

National Occupational Skill Standard (NOSS)

Occupational Title : Refrigeration and Air Conditioning Mechanic

Level : 3

Sector : Mechanical

Sub - Sector : Refrigeration and Air Conditioning

NOSS ID/NSCO ID :

ISCO NO :



Council for Technical Education and Vocational Training

NATIONAL SKILL TESTING BOARD

Madhyapur Thimi-17, Sanothimi, Bhaktapur, Nepal

Developed: 25-05-2023 (11-02-2080)



2045

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Approved by the Tripartite National Skill Testing Board. 1993



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The National Occupational Skill Standard Developed by:

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Recommended by Mechanical Technical Sub Committee: 25 May 2023 (11 Jestha 2080)



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1	Occupational Title: Refrigeration and Air Conditioning Mechanic Level: 3
2	Job Description: Refrigeration and Air Conditioning Mechanic L-3, repairs and maintains automobile air conditioning system; installs, repairs and maintains Variable Refrigerant Flow (VRF) air conditioning system; installs, repairs and maintains Air Handling Unit (AHU)/Fan Coil Unit (FCU); installs, repairs and maintains stationary refrigeration system; repairs and maintains transport refrigeration system.
3	UNITS OF COMPETENCY: <ol style="list-style-type: none"> 1. Repair and maintain automobile air conditioning system 2. Install, repair and maintain Variable Refrigerant Flow (VRF) air conditioning system 3. Install, repair and maintain Air Handling Unit (AHU)/Fan Coil Unit (FCU) 4. Install, repair and maintain stationary refrigeration system 5. Repair and maintain transport refrigeration system 6. Perform communication 7. Develop professionalism <p><i>*Note: Units 6 and 7 are not for testing purpose.</i></p>
4	Qualifying Notes/Prerequisites: <ul style="list-style-type: none"> • Physical Requirements: Sound health • Entry Requirements: As per NSTB rules Additional Information: <ul style="list-style-type: none"> • Assessment Types: Performance and written test • Assessment Duration: 8 to 10 Hours (Single Competency: Refrigeration or Air conditioning system) 16 to 18 hours (Full Competency) • Recommended Group Size: 3 to 5 candidates



5	Unit No:1		Unit code:	
	Unit Title: Repair and maintain automobile air conditioning system			
	Elements of competency	Performance standards		
	1.1 Prepare tools, equipment and materials	1.1.1 Personal protective equipment (PPE) used in accordance with task requirement. 1.1.2 Tools and equipment collected as per task requirement. 1.1.3 Materials collected and prepared as per task requirement.		
1.2 Estimate cost	1.2.1 Materials required for servicing/repair listed. 1.2.2 Servicing/repair cost calculated as per industry norms. 1.2.3 Client informed about estimated cost and risk factor.			
1.3 Service air conditioning system	1.3.1 Air conditioning system inspected through general inspection and testing . 1.3.2 Components and accessories of air conditioning unit cleaned, inspected and lubricated as per preventive maintenance schedule. 1.3.3 Refrigerant lines and drain lines checked for abnormal condition and fixed. 1.3.4 Control box, electrical wiring and connection checked and tightened. 1.3.5 Damaged or worn-out components and accessories replaced in specific time interval as per manufacturer's instruction. 1.3.6 Refrigerant system leak tested, evacuated and charged with correct amount of refrigerant. 1.3.7 Performance of air conditioning system checked and adjusted as per manufacturer's instruction. 1.3.8 Servicing details recorded as per industry norms.			



	<p>1.4 Repair air conditioning system</p>	<p>1.4.1 Faulty history collected from clients and recorded as per industry norms.</p> <p>1.4.2 Electrical parameters measured and verified against manufacturer's specification.</p> <p>1.4.3 Fault in air conditioning identified through general inspection and testing.</p> <p>1.4.4 Air conditioning system disassembled sequentially as per manufacturer's specification and components tagged.</p> <p>1.4.5 Components of air conditioning system inspected, cleaned and foreign materials removed.</p> <p>1.4.6 Refrigerant recovered and stored according to standard procedure.</p> <p>1.4.7 Damaged components repaired or replaced with new components of correct specification.</p> <p>1.4.8 Air conditioning system reassembled as per manufacturer's specification.</p> <p>1.4.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>1.4.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>1.4.11 Post repair testing carried out as per the checklist.</p>
	<p>1.5 Clean workplace</p>	<p>1.5.1 Unused materials collected and stored in designated area.</p> <p>1.5.2 Tools and equipment cleaned, checked for damage and stored in designated area.</p> <p>1.5.3 Workplace cleaned neatly and waste disposed as per 3R's principle in designated area.</p>
<p>6</p>	<p>Task Performance Requirements (Tools, equipment, and materials):</p> <ul style="list-style-type: none"> Automobile air conditioning system, screwdriver set, spanner set, knife, silicone, silicone gun, socket wrench set, Allen key, fin comb, pliers, 	



	<p>circlip pliers, wire stripper, phase tester, multimeter, measuring tape, steel ruler, file set, hacksaw, hammer, adjustable wrench, scissor, Nitrogen gas cylinder with regulator, pipe/tube cutter, spirit level, sealant, chisel set, micron gauge, hand grinder, center punch, tube bender, drill machine with drill bit set, ratchet, electric air blower, mallet, pipe wrench, vacuum pump, gauge manifold, flaring and swaging tool kit, electronic leak detector, water pressure gun, soldering iron, de-soldering tool, oxy-acetylene brazing set, side mirror, lock ring tool, clamp-on ampere meter, reamer, torch, nozzle, weighing scale, charging unit, refrigerant, compressor oil, thermometer, refrigerant recovery unit, tachometer, megger, anemometer, sound meter, ladder, extension cord, dust bin, dust pan, flare nuts, insulating materials, brazing rod, brazing flux, emery paper, brush, cleaning agent, cotton rag, lubricants, pen, paper, register, broom, first aid kit, and personal protective equipment (PPE).</p>
<p>7</p>	<p>Safety and Hygiene (Occupational Health and Safety):</p> <ul style="list-style-type: none"> • Use personal protective equipment. • Safe handling of materials, tools and equipment. • Hazards involved in lifting tools, equipment, and materials. • Prevent from chemical, electrical and pressure related hazards. • Prevent from hazards involved in handling refrigerants. • Protect work area while working with Hydro carbon. • Make sure the work area is well ventilated. • Evacuate system before brazing and de-brazing.



8	Required Knowledge		
	Technical Knowledge	Applied Calculation	Graphical Information
	<ul style="list-style-type: none"> • Tools, equipment, and materials <ul style="list-style-type: none"> ○ Types ○ Uses ○ Preparation ○ Safe handling • Automobile air conditioning system <ul style="list-style-type: none"> ○ Mechanical components and their function ○ Electrical and electronic components and their function ○ Dismantling and assembling process ○ Insulation and cleaning process ○ Servicing techniques ○ Common faults/defects ○ Electrical testing procedure ○ Mechanical testing procedure ○ Troubleshooting technique • Preventive maintenance <ul style="list-style-type: none"> ○ Maintaining electrical system ○ Maintaining mechanical system 	<ul style="list-style-type: none"> • Perform conversion of refrigeration unit • Estimate cost of installation, servicing and repair 	<ul style="list-style-type: none"> • Read and interpret electric circuit and drawing • Read and interpret workshop manual • Read and interpret manufacturer's specification



	<ul style="list-style-type: none"> • Refrigerant <ul style="list-style-type: none"> ○ Types ○ Evacuation ○ Charging ○ Recovery ○ Pressure temperature relationship of refrigerants • Ozone depleting substances, refrigerant and environmental issues • Basic automotive related to air conditioning system • Costing and estimation • Record keeping • Waste management • Occupational health and safety rules and regulations 		
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9	Assessment of Competency				
Unit: 1					
Unit Title: Repair and maintain automobile air conditioning system					
Candidate Details			Assessors Detail		
Candidate's Name:			Assessors' Name		ID/License No:
Registration Number:			1.		
Symbol No:			2.		
Test Centre:			3.		
Test Date:					
Element of competency	Performance Standards	Standard Met	Standard Not Met	Evidence Type	Comments
1.1 Prepare tools, equipment and materials	1.1.1 Personal protective equipment (PPE) used in accordance with task requirement.				
	1.1.2 Tools and equipment collected as per task requirement.				
	1.1.3 Materials collected and prepared as per task requirement.				
1.2 Estimate cost	1.2.1 Materials required for servicing/repair listed.				
	1.2.2 Servicing/repair cost calculated as per industry norms.				
	1.2.3 Client informed about estimated cost and risk factor.				
1.3 Service air conditioning system	1.3.1 Air conditioning system inspected through general inspection and testing.				
	1.3.2 Components and accessories of air conditioning unit cleaned, inspected and lubricated as per preventive				



