TECHNICAL &
VOCATIONAL
EDUCATION &
TRAINING
AUTHORITY

National Competency Standard for Refrigeration and Air Conditioning Mechanic

Standard Code: FNA02s08V1

PREFACE

The ADB Loan 2028 MLD, Employment Skills Training Project's (ESTP) objective is to increase the number of Maldivians, men and women, actively participating in the labor force, employed and self-employed. The Project will support the expansion of demand driven employment-oriented skills training in priority occupations and improve the capacity to develop and deliver Competency Based Skill Training (CBST). The Project aims to (i) provide youth with employment-oriented skills training; (ii) improve public perception of training and employment in locally available skills-oriented occupations; (iii) make available employment-related information to more Maldivians; and (iv) strengthen the capacity for labor administration and for labor market analysis.

The objective of the project is to deliver CBST programs to satisfy employer demand-driven needs. The National Competency Standards (NCS) provide the base for this training. Initially training will be focused on five key sectors: tourism, fisheries and agriculture, transport, construction and the social sectors. These sectors are included as priority sectors in the national development plan and play a vital role in the continued economic growth of the country.

The NCS are developed in consultation with Employment Sector Councils representing employers. They are designed using a consensus format endorsed by the Maldives Accreditation Board (MAB) to maintain uniformity of approach and the consistency of content amongst occupations. This single format also simplifies benchmarking the NCS against relevant regional and international standards.

NCS specify the standards of performance of a competent worker and the various contexts in which the work may take place. NCS also describes the knowledge, skills and attitudes required in a particular occupation. They provide explicit advice to assessors and employers regarding the knowledge, skills and attitudes to be demonstrated by the candidates seeking formal recognition for the competency acquired following training or through work experience. By sharing this information, all participants in the training process have the same understanding of the training required and the standard to be reached for certification. Certification also becomes portable and can be recognized by other employers and in other countries with similar standards.

NCS are the foundation for the implementation of the Technical and Vocational Education and Training (TVET) system in Maldives. They ensure that all skills, regardless of where or how they were developed can be assessed and recognized. They also form the foundation for certifying skills in the Maldives National Qualification Framework (MNQF).

Ncs are developed by the tvet section of ministry of higher education. The ncs are endorsed by the Employment Sector Councils of the respective sectors and validated by the MQA.

KEY FOR CODING

Coding Competency Standards and Related Materials

DESCRIPTION	REPRESENTED BY
Industry Sector as per ESC (Three letters)	Construction Sector **(CON)** Fisheries and Agriculture Sector **(FNA)** Transport sector **(TRN)** Tourism Sector **(TOU)** Social Sector **(SOC)** Foundation **(FOU)**
Competency Standard	**S**
Occupation with in a industry Sector	**Two digits 01-99**
Unit	**U**
Common Competency	**1**
Core Competency	**2**
Optional/ Elective Competency	**3**
Assessment Resources Materials	**A**
Learning Resources Materials	**L**
Curricula	**C**
Qualification	**Q1, Q2 etc**
MNQF level of Qualification	**L1, L2 etc**
Version Number	**V1, V2 etc**
Year of endorsement of standard, qualification	**By two digits Example- 07**

1. Endorsement Application for Qualification 01	
2. NATIONAL CERTIFICATE III IN REFRIGERATION AND AIR CONDITIONING MECHANIC	
3. Qualification code: FNA02SQ1L307	**Total Number of Credits 58**
4. Purpose of the qualification To certify that the holder of this qualification has acquired the competencies listed in section 5	
5. Regulations for the qualification	National Certificate III in Refrigeration and Air Conditioning (domestic) Mechanic will be awarded to those who are competent in units 1+2+3+4

6. Schedule of Units

Unit Title	Unit Title	Code
1	Perform installation of window and split type air conditioners	FNA02S2U01V1
2	Repair Air Window & Split Type Air Conditioners	FNA02S2U02V1
3	Prepare refrigerators, deep freezers, display units, bottle coolers, water coolers and mobile refrigeration plants	FNA02S2U03V1
4	Prepare estimate on installations and /or maintenance of refrigeration and air conditioning systems	FNA02S2U04V1

7. Accreditation requirements	The training provider should have a workshop or similar training facility to provide the trainees the hands-on experience related to this qualification
8. Recommended sequencing of units	As appearing under the section 06

1. Endorsement Application for Qualification 02	
2. NATIONAL CERTIFICATE IV IN REFRIGERATION AND AIR CONDITIONING MECHANIC	
3. Qualification code: FNA02SQ2L407	**Total Number of Credits 134**
4. Purpose of the qualification To certify that the holder of this qualification has acquired the competencies listed in section 5	
5. Regulations for the qualification	National Certificate IV in Refrigeration and Air Conditioning (industrial) will be awarded to those who are competent in units 1+2+3+4+5+6+7+8+9

6. Schedule of Units

Unit Title	Unit Title	Code
1	Perform installation of window and split type air conditioners	FNA02S2U01V1
2	Repair Air Window & Split Type Air Conditioners	FNA02S2U02V1
3	Prepare refrigerators, deep freezers, display units, bottle coolers, water coolers and mobile refrigeration plants	FNA02S2U03V1
4	Prepare estimate on installations and /or maintenance of refrigeration and air conditioning systems	FNA02S2U04V1
5	Performs installation of Central air Conditioners	FNA02S2U05V1
6	Operate & Maintain Central Air Conditioning Systems	FNA02S2U06V1
7	Install, Maintain & Repair Cold Rooms / Freezer Rooms / Ice Plants	FNA02S2U07V1
8	Install & Service Freezer Truck Freezer Units	FNA02S2U08V1
9	Perform Refrigerant Recovery & Re - Cycling	FNA02S2U09V1

7. Accreditation requirements	The training provider should have a workshop or similar training facility to provide the trainees the hands-on experience related to this qualification
8. Recommended sequencing of units	As appearing under the section 06

