyclable material Check and store tools and equipment or identify any faulty electrical equipment tagged and isolated according to workplace procedures **P3.** Process workplace documentation according to workplace procedures

Knowledge and Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Ozone Protection and Synthetic Greenhouse Gas Management Act 1989
- Fundamental knowledge of HVACR, Electric and Electronics
- Techniques for repairing of Window / Split air conditioners
- Operations of split air conditioners
- Electrical circuit diagrams.
- Copper piping layout
- Techniques of Diagnose and Troubleshooting of Residential Air conditioners
- Familiar with Residential Air conditioners error codes and solution
- Types of Motors used in Residential Air conditioners
- Types of Lubricants and their properties
- Capable to replace PCB Card
- Compressor types/ Specifications and applications

- Gas welding (Soldering and Brazing)
- Methods of Pressurizing/ Evacuation / Purging / Refrigerant charging
- Types of Refrigerant, its properties, recovery and reclaiming
- Record keeping and reporting

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Dismantle compressor
- Servicing of compressor
- Cleaning of compressor
- Reassembling of compressor

List of Tools, Equipment and Machinery

Sr. No	*Description*
1	Personal Protective Equipment
2	Basic Measuring tools
3	Basic Hand tools
4	Basic Cutting tools
5	Basic Power tools
6	Basic Marking tools
7	Basic Electric tools
8	Portable Refrigerant Charging Station
9	Electronic Leak Detector
10	Tube Cutter
11	Micron Pressure Gauge
12	Digital Pressure Gauges Set (High &Combine)
13	Pinch-Off Plier
14	Flaring and Swaging Tool Kit
15	Electric Hand Grinder
16	Vacuum Pump 2-Stage, 6cfm
17	Digital Clamp-On Ampere Meter
18	Digital Multi Meter
19	Electric Hand Drills

20	Screwdriver Set

Repair and Service Residential Refrigeration Units

Overview

This Competency Standard covers the competencies required to diagnose / repair / service residential refrigeration units at workplace in accordance with the manufacturer specifications / guidelines. This unit covers the knowledge regarding safety rules, Personal Protective Equipment, and international standards for repairing / servicing of residential refrigeration units to provide you the basis for student work.

Competency Units	*Performance Criteria*
1. Diagnose Faults in Residential Refrigeration Units	**P1.** Check for obvious problem to determine which component or system is causing the problem **P2.** Select tools, equipment and related accessories according to requirements and standards **P3.** Check power supply, electric wiring, electric / electronic components and refrigerant pressure to determine the exact problem by using AVO Meter / Gauge manifold as recommended by manufacturer and record the results **P4.** Eliminate the causes of the problem according to the manufacturer manual and standards **P5.** Isolate and recheck the causes of the problem and rectify the fault **P6.** Start the refrigeration unit and recheck as specified in the manufacturer manual and record the results
2. Repair Window / Split Air Conditioner	**P1.** Select tools, equipment and related accessories according to job requirements **P2.** Disconnect the Refrigerator / Freezer from electric supply and follow the instructions in manufacture manual for rectification **P3.** Rectify the diagnosed faults; repair / replace the components, as necessary **P4.** Check, wash and restore to the actual condition Refrigerator / Freezer Body / Cabinets **P5.** Check, service, and replace if necessary, the proper functioning of Thermostat / Door Gasket / Heaters **P6.** Switch on the Refrigerator / Freezer to check the performance of electrical/ electronic and mechanical components as specified in the manufacturer manual and record the results
3. Repair / Service Residential Electric Water Cooler / Water Dispenser	**P1.** Select tools, equipment and related accessories according to job requirements

	P2. Disconnect the water cooler / dispenser from electric supply and follow the manual instructions for rectification **P3.** Rectify the diagnosed faults; repair / replace the components, as necessary **P4.** Check, wash and restore to actual condition Water Cooler / Dispenser Body / Mounts **P5.** Switch on water cooler / dispenser to check the performance of electrical/ electronic and mechanical components as specified in the manufacturer manual and record the results