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	<p>maintenance schedule.</p> <p>1.3.3 Refrigerant lines and drain lines checked for abnormal condition and fixed.</p> <p>1.3.4 Control box, electrical wiring and connection checked and tightened.</p> <p>1.3.5 Damaged or worn-out components and accessories replaced in specific time interval as per manufacturer's instruction.</p> <p>1.3.6 Refrigerant system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>1.3.7 Performance of air conditioning system checked and adjusted as per manufacturer's instruction.</p> <p>1.3.8 Servicing details recorded as per industry norms.</p>				
<p>1.4 Repair air conditioning system</p>	<p>1.4.1 Faulty history collected from clients and recorded as per industry norms.</p> <p>1.4.2 Electrical parameters measured and verified against manufacturer's specification.</p> <p>1.4.3 Fault in air conditioning identified through general inspection and testing.</p> <p>1.4.4 Air conditioning system disassembled sequentially as per manufacturer's specification and components tagged.</p>				



	<p>1.4.5 Components of air conditioning system inspected, cleaned and foreign materials removed.</p> <p>1.4.6 Refrigerant recovered and stored according to standard procedure.</p> <p>1.4.7 Damaged components repaired or replaced with new components of correct specification.</p> <p>1.4.8 Air conditioning system reassembled as per manufacturer's specification.</p> <p>1.4.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>1.4.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>1.4.11 Post repair testing carried out as per the checklist.</p>				
<p>1.5 Clean workplace</p>	<p>1.5.1 Unused materials collected and stored in designated area.</p> <p>1.5.2 Tools and equipment cleaned, checked for damage and stored in designated area.</p> <p>1.5.3 Workplace cleaned neatly and waste disposed as per 3R's principle in designated area.</p>				

WT- Written Test

OQ- Oral Question

PT- Practical Test

DO – Direct Observation

SR- Supervisor’s report

SN–Simulation

RP- Role Play

PG –Photographs

VD- Video

CT – Certificates

TS – Testimonials (Reward)

PP – Product Produced

CS – Case Study



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Range Statement

Variable	Range
Personal protective equipment (PPE)	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Helmet • Mask • Apron • Goggles • Gloves • Safety shoes • Ear plug • Welding face shield
General inspection and testing	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Abnormal noise • Physical damage • Leakage • Clog • Temperature • Pressure • Current • Air flow • Refrigerant flow • Refrigerant level • Oil level



	<ul style="list-style-type: none"> • Vibration • RPM • Insulation • Resistance • Continuity • Smoke • Humidity
<p>Components and accessories</p>	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Compressor • Condenser • Evaporator • Expansion device • Pulley assembly • Auto controller • Receiver cum filter dryer • Vibration absorber • Valves • Sight glass • Liquid receiver • Pressure cut out switch • Operating switch • Refrigerant lines and drain lines • Electrical components: fuse, relay, control circuit, wire harness, cables



<p>Electrical parameters</p>	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Voltage • Resistance • Continuity • Current • Capacitance • Voltage drop • Short circuit • Open circuit
<p>3R's principle</p>	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Reduce • Reuse • Recycle



5	Unit No:2 Unit Title: Install, maintain and repair Variable Refrigerant Flow (VRF) air conditioning system	Unit code:
	Elements of competency	Performance standards
2.1 Prepare tools and equipment	2.1.1 Personal protective equipment (PPE) used in accordance with task requirement. 2.1.2 Tools and equipment collected as per task requirement. 2.1.3 Materials collected and prepared as per task requirement.	
2.2 Estimate cost	2.2.1 Materials required for installation/repair listed. 2.2.2 Installation/repair cost calculated as per industry norms. 2.2.3 Client informed about estimated cost and risk factor.	
2.3 Install VRF system	2.3.1 Installation requirement for VRF System inspected and prepared as per manufacturer's instruction. 2.3.2 Location of indoor and outdoor units identified and marked as per drawing. 2.3.3 Plumbing works and electrical works checked, prepared and supervised as per the manufacturer's requirement. 2.3.4 Refrigerant pipeline tested using dry Nitrogen and the entire system evacuated as per manufacturer's instruction. 2.3.5 Indoor unit and outdoor unit installed in marked location. 2.3.6 Refrigerant system tested using dry Nitrogen and the entire system evacuated as per manufacturer's instruction. 2.3.7 Electrical connection connected to the respective power supply as per wiring diagram. 2.3.8 Additional refrigerant required calculated based on pipe length and charged as per	



		<p>manufacturer's instruction.</p> <p>2.3.9 VRF system operated and tested for proper functioning.</p> <p>2.3.10 Service data recorded as per industry norms.</p>
	<p>2.4 Service VRF system</p>	<p>2.4.1 VRF system inspected through general inspection and testing.</p> <p>2.4.2 Components and accessories of VRF system cleaned, inspected and lubricated as per preventive maintenance schedule.</p> <p>2.4.3 Refrigerant lines and drain lines checked for abnormal condition and fixed.</p> <p>2.4.4 Control box, electrical wiring and connection checked and tightened.</p> <p>2.4.5 Damaged or worn-out components and accessories replaced in specific time interval as per manufacturer's instruction.</p> <p>2.4.6 Temperature and defrost settings checked and adjusted.</p> <p>2.4.7 Refrigerant system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>2.4.8 Operation of VRF system checked for proper functioning and adjusted as per manufacturer's instruction.</p> <p>2.4.9 Servicing details recorded as per industry norms.</p>
	<p>2.5 Repair VRF system</p>	<p>2.5.1 Faulty history collected from clients and recorded as per industry norms.</p> <p>2.5.2 Electrical parameters measured and verified against wiring diagram.</p> <p>2.5.3 Fault in VRF system identified through general inspection and testing.</p> <p>2.5.4 VRF system disassembled sequentially as per manufacturer's specification and components tagged.</p>



		<p>2.5.5 Electrical problems fixed as per circuit diagram.</p> <p>2.5.6 Controls and settings checked and adjusted.</p> <p>2.5.7 Refrigerant recovered and stored according to standard procedure.</p> <p>2.5.8 Defective components repaired or replaced with new components of correct specification.</p> <p>2.5.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>2.5.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>2.5.11 Post repair testing carried out as per the checklist.</p>
	2.6 Clean workplace	<p>2.6.1 Unused materials collected and stored in designated area.</p> <p>2.6.2 Tools and equipment cleaned, checked for damage and stored in designated area.</p> <p>2.6.3 Workplace cleaned neatly and waste disposed as per 3R's principle in designated area.</p>
6	<p>Task Performance Requirements (Tools, equipment, and materials):</p> <ul style="list-style-type: none"> VRF system, screwdriver set, spanner set, knife, silicone, silicone gun, socket wrench set, Allen key, fin comb, pliers, circlip pliers, wire stripper, phase tester, multimeter, measuring tape, steel ruler, file set, hacksaw, hammer, adjustable wrench, scissor, Nitrogen gas cylinder with regulator, recovery unit with cylinder, pipe/tube cutter, spirit level, sealant, chisel set, micron gauge, hand grinder, center punch, tube bender, drill machine with drill bit set, ratchet, electric air blower, mallet, pipe wrench, vacuum pump, gauge manifold, flaring and swaging tool kit, electronic leak detector, water pressure gun, soldering iron, de-soldering tool, oxy-acetylene brazing set, side mirror, lock ring tool, clamp-on ampere meter, reamer, torch, nozzle, weighing scale, refrigerant, charging unit, vacuum cleaner, thermometer, refrigerant recovery unit, tachometer, megger, anemometer, sound meter, ladder, extension cord, dust bin, dust pan, flare nuts, insulating materials, brazing rod, 	



	<p>brazing flux, emery paper, cleaning cover bag, brush, cleaning agent, cotton rag, lubricants, pen, paper, register, broom, first aid kit, and personal protective equipment (PPE).</p>
7	<p>Safety and Hygiene (Occupational Health and Safety):</p> <ul style="list-style-type: none"> • Use personal protective equipment. • Safe handling of materials, tools and equipment. • Hazards involved in lifting tools, equipment, and materials. • Prevent from chemical, electrical and pressure related hazards. • Prevent from hazards involved in handling refrigerants. • Protect work area while working with Hydro carbon. • Make sure the work area is well ventilated. • Evacuate system before brazing and de-brazing.