UNITS DETAILS

Unit Title	Unit Title	Code	Level	No of credits
1	Perform installation of window and split type air conditioners	FNA02S2U01V1	3	12
2	Repair Air Window & Split Type Air Conditioners	FNA02S2U02V1	3	18
3	Prepare refrigerators, deep freezers, display units, bottle coolers, water coolers and mobile refrigeration plants	FNA02S2U03V1	3	24
4	Prepare estimate on installations and /or maintenance of refrigeration and air conditioning systems	FNA02S2U04V1	4	4
5	Performs installation of Central air Conditioners	FNA02S2U05V1	4	18
6	Operate & Maintain Central Air Conditioning Systems	FNA02S2U06V1	4	12
7	Install, Maintain & Repair Cold Rooms / Freezer Rooms / Ice Plants	FNA02S2U07V1	4	24
8	Install & Service Freezer Truck Freezer Units	FNA02S2U08V1	4	18
9	Perform Refrigerant Recovery & Re - Cycling	FNA02S2U09V1	4	4

Packaging of National Qualifications:

National Certificate III in Refrigeration and Air Conditioning Mechanic (Domestic) will be awarded to those who are competent in units 1+2+3+4

Qualification Code: FNA02SQ1L307

National Advanced Certificate in Refrigeration and Air Conditioning Mechanic (Industrial) will be awarded to those who are competent in units 1+2+3+4+5+6+7+8+9

Qualification Code: FNA02SQ2L407

UNIT TITLE	Perform installation of window and split type air conditioners				
DESCRIPTOR	This unit covers the competencies required to install different types and sizes of Window and Split type Air Conditioners using specified tools & material according to manufacturer's specifications/instructions, while ensuring safe working in such operations, and also in the use of related tools, equipment and materials.				
CODE	FNA02S2U01V1	LEVEL	3	CREDIT	12

ELEMENTS OF COMPETENCIES	**PERFORMANCE CRITERIA**
1. Install Window type Air Conditioner	1.1. Location where air conditioner is to be installed identified according to specifications or client's requirements 1.2. Location for installation of Air Conditioner checked and marked 1.3. Unit mounted firmly on supporting structures according to manufacturer's specifications, and air conditioner fixed according to manufactures specifications 1.4. Wall surface finished as per client's requirements 1.5. Power supply checked, air conditioner switched on, and unit tested for satisfactory performance
2. Install Split type air conditioner	2.1. Location where air conditioner is to be installed marked according to specifications / client's requirements 2.2. Location for installation of Air Conditioner prepared 2.3. Supporting structures to hold Air Conditioner fixed according to manufacturer's specifications 2.4. Condenser (out door unit) fixed according to manufacturer's specifications

	2.5. Evaporator (in door unit) fixed according to manufacturer's specifications 2.6. Refrigerant lines connected to condensing (out door) unit and evaporator (in door) unit with extensions if required. 2.7. Refrigerant lines purged / vaccume as necessary, pressure tested and charged with refrigerant. 2.8. Refrigerant lines insulated, as necessary 2.9. Electrical wring to main unit installed and connected, as necessary 2.10. Refrigerant lines mounted firmly using specified fixing accessories 2.11. System switched on, according to instructional manual and Performance of Air Conditioner checked 2.12. Unusual noises, vibrations etc. checked and defects rectified, as necessary 2.13. Major defects reported to relevant authorities

RANGE STATEMENT

Work outlined in this unit may take place in a commercial establishment or any other place where air conditioning is required. It may also take place in a building already constructed but subsequently to be installed with air conditioning after construction or on refurbishment.

The following types of air conditioners are included within this unit.

- Window type air conditioners
- Split type air conditioners

Tools, equipment and materials required may include:

- General electricians' and mechanics' tools
- Special air conditioning tools and equipment
- Hand and power tools

- Bench grinder
- Bench vice
- Refrigerants and dry nitrogen
- Arc and gas welding equipment
- Electrical testing & measuring instruments
- Insulation material
- Personal protective equipment
- Ladders and scaffolding
- Masonry / carpentry tools

Work is performed to drawings, sketches, specifications and instructions as appropriate and to predetermined standards of quality and safety.

The refrigerants and chemicals used should comply with the following:

- Sri Lanka Standards for Mechanical Refrigerating Systems used for Cooling and Heating prepared by Sri Lanka Standards Institution in collaboration with the National Ozone Unit of the Ministry of Environment & Natural Resources, and
- The National Policy for Cleaner Production for Sri Lanka drafted by the Ministry of Environment & Natural Resources.
- Ozone Action Programme of the United Nations Environment Programme

ASSESSMENT GUIDE

Forms of assessment

Continuous assessment coupled with final assessment is suitable for this unit.

Assessment context

This unit may be assessed on the job, off the job, or a combination of on and off the job demonstrated by an individual working alone or as part of a team.

Critical aspects

The assessment must confirm that the candidate in able to;

- Select and use correct tools & test instruments
- Ensure satisfactory performance/or functioning of the unit/s, without any leak of refrigerant

- Ensure adherence to safe working procedures & practices

Assessment condition

The candidate will have access to:

- All tools, equipment, material and documentation required.

The candidate will be permitted to refer to the following documents:

- Relevant workplace procedures.
- Relevant product and manufacturing specifications.
- Relevant drawings, manuals, codes, standards and reference material.

The candidate will be required to:

- Orally, or by other methods of communication, answer questions put by the assessor.
- Identify superiors who can be approached for the collection of competency evidence where appropriate.
- Present evidence of credit for any off-job training related to this unit.

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, and that he/she possesses the required knowledge.

Special notes

During assessment, the individual will:

- Demonstrate safe work practices at all times;
- Communicate information about processes, events or tasks being undertaken to ensure a safe and efficient working environment;
- Take responsibility for the quality of he/she own work;
- Plan tasks in all situations and review task requirements as appropriate;
- Perform all tasks in accordance with standard operating procedures;
- Perform all tasks to specification;
- Use accepted engineering techniques, practices, processes and workplace procedures.

Candidates are required to operate the plant according to the correct sequence of operations, diagnose any defects and attend to corrections as necessary. They are

expected to exhibit amenable attitudes towards the job and their fellow workers pertaining to this trade.

Tasks involved will be completed within reasonable time frames relating to typical workplace activities.