Knowledge and Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Ozone Protection and Synthetic Greenhouse Gas Management Act 1989
- Fundamental knowledge of HVACR, Electric and Electronics
- Techniques for repairing of Window / Split air conditioners
- Technical Operations of split air conditioners
- Electrical / Copper piping layout plans/wiring diagrams.
- Types of electrical wires and cables, including underground cables, their ratings and its applications
- Techniques of Diagnose and Troubleshooting of Residential Air conditioners
- Familiar with Residential Air conditioners error codes and solution
- Types of Motors used in Residential Air conditioners
- Types of Lubricants and their properties
- Capable to replace PCB Card
- Compressor types/ Specifications and applications
- Methods of Copper Tube cutting / Bending /Swaging / Flaring / Brazing / Jointing / fixing
- Gas welding (Soldering and Brazing)
- Types of Insulation and their applications
- Methods of Pressurizing/ Evacuation / Purging / Refrigerant charging
- Types of Refrigerant, its properties, recovery and reclaiming
- Record keeping and reporting

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

The candidate will demonstrate the following repair / service skills in a simulated Environment to provide evidence of competency:

- Diagnose faults of Refrigeration unit by using specified tools and instruments
- Check & Replace electrical accessories of unit
- Check & Replace the mechanical parts & accessories of the unit
- Charge the refrigerant in unit

List of Tools, Equipment and Machinery

Sr. No	*Description*
1	Personal Protective Equipment
2	Basic Measuring tools
3	Basic Hand tools
4	Basic Cutting tools
5	Basic Power tools
6	Basic Marking tools
7	Basic Electric tools
8	Portable Refrigerant Charging Station
9	Digital Air Flow / Velocity Meter
10	Water Pressure Gun for Service
11	Electronic Leak Detector
12	Tube Cutter
13	Digital Clamp-On Meter & AVO Meter
14	Micron Pressure Gauge
15	Digital Pressure Gauges Set (High &Combine)
16	Pinch-Off Plier

17	Flaring and Swaging Tool Kit
18	Vacuum Pump 2-Stage, 6cfm
19	Tube Benders (Spring Type and Pulley Bender Type)
21	Electric Hand Drills
22	Digital Capacitor Analyzer
23	Screwdriver Set

Test, recover, evacuate and charge refrigeration system

Overview

This Competency Standard covers the competencies required to test, recover and charge refrigeration system at workplace in accordance with the manufacturer's specifications / guidelines. This unit covers the knowledge regarding testing, recovering of refrigerants, evacuation and charging refrigeration system to provide you the basis for student work.

Competency Units	*Performance Criteria*
1. Assess refrigeration system operation	**P1.** Apply refrigeration system operating principles and terminology to assessment activities. **P2.** Obtain all relevant information and interpret correctly prior to the commencement of work on the refrigeration system. **P3.** Undertake refrigeration system checks safely in accordance with standard operating procedures, relevant codes and regulations. **P4.** Apply appropriate operating procedures as required. **P5.** Determine pressures and temperatures correctly and recorded. **P6.** Rectify faults
2. Recover refrigerant and evacuate system	**P1.** Recover the refrigerant from the system in accordance with standard operating procedures, codes and regulations. **P2.** Contain the refrigerant recovered from the refrigeration system in accordance with the relevant codes and regulations of ASHRAE. **P3.** Evacuate the refrigeration system in accordance with standard operating procedures, codes and regulations
3. Charge the refrigeration system	**P1.** Charge the refrigeration system with the correct refrigerant in accordance with standard operating procedures. **P2.** Add the appropriate lubricating oil to the refrigeration system in accordance with standard operating procedures. **P3.** Check the refrigeration system for leaks.

Knowledge and Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Ozone Protection and Synthetic Greenhouse Gas Management Act 1989
- Fundamental knowledge of HVACR, Electric and Electronics
- Techniques for repairing of Window / Split air conditioners
- Technical Operations of split air conditioners
- Electric circuit diagrams.
- Copper piping layout
- Types of electrical wires and cables, including underground cables, their ratings and its applications
- Techniques of Diagnose and Troubleshooting of Residential Air conditioners
- Familiar with Residential Air conditioners error codes and solution
- Types of Motors used in Residential Air conditioners
- Types of Lubricants and their properties
- Capable to replace PCB Card
- Compressor types/ Specifications and applications
- Methods of Copper Tube cutting / Bending /Swaging / Flaring / Brazing / Jointing / fixing
- Gas welding (Soldering and Brazing)
- Types of Insulation and their applications
- Methods of Pressurizing/ Evacuation / Purging / Refrigerant charging
- Types of Refrigerant, its properties, recovery and reclaiming
- Record keeping and reporting