8	Required Knowledge		
	Technical Knowledge	Applied Calculation	Graphical Information
	<ul style="list-style-type: none"> • Tools, equipment, and materials <ul style="list-style-type: none"> ○ Types ○ Uses ○ Preparation ○ Safe handling • Fundamentals of HVAC system • Variable Refrigerant Flow (VRF) air conditioning system <ul style="list-style-type: none"> ○ Concept of VRF technology and its benefits ○ Types ○ Key components and their function ○ Working principles ○ Installation and design consideration ○ Refrigeration cycle and components ○ Control system and operations • Preventive maintenance <ul style="list-style-type: none"> ○ Maintaining electrical system ○ Maintaining mechanical system ○ Servicing technique • Repair and maintenance 	<ul style="list-style-type: none"> • Perform conversion of refrigeration unit • Estimate cost of installation, servicing and repair 	<ul style="list-style-type: none"> • Read and interpret electric circuit and drawing • Read and interpret workshop manual • Read and interpret manufacturer's specification



- Common faults/defects
- Electrical testing procedure
- Mechanical testing procedure
- Diagnostic and troubleshooting technique
- System commissioning and performance testing
- Safety consideration
- Refrigerant
 - Types
 - Evacuation
 - Charging
 - Recovery
 - Pressure temperature relationship of refrigerants
- Ozone depleting substances, refrigerant and environmental issues
- Fundamentals of plumbing
- Types of pipes
- Fundamentals of electrical and electronics
- Costing and estimation
- Record keeping
- Waste management
- Occupational health and safety rules and regulations



9	Assessment of Competency				
Unit: 2					
Unit Title: Service, maintain and repair Variable Refrigerant Flow (VRF) air conditioning system					
Candidate Details			Assessors Detail		
Candidate's Name:			Assessors' Name		ID/License No:
Registration Number:			1.		
Symbol No:			2.		
Test Centre:			3.		
Test Date:					
Element of competency	Performance Standards	Standard Met	Standard Not Met	Evidence Type	Comments
2.1 Prepare tools and equipment	2.1.1 Personal protective equipment (PPE) used in accordance with task requirement.				
	2.1.2 Tools and equipment collected as per task requirement.				
	2.1.3 Materials collected and prepared as per task requirement.				
2.2 Estimate cost	2.2.1 Materials required for installation/repair listed.				
	2.2.2 Installation/repair cost calculated as per industry norms.				
	2.2.3 Client informed about estimated cost and risk factor.				
2.3 Install VRF system	2.3.1 Installation requirement for VRF System inspected and prepared as per manufacturer's instruction.				
	2.3.2 Location of indoor and outdoor units identified and marked as per drawing.				



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	<p>2.3.3 Plumbing works and electrical works checked, prepared and supervised as per the manufacturer's requirement.</p> <p>2.3.4 Refrigerant pipeline tested using dry Nitrogen and the entire system evacuated as per manufacturer's instruction.</p> <p>2.3.5 Indoor unit and outdoor unit installed in marked location.</p> <p>2.3.6 Refrigerant system tested using dry Nitrogen and the entire system evacuated as per manufacturer's instruction.</p> <p>2.3.7 Electrical connection connected to the respective power supply as per wiring diagram.</p> <p>2.3.8 Additional refrigerant required calculated based on pipe length and charged as per manufacturer's instruction.</p> <p>2.3.9 VRF system operated and tested for proper functioning.</p> <p>2.3.10 Service data recorded as per industry norms.</p>				
<p>2.4 Service VRF system</p>	<p>2.4.1 VRF system inspected through general inspection and testing.</p> <p>2.4.2 Components and accessories of VRF system cleaned, inspected and lubricated as per preventive maintenance schedule.</p> <p>2.4.3 Refrigerant lines and drain lines checked for abnormal condition and fixed.</p> <p>2.4.4 Control box, electrical wiring and connection checked and</p>				



	<p>tightened.</p> <p>2.4.5 Damaged or worn-out components and accessories replaced in specific time interval as per manufacturer's instruction.</p> <p>2.4.6 Temperature and defrost settings checked and adjusted.</p> <p>2.4.7 Refrigerant system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>2.4.8 Operation of VRF system checked for proper functioning and adjusted as per manufacturer's instruction.</p> <p>2.4.9 Servicing details recorded as per industry norms.</p>				
<p>2.5 Repair VRF system</p>	<p>2.5.1 Faulty history collected from clients and recorded as per industry norms.</p> <p>2.5.2 Electrical parameters measured and verified against wiring diagram.</p> <p>2.5.3 Fault in VRF system identified through general inspection and testing.</p> <p>2.5.4 VRF system disassembled sequentially as per manufacturer's specification and components tagged.</p> <p>2.5.5 Electrical problems fixed as per circuit diagram.</p> <p>2.5.6 Controls and settings checked and adjusted.</p> <p>2.5.7 Refrigerant recovered and stored according to standard</p>				



	<p>procedure.</p> <p>2.5.8 Defective components repaired or replaced with new components of correct specification.</p> <p>2.5.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>2.5.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>2.5.11 Post repair testing carried out as per the checklist.</p>				
2.6 Clean workplace	<p>2.6.1 Unused materials collected and stored in designated area.</p> <p>2.6.2 Tools and equipment cleaned, checked for damage and stored in designated area.</p> <p>2.6.3 Workplace cleaned neatly and waste disposed as per 3R's principle in designated area.</p>				

WT- Written Test

OQ- Oral Question

PT- Practical Test

DO – Direct Observation

SR- Supervisor’s report

SN–Simulation

RP- Role Play

PG –Photographs

VD- Video

CT – Certificates

TS – Testimonials (Reward)

PP – Product Produced

CS – Case Study



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Range Statement

Variable	Range
Personal protective equipment (PPE)	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Helmet • Mask • Apron • Goggles • Gloves • Safety shoes • Ear plug • Welding face shield
Plumbing works	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Pipe cutting • Pipe insulation • Pipe laying/hanging • Pipe connection • Piping support • Welding/Brazing • Flushing
Electrical works	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Communication/electrical wire cutting • laying • Wire connection



	<ul style="list-style-type: none"> • Installing power socket • Installing panel board • Installing control and protective device
<p>General inspection and testing</p>	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Abnormal noise • Physical damage • Leakage • Clog • Temperature • Pressure • Current • Air flow • Refrigerant flow • Refrigerant level • Vibration • RPM • Insulation • Resistance • Continuity • Smoke • Humidity • Error code
<p>Components and accessories</p>	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Compressor • Condenser



	<ul style="list-style-type: none"> • Evaporator • Expansion device • Auto controller • Receiver • Filter dryer • Vibration absorber • Valves • Sight glass • Liquid receiver • Pressure cut out switch • Operating switch • Refrigerant lines and drain lines • Electrical components: fuse, relay, control circuit, wire harness, cables
Electrical parameters	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Voltage • Resistance • Continuity • Current • Capacitance • Voltage drop • Short circuit • Open circuit
3R's principle	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Reduce • Reuse • Recycle



5	Unit No:3 Unit Title: Install, maintain and repair Air Handling Unit (AHU)/Fan Coil Unit (FCU)	Unit code:
	Elements of competency	Performance standards
	3.1 Prepare tools and equipment	3.1.1 Personal protective equipment (PPE) used in accordance with task requirement. 3.1.2 Tools and equipment collected as per task requirement. 3.1.3 Materials collected and prepared as per task requirement.
	3.2 Estimate cost	3.2.1 Materials required for installation/repair listed. 3.2.2 Installation/repair cost calculated as per industry norms. 3.2.3 Client informed about estimated cost and risk factor.
	3.3 Install direct expansion air handling unit (DX AHU)	3.3.1 Installation requirement for DX AHU inspected and prepared as per manufacturer's instruction. 3.3.2 Plumbing works and electrical works checked, prepared and supervised as per the manufacturer's requirement. 3.3.3 DX AHU installed as per manufacturer's instruction. 3.3.4 Refrigerant pipeline tested using dry Nitrogen and the entire system evacuated as per manufacturer's instruction. 3.3.5 Electrical connection connected to the respective power supply as per wiring diagram. 3.3.6 Additional refrigerant required calculated based on pipe length and charged as per manufacturer's instruction. 3.3.7 DX AHU system operated and tested for proper functioning. 3.3.8 Service data recorded as per industry norms.