Resources required for assessment:

All the tools, equipment, measuring instruments and related material listed under the range statement for the unit

UNDERPINNING KNOWLEDGE AND SKILLS

Underpinning Knowledge	Underpinning Skills
• Reading and interpretation of sketches and manuals and interpretation of measurements • Air conditioning principles • Basic electrical/electronic principles • Types of electrical tools and test instruments used for diagnosis of faults electrical circuits in Ref. & AC units/systems • Basic masonry & wood working methods • Basic metal/masonry and carpentry tools and its applications • Types of refrigerants and their applications • Methods of cutting /bending/ flaring/ swaging refrigerant tubes • Sequential testing of air conditioning systems • Refrigerant recovery and recycling • Safety procedures to be followed	• Refer to manufacturer's specifications/ instructions on installation of air conditioners • Voltage and Current measurements • Use basic metal, masonry, electrical and carpentry tools • Prepare supporting structures for the installation of air conditioners • Finishing of wall surfaces to required standard • Selection of refrigerants • Charging of refrigerants using specified charging equipment • Cut, bend & join refrigerant lines using correct tools • Swaging and flaring of tubes • Welding & brazing practices • Pressure testing and evacuating AC systems • Performance testing & final adjustments • Adherence to safety procedures & practices • Working at heights/ladders/scaffolds/platforms

UNIT TITLE	Repair Air Window & Split Type Air Conditioners				
DESCRIPTOR	This unit covers the competencies required to repair Window and split type Air Conditioners using specified tools, test & measuring instruments, according to manufacturer's specifications/instructions, while ensuring safe working conditions and the safe use of tools, equipment and materials.				
CODE	FNA02S2U02V1	Level	3	Credit	18

ELEMENTS OF COMPETENCIES	**PERFORMANCE CRITERIA**
1. Check and identify defects in window type & split type Air Conditioner	1.1. The unit checked and the extent of repair needed ascertain and recorded 1.2. Equipment / items, material and accessories listed as required for job 1.3. All components, of the electrical / electronic circuit checked according to standard/practises and manufacturers specifications to ensure correct performance 1.4. All components of the refrigerant circuit checked according to standard/practises and manufactures specifications to ensure correct performance 1.5. All components of the Air-flow system checked according to standard/practises and manufactures specifications to ensure correct performance 1.6. Outer cover / chassis checked for corrosion etc 1.7. System pressure tested with dry nitrogen, gas leaks located, using specified equipment following safety procedures

2. Repair window type & split type Air Conditioners	2.1. System evacuated using vacuum pump and tested, according to manufacturer's specifications and gas re-charged using specified type of gas and recharging equipment, to required specification following safety practices 2.2. Air filter cleaned as necessary 2.3. Corrosion in outer cover / chassis attended to and restored to required conditions 2.4. Unit operated, checked and satisfactory performance ensured, according to manufacturer's specifications

RANGE STATEMENT

Work outlined in this unit connected with air conditioners, may take place in a commercial establishment or in any other place where they are being used. It may also take place in a workshop where it is sent for repairs or where it is to be installed after repair or on reconditioning.

The air conditioners out lined in this unit include the following

- Window type air conditioners
- Split type air conditioners

Tools, equipment and materials required may include:

- General electricians' and mechanics' tools
- Special air conditioning tools and Equipment
- Hand and power tools
- Refrigerants and dry nitrogen
- Arc and gas welding equipment
- Testing & measuring instruments
- Safety clothing
- Material for repair of body work/chassis corrosion

- Work is performed to drawings, sketches, specifications and instructions as appropriate
- Personal protective equipment and to pre-determined standards of quality and safety.

The standards expected of the performance include the following.

ASHRAE : American Society of Heating Refrigerating & Air conditioning Engineers
JIS : Japan International Standards
SMACNA **:** Sheet Metal & Air conditioning Contractor's National Association

The refrigerants and chemicals used should comply with the following:

- Sri Lanka Standards for Mechanical Refrigerating Systems used for Cooling and Heating prepared by Sri Lanka Standards Institution in collaboration with the National Ozone Unit of the Ministry of Environment & Natural Resources, and
- The National Policy for Cleaner Production for Sri Lanka drafted by the Ministry of Environment & Natural Resources.
- Ozone Action Programme of the United Nations Environment Programme

ASSESSMENT GUIDE

Forms of assessment

Continuous assessment coupled with gathered evidence of performance is suitable for this unit.

Assessment context

This unit may be assessed on the job, off the job, or a combination of on and off the job demonstrated by an individual working alone or as part of a team.

Critical aspects

The assessment must confirm that the candidate in able to;

- Correct selection and use of tools , testing & measuring instruments and material
- Satisfactory performance of the plant
- Adherence to safety procedures & practices

Assessment conditions

The candidate will have access to:

- All tools, equipment, machines, material and documentations required

The candidate will be permitted to refer to the following documents:

- Relevant workplace procedures
- Relevant product and manufacturing specifications
- Relevant drawings, manuals, codes, standards and reference material

The candidate will be required to:

- Orally, or by other methods of communication, answer questions asked by the assessor
- Identify superiors who can be approached for the collection of competency evidence where appropriate
- Present evidence of credit for any off-job training related to this unit
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Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, and that he/she possesses the required knowledge.

Special notes

During the assessment, the individual will:

- Demonstrate safe work practices at all times;
- Communicate information about processes, events or tasks being undertaken to ensure a safe and efficient working environment;
- Take responsibility for quality of he/she own work;
- Plan tasks in all situations and review task requirements as appropriate;
- Perform all tasks in accordance with standard operating procedures;
- Perform all tasks to specifications;
- Use accepted engineering techniques, practices, processes and workplace procedures.

Candidates are required to operate the plant according to the correct sequence of operations, diagnose any defects and attend to them as necessary.

Tasks involved will be completed with in reasonable time frame relating to typical workplace activities.

Resources required for assessment:

All the tools, equipment, measuring instruments and related material listed under the range statement for the unit.