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:
The candidate will demonstrate the following repair / service skills in a simulated Environment to provide evidence of competency:

- Recover refrigerant
- Leak testing & Repair leaks
- Evacuate system
- Purge and charge refrigerant

List of Tools, Equipment and Machinery

Sr. No	*Description*
1	Personal Protective Equipment
2	Basic Measuring tools
3	Basic Hand tools
4	Basic Cutting tools
5	Basic Power tools
6	Basic Marking tools
7	Basic Electric tools
8	Portable Refrigerant Charging Station
9	Digital Air Flow / Velocity Meter
10	Electronic Leak Detector
11	Tube Cutter

12	Digital Optical Tachometer
13	Micron Pressure Gauge
14	Digital Pressure Gauges Set (High &Combine)
15	Pinch-Off Plier
16	Flaring and Swaging Tool Kit
17	Vacuum Pump 2-Stage, 6cfm
18	Digital Clamp-On Ampere Meter
19	Digital Multi Meter
20	Electric Hand Drills
21	Hot Air Gun
22	Digital Capacitor Analyzer
23	Screwdriver Set

Calculate Psychrometric Processes of Air

Overview

This competency standard identifies the competencies required to identify and evaluate cool & heat Psychrometric processes of air. Students will be expected to calculate and evaluate Psychrometric processes according to the nature of work at workplace. His underpinning knowledge regarding calculation and evaluation of Psychrometric process will be sufficient to provide the basis for his work.

Competency Units	*Performance Criteria*
1. Identify cool Psychrometric processes of air	**P1.** Identify and mark the sensible cooling process on Psychrometric chart as per given reading. **P2.** Identify and mark the cooling and humidification process on Psychrometric chart as per given reading. **P3.** Identify and mark the cooling and dehumidification process on Psychrometric chart as per given reading. **P4.** Identify and mark the evaporative cooling process on Psychrometric chart as per given reading.

	P5. Identify and mark the air mixing process on Psychrometric chart as per given reading.
2. Identify heat Psychrometric properties of air.	**P1.** Identify and mark the Sensible heating process on Psychrometric chart as per given reading. **P2.** Identify and mark the heating and humidification process on Psychrometric chart as per given reading. **P3.** Identify and mark the heating and dehumidification process on Psychrometric chart as per given reading. **P4.** Identify and mark the air mixing process on Psychrometric chart as per given reading.
3. Evaluate Psychrometric properties.	**P1.** Calculate sensible heating and cooling properties. **P2.** Calculate cooling and dehumidification properties. **P3.** Calculate heating humidification properties. **P4.** Calculate evaporative cooling properties. **P5.** Calculate air mixing properties.

Knowledge and understanding

The trainee must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- Identification and use of Personal Protective Equipment (PPE)
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Psychrometric chart
- Sensible Cooling, Sensible Heating, humidification and dehumidification
- Air mixing process
- Heating and humidification
- Heating and dehumidification
- Calculation of evaporative cooling process
- Cooling and Humidification (Evaporative Cooling)
- Cooling and Dehumidification (Summer Cooling)

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Draw different processes on Psychrometric chart
- Calculate Cooling, Heating with Humidification & Dehumidification

List of Tools, Equipment and Machinery

Sr. No	*Description*
1.	Sling Psychrometer
2.	Psychrometric Chart
3.	Lead Pencil
4.	Foot rule
5.	Eraser
6.	Sharpener

Calculate Psychrometric Properties of System Air

Overview

This Competency Standard identifies the competencies required to draw and calculate Psychrometric properties of system air. Students will be expected to calculate Psychrometric properties of system air according to the nature of work at workplace. His underpinning knowledge regarding calculation of Psychrometric properties of system air will be sufficient to provide the basis for his work.