	<p>3.4 Install chilled/hot water AHU/FCU</p>	<p>3.4.1 Installation requirement for chilled/hot water AHU/FCU inspected and prepared as per manufacturer's instruction.</p> <p>3.4.2 Plumbing works and electrical works checked, prepared and supervised as per the manufacturer's requirement.</p> <p>3.4.3 Chilled/hot water system AHU/FCU installed as per manufacturer's instruction.</p> <p>3.4.4 Water pressure of entire system tested as per manufacturer's instruction.</p> <p>3.4.5 Electrical connection connected to the respective power supply as per wiring diagram.</p> <p>3.4.6 Chilled/hot water AHU/FCU system operated and tested for proper functioning.</p> <p>3.4.7 Service data recorded as per industry norms.</p>
	<p>3.5 Service AHU/FCU</p>	<p>3.5.1 DX AHU/AHU/FCU inspected through general inspection and testing.</p> <p>3.5.2 Components and accessories of DX AHU/AHU/FCU cleaned, inspected and lubricated as per preventive maintenance schedule.</p> <p>3.5.3 Refrigerant lines and drain lines checked for abnormal condition and fixed.</p> <p>3.5.4 Control box, electrical wiring and connection checked and tightened.</p> <p>3.5.5 Damaged or worn-out components and accessories replaced in specific time interval as per manufacturer's instruction.</p> <p>3.5.6 Temperature settings checked and adjusted.</p> <p>3.5.7 Refrigerant system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>3.5.8 Operation of DX AHU/AHU/FCU checked for proper functioning and adjusted as per manufacturer's instruction.</p>



		3.5.9 Servicing details recorded as per industry norms.
	3.6 Repair AHU/FCU	<p>3.6.1 Faulty history collected from clients and recorded as per industry norms.</p> <p>3.6.2 Electrical parameters measured and verified against wiring diagram.</p> <p>3.6.3 Fault in DX AHU/AHU/FCU identified through general inspection and testing.</p> <p>3.6.4 DX AHU/AHU/FCU disassembled sequentially as per manufacturer's specification and components tagged.</p> <p>3.6.5 Electrical problems fixed as per circuit diagram.</p> <p>3.6.6 Controls and settings checked and adjusted.</p> <p>3.6.7 Refrigerant recovered and stored according to standard procedure.</p> <p>3.6.8 Defective components repaired or replaced with new components of correct specification.</p> <p>3.6.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>3.6.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>3.6.11 Post repair testing carried out as per the checklist.</p>
	3.7 Perform site clearance	<p>3.7.1 Unused materials are collected and stored in designated area.</p> <p>3.7.2 Tools and equipment are cleaned, checked for damage and stored in designated area.</p> <p>3.7.3 Worksite cleaned neatly and waste disposed as per 3R's principle in designated area.</p>
6	Task Performance Requirements (Tools, equipment, and materials): <ul style="list-style-type: none"> DX AHU, Chilled/hot water AHU, FCU, screwdriver set, spanner set, knife, silicone, silicone gun, socket wrench set, Allen key, fin comb, pliers, 	



	<p>wire stripper, phase tester, multimeter, measuring tape, steel ruler, file set, hacksaw, hammer, adjustable wrench, scissor, Nitrogen gas cylinder with regulator, recovery unit with cylinder, pipe/tube cutter, spirit level, sealant, chisel set, micron gauge, hand grinder, center punch, tube bender, drill machine with drill bit set, ratchet, electric air blower, mallet, pipe wrench, vacuum pump, gauge manifold, flaring and swaging tool kit, electronic leak detector, water pressure gun, soldering iron, de-soldering tool, oxy-acetylene brazing set, side mirror, lock ring tool, clamp-on ampere meter, reamer, torch, nozzle, weighing scale, refrigerant, charging unit, vacuum cleaner, thermometer, dust bin, dust pan, flare nuts, insulating materials, brazing rod, brazing flux, emery paper, tachometer, megger, anemometer, sound meter, ladder, extension cord, 3 way motorized valve, brush, cleaning agent, cotton rag, lubricants, pen, paper, register, broom, first aid kit, and personal protective equipment (PPE).</p>
<p>7</p>	<p>Safety and Hygiene (Occupational Health and Safety):</p> <ul style="list-style-type: none"> • Use personal protective equipment. • Safe handling of materials, tools and equipment. • Hazards involved in lifting tools, equipment, and materials. • Prevent from chemical, electrical and pressure related hazards. • Prevent from hazards involved in handling refrigerants. • Protect work area while working with Hydro carbon. • Make sure the work area is well ventilated. • Evacuate system before brazing and de-brazing.



8	Required Knowledge		
	Technical Knowledge	Applied Calculation	Graphical Information
	<ul style="list-style-type: none"> • Tools, equipment, and materials <ul style="list-style-type: none"> ○ Types ○ Uses ○ Preparation ○ Safe handling • Fundamentals of HAVC system • Air Handling Unit (AHU)/Fan Coil Unit (FCU) <ul style="list-style-type: none"> ○ Introduction ○ Types ○ Key components and their function ○ Working principles ○ Air distribution and ventilation ○ Installation and design consideration ○ Refrigeration cycle and components ○ Control system and operations • Preventive maintenance <ul style="list-style-type: none"> ○ Maintaining electrical system ○ Maintaining mechanical system ○ Servicing technique 	<ul style="list-style-type: none"> • Perform conversion of refrigeration unit • Estimate cost of installation, servicing and repair 	<ul style="list-style-type: none"> • Read and interpret electric circuit and drawing • Read and interpret workshop manual • Read and interpret manufacturer's specification



	<ul style="list-style-type: none"> • Repair and maintenance <ul style="list-style-type: none"> ○ Common faults/defects ○ Electrical testing procedure ○ Mechanical testing procedure ○ Diagnostic and troubleshooting technique ○ System commissioning and performance testing ○ Safety consideration • Refrigerant <ul style="list-style-type: none"> ○ Types ○ Evacuation ○ Charging ○ Recovery ○ Pressure temperature relationship of refrigerants • Fundamentals of plumbing • Types of pipes • Fundamentals of electrical and electronics • Ozone depleting substances, refrigerant and environmental issues • Costing and estimation • Record keeping • Waste management • Occupational health and safety rules and regulations 		
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9	Assessment of Competency				
Unit: 3					
Unit Title: Install, maintain and repair Air Handling Unit (AHU)/Fan Coil Unit (FCU)					
Candidate Details			Assessors Detail		
Candidate's Name:			Assessors' Name		ID/License No:
Registration Number:			1.		
Symbol No:			2.		
Test Centre:			3.		
Test Date:					
Element of competency	Performance Standards	Standard Met	Standard Not Met	Evidence Type	Comments
3.1 Prepare tools and equipment	3.1.1 Personal protective equipment (PPE) used in accordance with task requirement.				
	3.1.2 Tools and equipment collected as per task requirement.				
	3.1.3 Materials collected and prepared as per task requirement.				
3.2 Estimate cost	3.2.1 Materials required for installation/repair listed.				
	3.2.2 Installation/repair cost calculated as per industry norms.				
	3.2.3 Client informed about estimated cost and risk factor.				
3.3 Install direct expansion air handling unit (DX AHU)	3.3.1 Installation requirement for DX AHU inspected and prepared as per manufacturer's instruction.				
	3.3.2 Plumbing works and electrical works checked, prepared and supervised as per the manufacturer's requirement.				