UNDERPINNING KNOWLEDGE AND SKILLS

Underpinning Knowledge	Underpinning Skills

• Linear & cubic measurements • Reading and interpretation of drawings, sketches and manuals • Refrigeration cycle • Principles of Air conditioning • Types of tools, testing & measuring instruments used in Ref & AC • Type of refrigerants their properties uses • Types of refrigerant lubricants • Method of charging of Refrigerants • Sequential order of testing • Basic principles on electrical/electronics. Single and 3phase electrical power supply • Refrigerant recovery and recycling • Safety procedures to be followed	• Interpretation of measurements • Refer and Interpret manufacturer's manuals, specifications etc • Measurement of Voltage and Current using test equipment • Detection of unusual noises and vibrations • Cutting, bending, swaging and flaring of tubes • Welding and brazing • Pressure testing and evacuating & charging of refrigeration systems • Detection and repair of gas leaks • Select and fill refrigerant lubricants according to manufacturer's instructions • Charging of refrigerants • Performance testing and adjustments in Window & Split type Air conditioners • Check power supply and electrical/electronic components and correct faults • Adhere to safe working procedures & practices

UNIT TITLE	Prepare refrigerators, deep freezers, display units, bottle coolers, water coolers and mobile refrigeration plants				
DESCRIPTOR	This unit covers the competencies required to repair refrigerators, Deep Freezers, Display Units, Bottle Coolers Water Coolers and mobile Refrigeration plants using specified tools, testing & measuring instruments, according to manufacturer's specifications/instructions, while ensuring safe working conditions and the safe use of tools, equipment and materials.				
CODE	FNA02S2U03V1	Level	3	Credit	24

ELEMENTS OF COMPETETNCIES	**PERFORMANCE CRITERIA**

1.	Repair domestic refrigerators, deep freezers and bottle coolers	1.1.	Equipment checked and extent of repair needed ascertain
		1.2.	Equipment / items, material and accessories listed as required for job
		1.3.	All components, of the electrical / electronic circuit checked according to standard/procedures to ensure correct performance and defects rectified
		1.4.	All components of the refrigerant circuit checked according to manufactures specifications and to standard procedures to ensure correct performance and defects rectified
		1.5.	Body / cabinet / mounts checked and restored to the required condition
		1.6.	System pressure tested and gas leaks repaired and tested using specified test instruments
		1.7.	System evacuated using vacuum pump, recovered refrigerant stored in recovery unit, and gas recharged by weight using specified equipment according to specifications
		1.8.	Door heaters, thermostat, door gasket checked and serviced / replaced where necessary, to ensure proper functioning
		1.9.	Interior cooler space checked, cleaned and ensured dust / debris free
		1.10.	Unit operated and checked to ensure satisfactory performance according to manufactures specifications

2.	Repair water coolers	2.1. Equipment checked and extent of repair needed ascertain 2.2. Equipment / items, material and accessories listed as required for job 2.3. All components, of the electrical / electronic circuit checked according to standard/procedures to ensure correct performance and defects rectified 2.4. All components of the refrigerant circuit checked according to manufactures specifications and to standard procedures to ensure correct performance and defects rectified 2.5. Body / cabinet / mounts checked and restored to the required condition 2.6. System pressure tested using dry nitrogen gas and gas leaks repaired and tested using specified test instruments 2.7. System evacuated using vacuum pump, recovered refrigerant stored in recovery unit, and gas recharged by weight using specified equipment according to specifications 2.8. Thermostat checked and serviced/replaced as necessary 2.9. Unit operated and checked and its satisfactory performance ensured

3.	Repair refrigeration mobile plants	3.1. Mobile plant checked and extent of repair ascertained 3.2. Equipment material and accessories listed as required for its job 3.3. All components, of the electrical / electronic circuit checked according to standard/procedures to ensure correct performance and defects rectified 3.4. All components of the refrigerant circuit checked according to manufactures specifications 3.5. Body, mounts checked and restored to the required condition 3.6. System pressure tested using dry nitrogen gas and gas leaks repaired and tested using specified equipment's 3.7. System evacuated using vacuum pump, recovered refrigerant stored in recovery unit, and gas recharged by weight using specified equipment according to specifications 3.8. Door heaters, thermostat, door gasket checked and serviced/replaced where necessary to ensure prevention of condensation 3.9. Interior cooler space checked, cleaned and ensured dust / debris free 3.10. Unit operated and checked to ensure satisfactory performance according to manufactures specifications

RANGE STATEMENT

Work outlined in this unit connected with, refrigerators, display units, bottle coolers, deep freezers and water coolers, refrigeration mobile plants may take place in a commercial establishment or any other place where they are being used. It may also take place in a

workshop where it is sent for repairs or where it is to be installed after repair or on reconditioning.

The following components are included in a refrigerate circuits:

Compressor, condenser, metering device (refrigerant flow controller), evaporator, filter / drier, pipes and fittings, moisture indicators and other accessories.
The refrigeration electrical circuit components include the following:

Compressor motor, overload protector, starting relays, thermostat switch, pressure units, heaters, timers and other related electrical components found in refrigeration electrical systems.

The refrigeration units outlined in this unit may include refrigerators from mini bars to large multi door models. These may be of the following types.

- Refrigerators
- Display units
- Deep Freezers
- Bottle coolers
- Water coolers
- Mobile Refrigeration plants
- Other related refrigerator equipment.
- Ice cube maters,

Tools, equipment and materials required may include:

- General Electricians and mechanic's tools
- Special refrigeration tools and equipment
- Hand and power tools
- Refrigerants and dry nitrogen
- Arc and gas welding equipment
- Insulation material
- Material for repair of corrosion
- Testing & measuring instruments
- Personal protective equipment

Work is performed to drawings, sketches, specifications and instructions as appropriate and to predetermined standards of quality and safety

The standards expected of the performance include the following.

ASHRAE : American Society of Heating Refrigerating and Air conditioning Engineers
JIS : Japan International Standards
SMACNA : Sheet Metal and Air conditioning Contractor's National Association

The refrigerants and chemicals used should comply with the following:

- Sri Lanka Standards for Mechanical Refrigerating Systems used for Cooling and Heating prepared by Sri Lanka Standards Institution in collaboration with the National Ozone Unit of the Ministry of Environment and Natural Resources, and
- The National Policy for Cleaner Production for Sri Lanka drafted by the Ministry of Environment and Natural Resources.
- Ozone Action Programme of the United Nations Environment Programme

ASSESSMENT GUIDE

Forms of assessment

Continuous assessment coupled with gathered evidence of performance is suitable for this unit.

Assessment context

This unit may be assessed on the job, off the job, or a combination of on and off the job demonstrated by an individual working alone or as part of a team.