Competency Units	*Performance Criteria*
1. Calculate the Psychrometric properties of air.	**P1.** Calculate the relative humidity **P2.** Calculate the specific humidity **P3.** Calculate the specific enthalpy **P4.** Calculate the enthalpy **P5.** Calculate the specific volume **P6.** Calculate the volume of mixture per kg of dry air
2. Draw Psychrometric properties of air	**P1.** Draw dry bulb temperature line on Psychrometric chart. **P2.** Draw wet bulb temperature line on Psychrometric chart. **P3.** Draw dew point temperature line on Psychrometric chart. **P4.** Draw relative humidity curve on Psychrometric chart. **P1.** Draw specific humidity / humidity ration line on Psychrometric chart. **P2.** Draw saturation curve on Psychrometric chart. **P3.** Draw enthalpy line on Psychrometric chart. **P4.** Determine enthalpy deviation on Psychrometric chart. **P5.** Determine specific volume line on Psychrometric chart.
3. Calculate the properties of system air	**P1.** Calculate properties of air in heating or cooling process

	P2. Calculate the latent heat **P3.** Calculate the sensible heat **P4.** Calculate sensible heat factor **P5.** Calculate the properties of bypass return air **P6.** Calculate the properties of air in a duct

Knowledge and understanding

The trainee must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- Identification and use of Personal Protective Equipment (PPE)
- Hazards that are most likely to cause harm to health and safety with HVAC tools
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- Relative and specific humidity
- Enthalpy, specific volume and specific enthalpy
- Volume of mixture per kg of dry air
- Dry bulb temperature and wet bulb temperature
- Define humidification and de humidification
- Saturation and dew point temperature
- Calculation of enthalpy deviation and specific volume
- Heating and cooling processes of air
- Sensible heat factor / ratio
- Bypass return air
- Bypass factor
- Content factor
- Degree day

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Draw any two properties of air on Psychrometric chart
- Calculate all properties of air
- Calculate cooling & heating process

List of Tools, Equipment and Machinery

Sr. No	*Description*
1.	Sling Psychrometer

2.	Psychrometric Chart
3.	Lead Pencil
4.	Foot rule
5.	Eraser
6.	Sharpener

Develop Geometrical Solids

Overview

This Competency Standard identifies the competencies required to draw mechanical lines and surfaces, piping joints, duct / cone & transition and symbolic representations. Students will be expected to develop geometrical solids according to the nature of work at workplace. His underpinning knowledge regarding development of geometrical solids will be sufficient to provide the basis for his work.

Competency Units	*Performance Criteria*
1. Draw Mechanical lines and surfaces	**P1.** Draw straight lines and curved lines **P2.** Draw inclined and curved surfaces by parallel line and radial line method **P3.** Draw development of a cone by triangular method **P4.** Draw development of a cylinder by radial line method
2. Draw sketches of piping Joints	**P1.** Draw different types of joints **P2.** Draw Development of tea joint of a round pipe **P3.** Draw line of intersection for intersecting pipe
3. Draw sketches of Ducts, cone and transition pieces	**P1.** Draw different types of ducts **P2.** Draw truncated cone and pipe **P3.** Draw transition pieces used in pipes and ducts **P4.** Draw the development of rectangular duct **P5.** Draw the development of square duct **P6.** Draw development of truncated cone
4. Draw Symbolic Representation	**P1.** Draw symbols of HAVC components **P2.** Draw symbols of HAVC equipment **P3.** Draw sectioning symbols of different materials used in mechanical drawing

Knowledge and Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- Terms being used in drawing
- Application of drawing forms
- Scales used in drawing
- Fundamentals units i.e. arcs, circles and ellipse
- Single stroke and double stroke gothic letters
- Definitions of tolerance, limits and fits
- Layout and line drawing
- Development by a radial line method
- Pipe and duct joint
- Frustum of a cone
- Component symbols
- Complete detail of intersecting pipes

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Draw lines & shapes
- Make sketch for complex drawings
- Draw drawings for joints
- Draw specific symbols

List of Tools and Equipment

Sr. No	*Description*
1.	T-square
2.	Set square
3.	Compass
4.	Eraser
5.	Pencil
6.	Sharpener
7.	Drawing board

Draw Projection of Pipes

Overview

This Competency Standard identifies the competencies required to draw electric symbols, single- & double-line piping and orthographic projection of pipes. Students will be expected to draw projection of pipes according to the nature of work at workplace. His underpinning knowledge regarding drawings of projection pipes will be sufficient to provide the basis for his work.