	<p>3.3.3 DX AHU installed as per manufacturer's instruction.</p> <p>3.3.4 Refrigerant pipeline tested using dry Nitrogen and the entire system evacuated as per manufacturer's instruction.</p> <p>3.3.5 Electrical connection connected to the respective power supply as per wiring diagram.</p> <p>3.3.6 Additional refrigerant required calculated based on pipe length and charged as per manufacturer's instruction.</p> <p>3.3.7 DX AHU system operated and tested for proper functioning.</p> <p>3.3.8 Service data recorded as per industry norms.</p>				
<p>3.4 Install chilled/hot water AHU/FCU</p>	<p>3.4.1 Installation requirement for chilled/hot water AHU/FCU inspected and prepared as per manufacturer's instruction.</p> <p>3.4.2 Plumbing works and electrical works checked, prepared and supervised as per the manufacturer's requirement.</p> <p>3.4.3 Chilled/hot water system AHU/FCU installed as per manufacturer's instruction.</p> <p>3.4.4 Water pressure of entire system tested as per manufacturer's instruction.</p> <p>3.4.5 Electrical connection connected to the respective power supply as per wiring diagram.</p> <p>3.4.6 Chilled/hot water AHU/FCU system operated and tested</p>				



	for proper functioning.				
	3.4.7 Service data recorded as per industry norms.				
3.5 Service AHU/FCU	<p>3.5.1 DX AHU/AHU/FCU inspected through general inspection and testing.</p> <p>3.5.2 Components and accessories of DX AHU/AHU/FCU cleaned, inspected and lubricated as per preventive maintenance schedule.</p> <p>3.5.3 Refrigerant lines and drain lines checked for abnormal condition and fixed.</p> <p>3.5.4 Control box, electrical wiring and connection checked and tightened.</p> <p>3.5.5 Damaged or worn-out components and accessories replaced in specific time interval as per manufacturer's instruction.</p> <p>3.5.6 Temperature settings checked and adjusted.</p> <p>3.5.7 Refrigerant system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>3.5.8 Operation of DX AHU/AHU/FCU checked for proper functioning and adjusted as per manufacturer's instruction.</p> <p>3.5.9 Servicing details recorded as per industry norms.</p>				



<p>3.6 Repair AHU/FCU</p>	<p>3.6.1 Faulty history collected from clients and recorded as per industry norms.</p> <p>3.6.2 Electrical parameters measured and verified against wiring diagram.</p> <p>3.6.3 Fault in DX AHU/AHU/FCU identified through general inspection and testing.</p> <p>3.6.4 DX AHU/AHU/FCU disassembled sequentially as per manufacturer's specification and components tagged.</p> <p>3.6.5 Electrical problems fixed as per circuit diagram.</p> <p>3.6.6 Controls and settings checked and adjusted.</p> <p>3.6.7 Refrigerant recovered and stored according to standard procedure.</p> <p>3.6.8 Defective components repaired or replaced with new components of correct specification.</p> <p>3.6.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>3.6.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>3.6.11 Post repair testing carried out as per the checklist.</p>				
<p>3.7 Perform site clearance</p>	<p>3.7.1 Unused materials are collected and stored in designated area.</p>				



	<p>3.7.2 Tools and equipment are cleaned, checked for damage and stored in designated area.</p> <p>3.7.3 Worksite cleaned neatly and waste disposed as per 3R's principle in designated area.</p>				
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WT- Written Test

OQ- Oral Question

PT- Practical Test

DO – Direct Observation

SR- Supervisor’s report

SN–Simulation

RP- Role Play

PG –Photographs

VD- Video

CT – Certificates

TS – Testimonials (Reward)

PP – Product Produced

CS – Case Study



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Range Statement

Variable	Range
Personal protective equipment (PPE)	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Helmet • Mask • Apron • Goggles • Gloves • Safety shoes • Ear plug • Welding face shield
Plumbing works	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Pipe cutting • Pipe insulation • Pipe laying/hanging • Pipe connection • Piping support • Welding/brazing • Flushing
Electrical works	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Communication/electrical wire cutting • laying • Wire connection



	<ul style="list-style-type: none"> • Installing power socket • Installing panel board • Installing control and protective device
General inspection and testing	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Abnormal noise • Physical damage • Leakage • Clog • Temperature • Pressure • Current • Air flow • Refrigerant flow • Refrigerant level • Oil level • Vibration • RPM • Insulation • Resistance • Continuity • Smoke • Humidity
Components and accessories	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Compressor • Condenser



	<ul style="list-style-type: none"> • Evaporator • Expansion device • Pulley assembly • Auto controller • Receiver • Filter dryer • Vibration absorber • Valves • Sight glass • Liquid receiver • Pressure cut out switch • Operating switch • Refrigerant lines and drain lines • Fan blower • Air filter • Coil • Damper • Humidifier • Water pump • Electrical components: fuse, relay, control circuit, wire harness, cables
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Electrical parameters	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Voltage • Resistance • Continuity • Current • Capacitance
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	<ul style="list-style-type: none"> • Voltage drop • Short circuit • Open circuit
3R's principle	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Reduce • Reuse • Recycle



5	Unit No:4		Unit code:
	Unit Title: Install, repair and maintain stationary refrigeration system		
	Elements of competency	Performance standards	
	4.1 Prepare tools and equipment	4.1.1 Personal protective equipment (PPE) used in accordance with task requirement. 4.1.2 Tools and equipment collected as per task requirement. 4.1.3 Materials collected and prepared as per task requirement.	
4.2 Estimate cost	4.2.1 Materials required for installation/repair listed. 4.2.2 Installation/repair cost calculated as per industry norms. 4.2.3 Client informed about estimated cost and risk factor.		
4.3 Install instant chiller	4.3.1 Installation requirement for instant chiller inspected and prepared as per manufacturer's instruction. 4.3.2 Location of units identified and marked as per drawing. 4.3.3 Plumbing works and electrical works checked and supervised as per the manufacturer's requirement. 4.3.4 Water cooled condenser with cooling tower installed and connected with piping system as per drawing and manufacturer's specification. 4.3.5 Chilled water pump installed and connected with piping system. 4.3.6 Water pipeline tested for leakage. 4.3.7 Electrical connection connected to the respective power supply as per wiring diagram. 4.3.8 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN). 4.3.9 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.		



		<p>4.3.10 Instant chiller operated and tested for proper functioning.</p> <p>4.3.11 Service data recorded as per industry norms.</p>
	<p>4.4 Install Ice Bank Tank (IBT)</p>	<p>4.4.1 Installation requirement for IBT inspected and prepared as per manufacturer's instruction.</p> <p>4.4.2 Compressor, condenser and IBT placed separately on a prepared concrete foundations as per manufacturer's instruction and drawings.</p> <p>4.4.3 Plumbing works and electrical works checked and supervised as per the manufacturer's requirement.</p> <p>4.4.4 Water cooled condenser with cooling tower installed and connected with piping system as per drawing and manufacturer's specification.</p> <p>4.4.5 Chilled water pump installed and connected with piping system.</p> <p>4.4.6 Water pipeline tested for leakage.</p> <p>4.4.7 Refrigeration system pipelines insulated and connected as per manufacturer instructions.</p> <p>4.4.8 Electrical connection connected to the respective power supply as per wiring diagram.</p> <p>4.4.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.4.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.4.11 IBT operated and tested for proper functioning.</p> <p>4.4.12 Service data recorded as per industry norms.</p>



	<p>4.5 Install DX bulk milk cooler tank/milk chilling vat</p>	<p>4.5.1 Bulk milk cooler tank placed on level surface with easy access for loading milk and maintaining slope towards outlet for unloading milk.</p> <p>4.5.2 Bulk milk cooler components installed as per manufacturer's instruction.</p> <p>4.5.3 Refrigeration lines air tightly insulated without exposing copper lines.</p> <p>4.5.4 Electrical connection connected to the respective power supply as per circuit diagram.</p> <p>4.5.5 Stainless steel works supervised and connected to bulk milk cooler.</p> <p>4.5.6 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.5.7 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.5.8 Bulk milk cooler operated and tested for its proper functioning with water/milk.</p> <p>4.5.9 Service data recorded as per industry norms.</p>
	<p>4.6 Install walk in cold room refrigeration unit</p>	<p>4.6.1 Site checked and prepared as per design layout and specification.</p> <p>4.6.2 Walk in cold room panels assembled as per manufacturer's instruction and installed on the required position with proper alignment.</p> <p>4.6.3 Openings sealed tightly using sealing materials without air leak.</p> <p>4.6.4 Refrigeration system components and pressure relief damper installed as per manufacturer's instruction.</p> <p>4.6.5 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.6.6 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.6.7 Refrigeration system tested for normal functioning and required parameter level</p>



		checked to ensure that they are within the required range.
		4.6.8 Service data recorded as per industry norms.
4.7	Install ice cream freezer	<p>4.7.1 Installation requirement for ice cream freezer inspected and prepared as per manufacturer's instruction.</p> <p>4.7.2 Plumbing works and electrical works checked and supervised as per the manufacturer's requirement.</p> <p>4.7.3 Water cooled condenser with cooling tower installed and connected with piping system as per drawing and manufacturer's specification.</p> <p>4.7.4 Water pipeline tested for leakage.</p> <p>4.7.5 Air compressor installed and connected with air pipelines.</p> <p>4.7.6 Stainless steel pipelines connected with intake of ice cream freezer.</p> <p>4.7.7 Electrical connection connected to the respective power supply as per wiring diagram.</p> <p>4.7.8 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.7.9 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.7.10 Ice cream freezer operated and tested for proper functioning.</p> <p>4.7.11 Service data recorded as per industry norms.</p>
4.8	Service refrigeration system	<p>4.8.1 Refrigeration system inspected through general inspection and testing.</p> <p>4.8.2 Components and accessories of refrigeration system cleaned, inspected and lubricated as per preventive maintenance schedule.</p> <p>4.8.3 Refrigerant lines and drain lines checked for abnormal condition and fixed.</p>