Critical aspects

The assessment must confirm that the candidate in able to;

- Select & use correct tools, testing & measuring instruments and material
- Ensure satisfactory performance of the plant
- Ensure adherence to safety procedures & practices

Assessment conditions

The candidate will have access to:

- All tools, equipment, machines, material and documentations required

The candidate will be permitted to refer to the following documents:

- Relevant workplace procedures
- Relevant product and manufacturing specifications
- Relevant drawings, manuals, codes, standards and reference materials

The candidate will be required to:

- Orally, or by other methods of communication, answer questions put by the assessor
- Identify superiors who can be approached for the collection of competency evidence where appropriate
- Present evidence of credit for any off-job training related to this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, and that he/she possesses the required knowledge.

Special notes

During the assessment, the individual will:

- Demonstrate safe work practices at all times;
- Communicate information about processes, events or tasks being undertaken to ensure a safe and efficient working environment;
- Take responsibility for quality of work;
- Plan tasks in all situations and review task requirements as appropriate;
- Perform all tasks in accordance with standard operating procedures;
- Perform all tasks to specifications;
- Use accepted engineering techniques, practices, processes and workplace procedures.

Candidates are required to operate the plant according to the correct sequence of operations, diagnose any defects and attend to them as necessary.

Tasks involved will be completed with in reasonable time frame relating to typical workplace activities.

Resources required for assessment:

All the tools, equipment, machines and related material listed under the range statement for the unit.

UNDERPINNING KNOWLEDGE AND SKILLS

Underpinning Knowledge	Underpinning Skills
• Linear & cubic measurements • Reading and interpretation of drawings, sketches and manuals • Refrigeration cycle • Principles of Refrigeration • Basic principles of electrical/electronics Single and 3 phase electrical power supply • Types of tools, testing & measuring instruments used in Ref & AC • Type of refrigerants their properties and applications. • Types of refrigerant lubricants • Method of charging of Refrigerants • Procedure of testing performances • Refrigerant recovery and recycling • Safety procedures to be followed	• Interpretation of measurements • Refer and Interpret manufacturer's manuals, specifications etc., • Check power supply and electrical/electronic circuits and correct faults • Measurement of Voltage and Current using electrical test equipment • Cutting, bending, swaging and flaring of tubes • Welding and brazing • Selection of correct type of refrigerant • Pressure testing, evacuating & charging of refrigeration systems • Detection and repair of gas leaks • Select and fill refrigerant lubricants according to manufacturer's instructions • Charging of refrigerants and commissioning of Domestic refrigerator, Deep Freezer, Bottle cooler and Water cooler units • Performance testing and adjustments in refrigerators, Deep Freezers, Bottle coolers and Water coolers • Adhere to safe working procedures & practices

UNIT TITLE	Prepare estimate on installations and /or maintenance of refrigeration and air conditioning systems				
DESCRIPTOR	This unit covers the competencies required to prepare fair and competitive estimates to install, /or relocate, repair /or maintain Refrigeration & Air Conditioning units / systems, in accordance with company/enterprise procedures.				
CODE	FNA02S2U04V1	**LEVEL**	**4**	**CREDIT**	**4**

ELEMENTS OF COMPETENCIES	**PERFORMANCE CRITERIA**

1. Prepare estimate for repair & maintenance of refrigeration / air conditioning systems	1.1. Refer records on requirements of equipment/items, material and estimated labour hours for job 1.2. Replacement parts and components for repair/ maintenance of system listed out 1.3. Cost of parts and components to be replaced estimated 1.4. Cost of labour worked out 1.5. Cost of repair to be sub contracted identified and estimated 1.6. Cost of transport of service personnel, material, parts & components worked out 1.7. Overall overhead costs and taxes estimated 1.8. Total estimate including a profit margin worked out 1.9. Estimate submitted to engineer / client and approval obtained

2. Prepare estimate for new installation of air conditioning systems	2.1. Power requirement of air conditioner unit, availability and adequacy of supply power checked 2.2. Measurements of space to be air conditioned and its volume calculated and noted down 2.3. The purpose of the space usage identified to classify how it will be utilized 2.4. The average number of people who will be within this space and orientation of room identified and noted down 2.5. The type of construction of building identified to facilitate installation procedures 2.6. Number of lights and other heat dissipating equipment used within space identified and noted down 2.7. Correct type of air conditioner selected to suit customer's requirement 2.8. Cost of labour necessary to install AC worked out 2.9. Cost of transport for service personnel, material, parts & components worked out 2.10. Overall overhead costs including taxes and labour costs worked out 2.11. Total estimate for installation of air conditioning system worked out 2.12. Estimate submitted to engineer / client and approval obtained

3. Prepare estimate for new installation of Refrigeration Systems	3.1. Power requirement of refrigeration unit, and availability and adequacy of power supply checked 3.2. Measurements of space to be refrigerated and its cooling load calculated and noted down 3.3. Purpose of refrigeration unit usage identified to classify how it will be utilized 3.4. Number of lights and other heat dissipating equipment used within unit identified and noted down 3.5. Correct type of refrigeration system/or unit selected to suit customer's requirements 3.6. Cost of labour necessary to install refrigeration equipment, worked out 3.7. Cost of transport for service personnel, material, parts & components worked out 3.8. Overhead costs including taxes, worked out 3.9. Total estimate for installation of refrigeration system / unit including a profit margin, worked out 3.10. Estimate submitted to engineer / client and approval obtained

4. Prepare an estimate for relocation of Refrigeration / or Air conditioning Systems	4.1. System / Unit checked and its new location identified 4.2. Power requirement of refrigeration unit / Air conditioner, and availability and adequacy of supply power checked 4.3. Requirements of refrigerant tubing, other parts & components necessary for relocation of system / or unit listed out and estimated 4.4. Cost of blanking of existing location, recovery of gas, pumped out estimated 4.5. Cost of labour, transport and materials worked out 4.6. Total estimate including a profit margin worked out 4.7. Estimate submitted to relevant authority / or client and approval obtained

RANGE STATEMENT

This unit includes estimates for installation of the following Refrigeration and / or Air Conditioning systems /or units and also includes relocation.