Competency Units	*Performance Criteria*
1. Draw orthographic projection.	**P1.** Draw orthographic views of a square pipe **P2.** Draw orthographic views of a round pipe **P3.** Draw isometric view of square pipe **P4.** Draw isometric view of round pipe

2. Draw single- and double-line piping.	**P1.** Draw orthographic view of single line piping **P2.** Draw orthographic view of double line piping **P3.** Draw isometric view of single line piping **P4.** Draw isometric view of double line piping
3. Draw electrical symbols	**P1.** Draw complete drawing of electrical accessories **P2.** Draw working drawing of electrical accessories **P3.** Draw the symbolic representation of electrical accessories along with drawing

Knowledge and Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- Terms being used in drawing
- Application of drawing forms
- Scales used in drawing
- Fundamentals units i.e. arcs, circles and ellipse
- Single stroke and double stroke gothic letters
- Definitions of tolerance, limits and fits
- Layout and line drawing
- Orthographic drawing
- Isometric drawing
- Single line piping
- Double line piping
- Electrical symbols

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Draw different views of pipe
- Draw single line & double line piping system
- Draw specific symbols

List of Tools, Equipment and Machinery

Sr. No	*Description*
1.	T-square
2.	Set square
3.	Compass
4.	Eraser
5.	Pencil
6.	Sharpener
7.	Drawing board

Make Circuits Using Electronic Components

Overview:

This Competency Standard identifies the competencies required to make different types of Circuits using Electronics Components with the organization's approved guidelines and procedures. Student underpinning knowledge regarding basic electronics will be sufficient to provide the basis for this task.

Competency Units	*Performance Criteria*
1. Arrange tools/material for job	**P1.** Identify & collect tools and material as per job. **P2.** Prepare workplace for the job/task. **P3.** Prepare layouts/drawing for job/task **P4.** Arrange backup resources for lighting, power and safety purposes as per job requirement
2. Make rectifier circuit.	**P1.** Connect two diodes; make an "L" of their two ends marked with the white bands (cathodes). **P2.** Connect the remaining two diodes, this time with their ends having no bands (anodes) **P3.** Connect both sets of diodes according to the circuit diagram. **P4.** Verify the results that the circuit is converting complete cycle of AC supply into DC supply.
3. Make common emitter (CE) amplifier circuit.	**P1.** Connect the transistors according to circuit diagram. **P2.** Connect amplifier circuit to the power supply **P3.** Measure the input voltage (f=1 kHz). **P4.** Verify the output is 4Vpp at 1 kHz as compare to input.

4. Make DC motor speed control circuit.	**P1.** Connect the silicon-controlled rectifier (SCR) according to circuit diagram **P2.** Connect the dc motor with controlling circuit. **P3.** Connect the circuit to power supply. **P4.** Check and verify the circuit that speed of dc motor controlled properly
5. Make AC power control circuit.	**P1.** Connect the diac & triac according to circuit diagram. **P2.** Connect circuit to power source (AC supply). **P3.** Trigger the circuit at different positions of AC wave form **P4.** Check and verify the results that circuit is controlling AC power supply properly.
6. Make time delay circuit.	**P1** Connect the uni junction transistor (UJT) and SCR according to circuit diagram. **P2** Connect the circuit to power supply and adjust the power supply to 12V dc. **P3** Trigger the SCR through UJT to operational the circuit. **P4** Verify that by increase in resistance should change the time delay period longer. **P5** Verify that by decrease in resistance should change the time delay period shorter.

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- Definition and identification of diodes and its working.
- Theory of transformer
- Tools, equipment and materials required for the job
- Install equipment according to circuit diagram.
- Interpretation of drawings and circuit diagrams; soldering
- Testing procedures and equipment
- Describe SCR and its operation as dc motor power control.
- Working of diac and triac, and its application.
- Definition and working of UJT as time delay circuit.
- Working and operation of oscilloscope.
- Record keeping and reporting

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Draw circuit diagrams
- Make circuit on PCB
- Connect components by soldering
- Operate circuit

LIST OF TOOLS, EQUIPMENT AND MACHINERY

Sr. No	Description
1	Personal protective equipment. (PPE)
2	Diodes
3	Bread board
4	Jumper wires or leads.
5	Electric iron
6	Rosin paste
7	Soldering wire
8	Transistors
9	Oscilloscope
10	Silicone controlled rectifies. (SCRs)
11	DC motor
12	Power supply
13	Diac
14	Triac
15	Transformer
16	Uni junction transistors. (UJT)
17	Time delay relay

18	Plier
19	Cutter
20	Screwdriver
21	Voltmeter
22	Ampere meter
23	Frequency meter.