		<p>4.8.4 Control box, electrical wiring and connection checked and tightened.</p> <p>4.8.5 Damaged or worn-out components and accessories replace in specific time interval as per manufacturer's instruction.</p> <p>4.8.6 Temperature and defrost settings checked and adjusted.</p> <p>4.8.7 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.8.8 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.8.9 Operation of refrigeration system checked for proper functioning and adjusted as per manufacturer's instruction.</p> <p>4.8.10 Servicing details recorded as per industry norms.</p>
	<p>4.9 Repair refrigeration system</p>	<p>4.9.1 Faulty history collected from clients and recorded as per industry norms.</p> <p>4.9.2 Electrical parameters measured and verified against wiring diagram.</p> <p>4.9.3 Fault in refrigeration system identified through general inspection and testing.</p> <p>4.9.4 Refrigeration system disassembled sequentially as per manufacturer's specification and components tagged.</p> <p>4.9.5 Electrical problems fixed as per circuit diagram.</p> <p>4.9.6 Controls and settings checked and adjusted.</p> <p>4.9.7 Refrigerant recovered and stored according to standard procedure.</p> <p>4.9.8 Defective components repaired or replaced with new components of correct specification.</p> <p>4.9.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p>



		4.9.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant. 4.9.11 Post repair testing carried out as per the checklist.
	4.10 Clean workplace	4.10.1 Unused materials are collected and stored in designated area. 4.10.2 Tools and equipment are cleaned, checked for damage and stored in designated area. 4.10.3 Workplace and window unit cleaned neatly and waste disposed as per 3R's principle in designated area.

6	<p>Task Performance Requirements (Tools, equipment, and materials):</p> <ul style="list-style-type: none"> Instant chiller, ice bank tank, DX bulk milk cooler tank, walk in cold room refrigeration unit, ice cream freezer, screwdriver set, spanner set, knife, silicone, silicone gun, socket wrench set, Allen key, fin comb, pliers, circlip pliers, wire stripper, phase tester, multimeter, megger, measuring tape, steel ruler, file set, hacksaw, hammer, adjustable wrench, scissor, Nitrogen gas cylinder with regulator, recovery unit with cylinder, pipe/tube cutter, spirit level, sealant, chisel set, micron gauge, hand grinder, center punch, tube bender, drill machine with drill bit set, ratchet, electric air blower, mallet, pipe wrench, vacuum pump, gauge manifold, flaring and swaging tool kit, electronic leak detector, water pressure gun, soldering iron, de-soldering tool, oxy-acetylene brazing set, side mirror, lock ring tool, clamp-on ampere meter, reamer, torch, nozzle, weighing scale, refrigerant, charging unit, vacuum cleaner, thermometer, dust bin, dust pan, flare nuts, insulating materials, brazing rod, brazing flux, emery paper, tachometer, anemometer, sound meter, ladder, extension cord, brush, cleaning agent, cotton rag, lubricants, pen, paper, register, broom, first aid kit, and personal protective equipment (PPE). 	
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7	<p>Safety and Hygiene (Occupational Health and Safety):</p> <ul style="list-style-type: none"> Use personal protective equipment. Safe handling of materials, tools and equipment. 	
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- Hazards involved in lifting tools, equipment, and materials.
- Prevent from chemical, electrical and pressure related hazards.
- Prevent from hazards involved in handling refrigerants.
- Protect work area while working with Hydro carbon.
- Make sure the work area is well ventilated.
- Evacuate system before brazing and de-brazing.



8	Required Knowledge		
	Technical Knowledge	Applied Calculation	Graphical Information
	<ul style="list-style-type: none"> • Tools, equipment, and materials: <ul style="list-style-type: none"> ○ Introduction ○ Types ○ Preparation ○ Safe handling • Fundamentals of refrigeration system • Types of refrigeration system • Principles of operation of cooling tower • Instant chiller <ul style="list-style-type: none"> ○ Introduction to chiller system ○ Types of chillers and their capacity ○ Key components and their function ○ Working principles ○ Installation and design consideration ○ Refrigeration cycle and components ○ Installation technique and process • Ice Bank Tank <ul style="list-style-type: none"> ○ Introduction ○ Types 	<ul style="list-style-type: none"> • Perform conversion of refrigeration unit • Estimate cost of installation, servicing and repair 	<ul style="list-style-type: none"> • Read and interpret electric circuit and drawing • Read and interpret workshop manual • Read and interpret manufacturer's specification



- Key components and their function
- Working principles
- Installation and design consideration
- Installation technique and process
- Bulk milk cooler tank
 - Introduction
 - Types
 - Key components and their function
 - Working principles
 - Installation and design consideration
 - Installation technique and process
 - Cleaning process
- Walk in cold room refrigeration unit
 - Introduction
 - Types
 - Key components and their function
 - Working principles
 - Installation and design consideration
 - Installation technique and process
- Ice cream freezer
 - Introduction



- Types
- Key components and their function
- Working principles
- Installation and design consideration
- Installation technique and process
- Preventive maintenance
 - Maintaining electrical system
 - Maintaining mechanical system
 - Servicing technique
- Repair and maintenance
 - Common faults/defects
 - Electrical testing procedure
 - Mechanical testing procedure
 - Diagnostic and troubleshooting technique
 - System commissioning and performance testing
 - Safety consideration
- Refrigerant
 - Types
 - Evacuation
 - Charging
 - Recovery



	<ul style="list-style-type: none"> ○ Pressure temperature relationship of refrigerants • Types of compressor oil • Fundamentals of plumbing • Types of pipes • Fundamentals of electrical and electronics • Costing and estimation • Ozone depleting substances, refrigerant and environmental issues • Record keeping • Waste management • Occupational health and safety rules and regulations 		
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9	Assessment of Competency				
Unit: 4					
Unit Title: Service, maintain and repair stationary refrigeration system					
Candidate Details			Assessors Detail		
Candidate's Name:			Assessors' Name		ID/License No:
Registration Number:			1.		
Symbol No:			2.		
Test Centre:			3.		
Test Date:					
Element of competency	Performance Standards	Standard Met	Standard Not Met	Evidence Type	Comments
4.1 Prepare tools and equipment	4.1.1 Personal protective equipment (PPE) used in accordance with task requirement.				
	4.1.2 Tools and equipment collected as per task requirement.				
	4.1.3 Materials collected and prepared as per task requirement.				
4.2 Estimate cost	4.2.1 Materials required for installation/repair listed.				
	4.2.2 Installation/repair cost calculated as per industry norms.				
	4.2.3 Client informed about estimated cost and risk factor.				
4.3 Install instant chiller	4.3.1 Installation requirement for instant chiller inspected and prepared as per manufacturer's instruction.				
	4.3.2 Location of units identified and marked as per drawing.				
	4.3.3 Plumbing works and electrical works checked and				



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	<p>supervised as per the manufacturer's requirement.</p> <p>4.3.4 Water cooled condenser with cooling tower installed and connected with piping system as per drawing and manufacturer's specification.</p> <p>4.3.5 Chilled water pump installed and connected with piping system.</p> <p>4.3.6 Water pipeline tested for leakage.</p> <p>4.3.7 Electrical connection connected to the respective power supply as per wiring diagram.</p> <p>4.3.8 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.3.9 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.3.10 Instant chiller operated and tested for proper functioning.</p> <p>4.3.11 Service data recorded as per industry norms.</p>				
<p>4.4 Install Ice Bank Tank (IBT)</p>	<p>4.4.1 Installation requirement for IBT inspected and prepared as per manufacturer's instruction.</p> <p>4.4.2 Compressor, condenser and IBT placed separately on a prepared concrete foundations as per manufacturer's instruction and drawings.</p> <p>4.4.3 Plumbing works and electrical works checked and</p>				