- Window type air conditioners
- Split type air conditioners
- Packaged type Air Conditioners
- Domestic Refrigerators/ Freezers
- Commercial Refrigerators/Freezers & Coolers

Refrigeration systems /units mentioned in this unit can be domestic, commercial or industrial types. Air Conditioning Systems/units can be for industrial purposes or for human comfort.

Work outlined in this unit may take place in a residence, office, commercial establishment or any other place where the refrigeration system / unit or Air Conditioning System / unit is to be installed, /serviced/repaired or maintained.

The preparation of the estimates involves:

- Referring to records on details of equipment, items & material and the estimated number of labour hours needed for the job
- Referring to layout plans & manufacturer's specifications/instructions
- Current market prices of Refrigeration/or Air Conditioning systems/or Units
- Costing of material required for installation / repair / servicing
- Cost of labour/taxes/contingencies/overheads/ transport / profit margin etc.,

Tools, equipment and material required for testing of the equipment for preparing estimates/units may include;

- General electricians' and mechanics' tools
- Air conditioning tools and equipment
- Testing & measuring instruments
- Personal safety equipment

The standards expected of the performance include the following:

ASHRAE : American Society of Heating Refrigerating & Air conditioning Engineers

JIS : Japan International Standards

SMACNA : Sheet Metal & Air conditioning Contractor's National Association

The refrigerants and chemicals should comply with the following:

- Sri Lanka Standards for Mechanical Refrigerating Systems used for Cooling and Heating prepared by Sri Lanka Standards Institution in collaboration with the National Ozone Unit of the Ministry of Environment & Natural Resources, and
- The National Policy for Cleaner Production for Sri Lanka drafted by the Ministry of Environment & Natural Resources.
- Ozone Action Programme of the United Nations Environment Programme

ASSESSMENT GUIDE

Form of assessment

Continuous assessment coupled with gathered evidence of performance is suitable for this unit.

Assessment context

This unit may be assessed on the job, off the job, or a combination of on and off the job demonstrated by an individual working alone or as part of a team.

Critical aspects

The assessment must confirm that the candidate in able to;

- Safety of self others and property
- Carry out systematic fault diagnosis on Ref. & AC units
- Exhibit knowledge of current market prices of spares, material etc.,
- Prepare reasonable and competitive estimates

Assessment conditions

The candidate will have access to:

- All tools, equipment, material and documentation required.

The candidate will be permitted to refer to the following documents:

- Relevant workplace procedures.
- Relevant product and manufacturing specifications.
- Relevant drawings, manuals, codes, standards and reference material.

The candidate will be required to:

- Orally, or by other methods of communication, answer questions asked by the assessor.
- Identify superiors who can be approached for the collection of competency evidence where appropriate.
- Present evidence of credit for any off-job training related to this unit.

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, and that he/she possesses the required knowledge.

Special notes

During assessment, the individual will:

- Demonstrate safe work practices at all times;
- Communicate information about processes, events or tasks being undertaken to ensure a safe and efficient working environment;
- Take responsibility for the quality of work;
- Plan tasks in all situations and review task requirements as appropriate;
- Perform all tasks in accordance with standard operating procedures;
- Perform all tasks to specifications;
- Use accepted engineering techniques, practices, processes and workplace procedures.

Candidates are required to operate the plant according to the correct sequence of operations, diagnose any defects. They are expected to exhibit amenable attitudes towards the job and their fellow workers pertaining to this trade.

Tasks involved will be completed within reasonable time frames relating to typical workplace activities.

Resources required for assessment:

All the tools, equipment, measuring instruments and related material listed under the range statement for the unit

UNDERPINNING KNOWLEDGE AND SKILLS

Underpinning knowledge	Underpinning skills
• Linear & cubic measurements • Reading and interpretation of manufacturer's manuals, drawings, sketches pertaining to installation/repair/servicing of refrigerators and air conditioners • Market prices of refrigeration/air conditioning units spares & material • Identification of electronic components and their applications • Company/enterprise policies/procedures on estimation of refrigeration & air conditioning installations/ repair/ and maintenance work • Knowledge on gas recovery procedures	• Calculate areas & volumes • Refer manufacturer's manuals/ specification etc., on installation/repair /servicing or maintenance of Ref & AC Systems • Cost of various refrigeration & air conditioning installations/ /repair/or maintenance work, including overheads, labour, manpower and material costs etc., • Prepare total estimates according to company/enterprise policies/procedures

UNIT TITLE	Performs installation of Central air Conditioners				
DESCRIPTOR	This unit covers the competencies required to install Central Air Conditioners using specified tools & equipment and according to manufacturer's specifications/instructions/layout plans, while ensuring safe working conditions and the safe use of tools, equipment and materials.				
CODE	FNA02S2U05V1	Level	4	Credit	18

ELEMENTS OF COMPETENCIES	**PERFORMANCE CRITERIA**

1. Install the main air conditioning plant	1.1. Availability of required electrical power supply checked and ensured 1.2. Air Conditioner checked and its suitability according to requirement ensured 1.3. Layout plan and manufacturer's specifications/instructions referred to, and location of installation identified 1.4. A list of items and material prepared and number of labour hours required for the job estimated. 1.5. Floor / foundation checked & tested and required level and firmness confirmed 1.6. Unit transferred to required location giving attention to safety precautions 1.7. The unit mounted at pre-identified location, adjusted and levelled 1.8. Piping & connections for chilled water & condenser water installed 1.9. Stop valves in condenser and evaporator, and thermometer wells and pressure taps installed according to specification 1.10. Condenser and chilled water pumps installed according to specification 1.11. Electrical wiring and control panels/switchgear installed according to specifications

2. Install Cooling Tower	2.1. Cooling Tower inspected and its suitability verified and confirmed 2.2. Layout plan and manufacturer's specifications/instructions referred to, and location for installation identified 2.3. Floor / foundation checked & tested and required level and firmness confirmed 2.4. Unit transferred to required location ensuring safety precautions 2.5. Unit mounted at pre-identified location, adjusted and levelled 2.6. Cooling tower basin installed and levelled 2.7. Fill packs installed 2.8. Cooling tower motor and fan installed 2.9. Water pipes to cooling tower connected, as necessary 2.10. Electrical wiring to cooling tower connected 2.11. Cooling tower tested for satisfactory performance and adjustments made, where necessary
3. Install Air Handling Equipment	3.1. Air handling equipment installed according to specification at the specified location 3.2. Electrical supply, piping and duct lines connected using specifies accessories and tools