	<p>supervised as per the manufacturer's requirement.</p> <p>4.4.4 Water cooled condenser with cooling tower installed and connected with piping system as per drawing and manufacturer's specification.</p> <p>4.4.5 Chilled water pump installed and connected with piping system.</p> <p>4.4.6 Water pipeline tested for leakage.</p> <p>4.4.7 Refrigeration system pipelines insulated and connected as per manufacturer instructions.</p> <p>4.4.8 Electrical connection connected to the respective power supply as per wiring diagram.</p> <p>4.4.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.4.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.4.11 IBT operated and tested for proper functioning.</p> <p>4.4.12 Service data recorded as per industry norms.</p>				
<p>4.5 Install DX bulk milk cooler tank/milk chilling vat</p>	<p>4.5.1 Bulk milk cooler tank placed on level surface with easy access for loading milk and maintaining slope towards outlet for unloading milk.</p> <p>4.5.2 Bulk milk cooler components installed as per</p>				



	<p>manufacturer's instruction.</p> <p>4.5.3 Refrigeration lines air tightly insulated without exposing copper lines.</p> <p>4.5.4 Electrical connection connected to the respective power supply as per circuit diagram.</p> <p>4.5.5 Stainless steel works supervised and connected to bulk milk cooler.</p> <p>4.5.6 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.5.7 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.5.8 Bulk milk cooler operated and tested for its proper functioning with water/milk.</p> <p>4.5.9 Service data recorded as per industry norms.</p>				
<p>4.6 Install walk in cold room refrigeration unit</p>	<p>4.6.1 Site checked and prepared as per design layout and specification.</p> <p>4.6.2 Walk in cold room panels assembled as per manufacturer's instruction and installed on the required position with proper alignment.</p> <p>4.6.3 Openings sealed tightly using sealing materials without air leak.</p>				



	<p>4.6.4 Refrigeration system components and pressure relief damper installed as per manufacturer's instruction.</p> <p>4.6.5 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.6.6 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.6.7 Refrigeration system tested for normal functioning and required parameter level checked to ensure that they are within the required range.</p> <p>4.6.8 Service data recorded as per industry norms.</p>				
<p>4.7 Install ice cream freezer</p>	<p>4.7.1 Installation requirement for ice cream freezer inspected and prepared as per manufacturer's instruction.</p> <p>4.7.2 Plumbing works and electrical works checked and supervised as per the manufacturer's requirement.</p> <p>4.7.3 Water cooled condenser with cooling tower installed and connected with piping system as per drawing and manufacturer's specification.</p> <p>4.7.4 Water pipeline tested for leakage.</p> <p>4.7.5 Air compressor installed and connected with air pipelines.</p> <p>4.7.6 Stainless steel pipelines connected with intake of ice cream freezer.</p>				



	<p>4.7.7 Electrical connection connected to the respective power supply as per wiring diagram.</p> <p>4.7.8 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.7.9 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.7.10 Ice cream freezer operated and tested for proper functioning.</p> <p>4.7.11 Service data recorded as per industry norms.</p>				
<p>4.8 Service refrigeration system</p>	<p>4.8.1 Refrigeration system inspected through general inspection and testing.</p> <p>4.8.2 Components and accessories of refrigeration system cleaned, inspected and lubricated as per preventive maintenance schedule.</p> <p>4.8.3 Refrigerant lines and drain lines checked for abnormal condition and fixed.</p> <p>4.8.4 Control box, electrical wiring and connection checked and tightened.</p> <p>4.8.5 Damaged or worn-out components and accessories replace in specific time interval as per manufacturer's instruction.</p>				



	<p>4.8.6 Temperature and defrost settings checked and adjusted.</p> <p>4.8.7 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.8.8 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.8.9 Operation of refrigeration system checked for proper functioning and adjusted as per manufacturer's instruction.</p> <p>4.8.10 Servicing details recorded as per industry norms.</p>				
<p>4.9 Repair refrigeration system</p>	<p>4.9.1 Faulty history collected from clients and recorded as per industry norms.</p> <p>4.9.2 Electrical parameters measured and verified against wiring diagram.</p> <p>4.9.3 Fault in refrigeration system identified through general inspection and testing.</p> <p>4.9.4 Refrigeration system disassembled sequentially as per manufacturer's specification and components tagged.</p> <p>4.9.5 Electrical problems fixed as per circuit diagram.</p> <p>4.9.6 Controls and settings checked and adjusted.</p> <p>4.9.7 Refrigerant recovered and stored according to standard procedure.</p>				



	<p>4.9.8 Defective components repaired or replaced with new components of correct specification.</p> <p>4.9.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>4.9.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>4.9.11 Post repair testing carried out as per the checklist.</p>				
4.10 Clean workplace	<p>4.10.1 Unused materials are collected and stored in designated area.</p> <p>4.10.2 Tools and equipment are cleaned, checked for damage and stored in designated area.</p> <p>4.10.3 Workplace and window unit cleaned neatly and waste disposed as per 3R's principle in designated area.</p>				

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Range Statement

Variable	Range
Personal protective equipment (PPE)	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Helmet • Mask • Apron • Goggles • Gloves • Safety shoes • Ear plug • Welding face shield
Plumbing works	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Pipe cutting • Pipe insulation • Pipe laying/hanging • Pipe connection • Pipe support • Welding/brazing • Flushing
Electrical works	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Communication/electrical wire cutting • laying • Wire connection



	<ul style="list-style-type: none"> • Installing power socket • Installing panel board • Installing control and protective device
<p>General inspection and testing</p>	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Abnormal noise • Physical damage • Leakage • Clog • Temperature • Pressure • Current • Air flow • Refrigerant flow • Refrigerant level • Oil level • Vibration • RPM • Insulation • Resistance • Continuity • Smoke • Humidity • Error code
<p>Components and accessories</p>	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Compressor



	<ul style="list-style-type: none"> • Condenser • Evaporator • Expansion device • Thermometer • Thermostat • Oil separator • Refrigeration lines and drain lines • Fan blade and motor • Filter drier • Insulation • Door accessories • Receiver • Pressure cut out switch • Operating switch • Sight glass • Solenoid valve • Suction filter • Accumulator • Electrical components: fuse, relay, control circuit, wire harness, cables
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Electrical parameters	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Voltage • Resistance • Continuity • Current • Capacitance • Voltage drop
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	<ul style="list-style-type: none"> • Short circuit • Open circuit
3R's principle	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Reduce • Reuse • Recycle



5	Unit No: 5		Unit code:		
	Unit Title: Repair and maintain transport refrigeration system				
	Elements of competency		Performance standards		
	5.1 Prepare tools, equipment and materials		5.1.1	Personal protective equipment (PPE) used in accordance with task requirement.	
5.1.2			Tools and equipment prepared as per task requirement.		
5.1.3			Materials collected and prepared as per task requirement.		
5.2 Estimate cost		5.2.1	Materials required for installation/repair listed.		
		5.2.2	Installation/repair cost calculated as per industry norms.		
		5.2.3	Client informed about estimated cost and risk factor.		
5.3 Service refrigeration system		5.3.1	Refrigeration system inspected through general inspection and testing .		
		5.3.2	Components and accessories of refrigeration unit cleaned, inspected and lubricated as per preventive maintenance schedule.		
		5.3.3	Refrigerant lines and drain lines checked for abnormal condition and fixed.		
		5.3.4	Control box, electrical wiring and connection checked and tightened.		
		5.3.5	Damaged or worn-out components and accessories replaced in specific time interval as per manufacturer's instruction.		
		5.3.6	Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).		
		5.3.7	Refrigerant system leak tested, evacuated and charged with correct amount of refrigerant.		
		5.3.8	Performance of refrigeration unit checked and adjusted as per manufacturer's instruction.		
		5.3.9	Servicing details recorded as per industry norms.		



	5.4 Repair refrigeration system	<p>5.4.1 Fault history collected from clients and recorded as per industry norms.</p> <p>5.4.2 Electrical parameters measured and verified against manufacturer's specification.</p> <p>5.4.3 Fault in refrigeration system identified through general inspection and testing.</p> <p>5.4.4 Refrigeration system disassembled sequentially as per manufacturer's specification and components tagged.</p> <p>5.4.5 Components of refrigeration system inspected, cleaned and foreign materials removed.</p> <p>5.4.6 Refrigerant recovered and stored according to standard procedure.</p> <p>5.4.7 Damaged components repaired or replaced with new components of correct specification.</p> <p>5.4.8 Refrigeration system reassembled as per manufacturer's specification.</p> <p>5.4.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>5.4.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>5.4.11 Post repair testing carried out as per the checklist.</p>
	5.5 Clean workplace	<p>5.5.1 Unused materials collected and stored in designated area.</p> <p>5.5.2 Tools and equipment cleaned, checked for damage and stored in designated area.</p> <p>5.5.3 Workplace cleaned neatly and waste disposed as per 3R's principle in designated area.</p>
6	<p>Task Performance Requirements (Tools, equipment, and materials):</p> <ul style="list-style-type: none"> Transport refrigeration system, screwdriver set, spanner set, knife, silicone, silicone gun, socket wrench set, Allen key, fin comb, pliers, circlip pliers, wire stripper, phase tester, multimeter, megger, measuring tape, steel ruler, file set, hacksaw, hammer, adjustable wrench, scissor, 	



	<p>Nitrogen gas cylinder with regulator, recovery unit with cylinder, pipe/tube cutter, spirit level, sealant, chisel set, micron gauge, hand grinder, center punch, tube bender, drill machine with drill bit set, ratchet, electric air blower, mallet, pipe wrench, vacuum pump, gauge manifold, flaring and swaging tool kit, electronic leak detector, water pressure gun, soldering iron, de-soldering tool, oxy-acetylene brazing set, side mirror, lock ring tool, clamp-on ampere meter, reamer, torch, nozzle, weighing scale, refrigerant, charging unit, vacuum cleaner, thermometer, dust bin, dust pan, flare nuts, insulating materials, brazing rod, brazing flux, emery paper, tachometer, anemometer, sound meter, ladder, extension cord, brush, cleaning agent, cotton rag, lubricants, pen, paper, register, broom, first aid kit, and personal protective equipment (PPE).</p>
<p>7</p>	<p>Safety and Hygiene (Occupational Health and Safety):</p> <ul style="list-style-type: none"> • Use personal protective equipment. • Safe handling of materials, tools and equipment. • Hazards involved in lifting tools, equipment, and materials. • Prevent from chemical, electrical and pressure related hazards. • Prevent from hazards involved in handling refrigerants. • Protect work area while working with Hydro carbon. • Make sure the work area is well ventilated. • Evacuate system before brazing and de-brazing.



8	Required Knowledge		
	Technical Knowledge	Applied Calculation	Graphical Information
	<ul style="list-style-type: none"> • Tools, equipment, and materials <ul style="list-style-type: none"> ○ Types ○ Uses ○ Preparation ○ Safe handling • Transport refrigeration system <ul style="list-style-type: none"> ○ Mechanical components and their function ○ Electrical and electronic components and their function ○ Dismantling and assembling process ○ Insulation and cleaning process ○ Servicing techniques ○ Common faults/defects ○ Electrical testing procedure ○ Mechanical testing procedure ○ Troubleshooting technique • Preventive maintenance <ul style="list-style-type: none"> ○ Maintaining electrical system ○ Maintaining mechanical system 	<ul style="list-style-type: none"> • Perform conversion of refrigeration unit • Estimate cost of installation, servicing and repair 	<ul style="list-style-type: none"> • Read and interpret electric circuit and drawing • Read and interpret workshop manual • Read and interpret manufacturer's specification



	<ul style="list-style-type: none"> • Refrigerant <ul style="list-style-type: none"> ○ Types ○ Evacuation ○ Charging ○ Recovery ○ Pressure temperature relationship of refrigerants • Ozone depleting substances, refrigerant and environmental issues • Basic automotive related to refrigeration system • Costing and estimation • Record keeping • Waste management • Occupational health and safety rules and regulations 		
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9	Assessment of Competency				
Unit: 5					
Unit Title: Repair and maintain transport refrigeration system					
Candidate Details			Assessors Detail		
Candidate's Name:			Assessors' Name		ID/License No:
Registration Number:			1.		
Symbol No:			2.		
Test Centre:			3.		
Test Date:					
Element of competency	Performance Standards	Standard Met	Standard Not Met	Evidence Type	Comments
5.1 Prepare tools, equipment and materials	5.1.1 Personal protective equipment (PPE) used in accordance with task requirement.				
	5.1.2 Tools and equipment prepared as per task requirement.				
	5.1.3 Materials collected and prepared as per task requirement.				
5.2 Estimate cost	5.2.1 Materials required for installation/repair listed.				
	5.2.2 Installation/repair cost calculated as per industry norms.				
	5.2.3 Client informed about estimated cost and risk factor.				
5.3 Service refrigeration system	5.3.1 Refrigeration system inspected through general inspection and testing.				
	5.3.2 Components and accessories of refrigeration unit cleaned, inspected and lubricated as per preventive maintenance				



	<p>schedule.</p> <p>5.3.3 Refrigerant lines and drain lines checked for abnormal condition and fixed.</p> <p>5.3.4 Control box, electrical wiring and connection checked and tightened.</p> <p>5.3.5 Damaged or worn-out components and accessories replaced in specific time interval as per manufacturer's instruction.</p> <p>5.3.6 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>5.3.7 Refrigerant system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>5.3.8 Performance of refrigeration unit checked and adjusted as per manufacturer's instruction.</p> <p>5.3.9 Servicing details recorded as per industry norms.</p>				
<p>5.4 Repair refrigeration system</p>	<p>5.4.1 Fault history collected from clients and recorded as per industry norms.</p> <p>5.4.2 Electrical parameters measured and verified against manufacturer's specification.</p> <p>5.4.3 Fault in refrigeration system identified through general inspection and testing.</p>				



	<p>5.4.4 Refrigeration system disassembled sequentially as per manufacturer's specification and components tagged.</p> <p>5.4.5 Components of refrigeration system inspected, cleaned and foreign materials removed.</p> <p>5.4.6 Refrigerant recovered and stored according to standard procedure.</p> <p>5.4.7 Damaged components repaired or replaced with new components of correct specification.</p> <p>5.4.8 Refrigeration system reassembled as per manufacturer's specification.</p> <p>5.4.9 Refrigeration system flushed with Oxygen Free Dry Nitrogen (OFDN).</p> <p>5.4.10 Refrigeration system leak tested, evacuated and charged with correct amount of refrigerant.</p> <p>5.4.11 Post repair testing carried out as per the checklist.</p>				
5.5 Clean workplace	<p>5.5.1 Unused materials collected and stored in designated area.</p> <p>5.5.2 Tools and equipment cleaned, checked for damage and stored in designated area.</p> <p>5.5.3 Workplace cleaned neatly and waste disposed as per 3R's principle in designated area.</p>				

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Range Statement

Variable	Range
Personal protective equipment (PPE)	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Helmet • Mask • Apron • Goggles • Gloves • Safety shoes • Ear plug • Welding face shield
General inspection and testing	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Abnormal noise • Physical damage • Leakage • Clog • Temperature • Pressure • Current • Air flow • Refrigerant flow • Refrigerant level • Oil level



	<ul style="list-style-type: none"> • Vibration • RPM • Insulation • Resistance • Continuity • Smoke • Humidity
<p>Components and accessories</p>	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Compressor • Condenser • Evaporator • Expansion device • Refrigeration accessories: defrost solenoid, filter dryer, vibration absorber, valves, sight glass, oil separator, liquid receiver, suction accumulator, pressure cut out switch, operation switch, gasket, fans, AC/DC motors • Refrigerant lines and drain lines • Pulley assembly • Electrical components: fuse, relay, control circuit, wire harness, cables • Curtain • Door accessories
<p>Electrical parameters</p>	<p><i>May include but not limited to:</i></p> <ul style="list-style-type: none"> • Voltage • Resistance • Continuity • Current



	<ul style="list-style-type: none"> • Capacitance • Voltage drop • Short circuit • Open circuit
3R's principle	<p><i>May include but are not limited to:</i></p> <ul style="list-style-type: none"> • Reduce • Reuse • Recycle