4. Install Ducts	4.1. Drawings and specifications for installing ducts read & interpreted 4.2. Places where ducts are to be laid, marked according to specifications 4.3. Brackets / supports for mounting of ducts installed as necessary 4.4. Ducts mounted, levelled and adjusted, as necessary 4.5. Fire dampers and air volume dampers in ducts installed as per drawings 4.6. Ducts heat insulated according to manufacturer's specifications 4.7. Final connections of ducts to air handling plant done as per manufacturer's instructions 4.8. Availability of required electrical power supply checked and ensured 4.9. Air side equipment of system energised 4.10. Defects in air side checked and adjustments done, as necessary

5. Operate and test the Air Conditioning system	5.1. Condensing medium equipment such as air cooled condensers / cooling towers and pumps checked 5.2. Crank case heaters of main plant energised for specified number of hours according to manufacturer's specifications, and main air conditioning equipment switched on 5.3. Readings of electrical power taken and electrical safety gear checked, unusual noises & vibrations identified checked and corrected and refrigerant circuit of air conditioning system checked and leaks attended 5.4. All checks specified in instructions manual carried out and readings recorded 5.5. System operated and checked for satisfactory performance 5.6. Performance of the equipment recorded 5.7. Major defects reported to engineer and his advice sought

RANGE STATEMENT

Work outlined in this unit may take place in an industrial complex or in a commercial building where the central air conditioner is to be installed. It may also take place in a building already constructed but decided to be installed with central air conditioning after construction or on refurbishment.

The central air conditioners outlined in this unit include the following;

- Water cooled packaged systems
- Air-cooled packaged systems
- Water cooled chilled water systems
- Air cooled chilled water systems.

The central air conditioning units outlined within this unit include those which are above 5 tons of refrigeration (60,000 BTU per hour)

The installation work of central air conditioning may involve;

- Ducting,
- Plumbing,
- Electrical work

Tools, equipment and materials required may include:

- General electricians' and mechanics' tools
- Special air conditioning tools and equipment
- Hand and power tools
- Refrigerants and dry nitrogen
- Arc and gas welding equipment
- Electrical testing & measuring instruments
- Pressure test pump
- Personal protective equipment
- Plumbing tools

Work is performed to drawings, sketches, specifications and instructions as appropriate and to predetermined standards of quality and safety.

The responsibility of commissioning the plant lies with the engineer. The Air Conditioning Mechanic will be assisting him.

The quality standards expected for the installation and performance include those specified for such installations by the following.

ASHRAE **:** American Society of Heating Refrigerating & Air conditioning Engineers
JIS **:** Japan International Standards
SMACNA : Sheet Metal & Air conditioning Contractor's National Association

The refrigerants and chemicals used should comply with the following:

- Sri Lanka Standards for Mechanical Refrigerating Systems used for Cooling and Heating prepared by Sri Lanka Standards Institution in collaboration with the National Ozone Unit of the Ministry of Environment & Natural Resources, and

- The National Policy for Cleaner Production for Sri Lanka drafted by the Ministry of Environment & Natural Resources.
- Ozone Action Programme of the United Nations Environment Programme

ASSESSMENT GUIDE

Forms of assessment

Continuous assessment coupled with gathered evidence of performance is suitable for this unit.

Assessment context

This unit may be assessed on the job, off the job, or a combination of on and off the job demonstrated by an individual working alone or as part of a team.

Critical aspects

The assessment must confirm that the candidate in able to;

- Select and use correct tools, testing & measuring instruments and material
- Ensure satisfactory performance of the system
- Ensure adherence to safety procedures & practices

Assessment conditions

The candidate will have access to:

- All tools, equipment, machines, material and documentations required

The candidate will be permitted to refer to the following documents:

- Relevant workplace procedures
- Relevant product and manufacturing specifications
- Relevant drawings, manuals, codes, standards and reference material

The candidate will be required to:

- Orally, or by other methods of communication, answer questions asked by the assessor
- Identify superiors who can be approached for the collection of competency evidence where appropriate
- Present evidence of credit for any off-job training related to this unit

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, and that he/she possesses the required knowledge.

Special notes

During the assessment, the individual will:

- Demonstrate safe work practices at all times;
- Communicate information about processes, events or tasks being undertaken to ensure a safe and efficient working environment;
- Take responsibility for quality of the work;
- Plan tasks in all situations and review task requirements as appropriate;
- Perform all tasks in accordance with standard operating procedures;
- Perform all tasks to specifications;
- Use accepted engineering techniques, practices, processes and workplace procedures.

Candidates are required to operate the plant according to the stated sequence of operations, diagnose any defects and attend to corrections as necessary. They are expected to exhibit amenable attitudes towards the job and their fellow workers pertaining to this trade.

Tasks involved will be completed with in reasonable time frame relating to typical workplace activities.

Resources required for assessment:

All tools, equipment, measuring instruments, machinery and related material listed under the range statement for the unit.

UNDERPINNING KNOWLEDGE AND SKILLS

Underpinning Knowledge	Underpinning Skills

• Reading and interpretation of sketches and manuals and interpretation of measurements • Air conditioning principles • Basic electrical/electronic principles • Basic masonry & wood working techniques • Types of central air conditioning units and their applications • Types of refrigerants and their uses • Types of tools used for cutting /bending/ flaring/ swaging refrigerant tubes. • Types of testing & measuring instruments used in air conditioning work • Basic masonry and carpentry tools and its applications • Testing procedures & adjustments in central air conditioning systems • Testing procedure of water for pH value and hardness • Refrigerant recovery and recycling • Safety procedures to be followed	• Refer to manufacturer's specifications/ instructions on installation of air conditioners • Levelling of AC units/ finishing of wall surfaces • Select suitable type and size of Air conditioning system • Selection of refrigerants according to the type of system • Charging of refrigerants using specified equipment • Cut, bend & join refrigerant lines using correct tools • Swaging and flaring of tubes • Welding & brazing practices • Pressure testing and evacuating the refrigeration systems using specified test instruments • Check and repair gas leaks • Voltage and Current measurements • Use Basic masonry, electrical and carpentry tools Preparation of supporting structures for the installation of air conditioners • Test Central Air Conditioning Systems in sequential order and according to manufacturer's instructions/specifications • Performance testing & final adjustments • Test water for pH value and hardness using specified test instruments • Adherence to safety procedures & practices • Working heights/ladders/scaffolds/platforms

UNIT TITLE	Operate & Maintain Central Air Conditioning Systems				
DESCRIPTOR	This unit covers the competencies required to operate and maintain all the types and sizes of Central Air Conditioners according to manufacturer's specifications, instructions etc., using specified tools, testing & measuring instruments while ensuring safe working conditions and the safe use of tools, equipment and material.				
CODE	FNA02S2U06V1	Level	4	Credit	12

ELEMENTS OF COMPETENCIES	**PERFORMANCE CRITERIA**
1. Identify the central air conditioning system for operation / maintenance	1.1. Electrical source of supply checked and supply being within the requirements verified 1.2. Availability of continuous supply of good quality water checked and ensured

2. Start & operate the central chilled water air conditioning system (with water cooled condenser)	2.1. Operational manual and other operational guide lines provided by manufacturer for operating plant, studied and steps to be followed identified 2.2. Air purge valve and water level of expansion tank checked 2.3. Cooling tower fans started, checked and correct operation ensured 2.4. Unusual noises checked and attended to, and correct performance of cooling tower fans ensured 2.5. Condenser cooling water pumps, started, their performance checked and servicing / repairs carried out, as necessary 2.6. Chilled water pumps, started, their performance checked and servicing/or repairs carried out, as necessary 2.7. Air side equipment activated and necessary servicing / repairs carried out 2.8. Main air conditioning plant started and servicing / repairs done, as necessary 2.9. Temperature readings taken at all places of air conditioned space and recorded 2.10. Main plant checked, readings taken at regular intervals and recorded in operational log sheets

3. Start & operate the chilled water central air conditioning system (with air cooled condenser)	3.1. Instructions on starting operations and other operational guide lines provided by manufacturer, referred to and interpreted 3.2. Steps outlined in manufacturer's guidelines for starting & operating unit, followed as specified 3.3. Condenser fans, started and their performance checked to ensure proper performance 3.4. Unusual noises in condenser fans checked and faults cleared 3.5. Main plant started, readings taken at regulator intervals and recorded in log sheets
4. Maintain central air conditioning systems	4.1. Compressor checked, oil changed as specified by manufacturer 4.2. Water cooled condenser checked and its satisfactory performance ensured 4.3. Electrical controls and panels cleaned & serviced / replaced, as necessary, according to instructions of manufacturer 4.4. Refrigerant pressure, water flow rates, water inlet & outlet temperatures checked and necessary adjustments attended to as necessary 4.5. Cooling tower and water treatment systems checked and their satisfactory performance ensured 4.6. Water pumps, cooling towers and condensing units checked for their satisfactory performance and adjustments done, as necessary 4.7. Corrosion checked and removed, as necessary

RANGE STATEMENT

Work outlined in this unit may take place in a commercial or industrial complex where the air conditioning is installed. It may also take place in a building already constructed but installed with central air conditioning after construction or on refurbishment.

The following types of air conditioners are included within this unit.

- Central AC systems used in industrial and commercial environments

The performance of the air conditioner unit will include checking of the following.

- The pressures in the refrigerant circuit (suction & discharge)
- The temperature at specified places, including ambient temperature.
- Current drawn while running.
- Current drawn on starting
- Air flow rate

Tools, equipment and materials required may include:

- General electricians' and mechanics' tools
- Special Refrigeration & air conditioning tools and equipment
- Personal protective equipment
- Refrigerants and dry nitrogen
- Hand and power tools
- Pressure test pump
- Arc and gas welding equipment
- Material for repair of corrosions in the
- Electrical Testing & measuring instrument body work/chassis

Work is performed to specifications and instructions as appropriate and to predetermined standards of quality and safety.

The standards expected of the performance include the following.

ASHRAE : American Society of Heating Refrigerating & Air conditioning Engineers

JIS : Japan International Standards

SMACNA : Sheet Metal & Air conditioning Contractor's National Association

The refrigerants and chemicals used should comply with the following:

- Sri Lanka Standards for Mechanical Refrigerating Systems used for Cooling and Heating prepared by Sri Lanka Standards Institution in collaboration with the National Ozone Unit of the Ministry of Environment & Natural Resources, and
- The National Policy for Cleaner Production for Sri Lanka drafted by the Ministry of Environment & Natural Resources.
- Ozone Action Programme of the United Nations Environment Programme

ASSESSMENT GUIDE

Forms of assessment

Continuous assessment coupled with gathered evidence of performance is suitable for this unit.

Assessment context

This unit may be assessed on the job, off the job, or a combination of on and off the job demonstrated by an individual working alone or as part of a team.

Critical aspects

The assessment must confirm that the candidate in able to;

- Carry out the correct selection and use of tools
- Ensure satisfactory performance of the and measuring instruments plant/s
- Adhere to safety procedures & practices

Assessment conditions

The candidate will have access to:

- All tools, equipment, material and documentation required.

The candidate will be permitted to refer to the following documents:

- Relevant workplace procedures.
- Relevant product and manufacturing specifications.

- Relevant drawings, manuals, codes, standards and reference material.

The candidate will be required to:

- Orally, or by other methods of communication, answer questions asked by the assessor.
- Identify superiors who can be approached for the collection of competency evidence where appropriate.
- Present evidence of credit for any off-job training related to this unit.

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, and that he/she possesses the required knowledge.

Special notes

During assessment, the individual will:

- Demonstrate safe work practices at all times;
- Communicate information about processes, events or tasks being undertaken to ensure a safe and efficient working environment;
- Take responsibility for the quality of his/her own work;
- Plan tasks in all situations and review task requirements as appropriate;
- Perform all tasks in accordance with standard operating procedures;
- Perform all tasks to specification;
- Use accepted engineering techniques, practices, processes and workplace procedures.

Candidates are required to operate the plant according to the correct sequence of operations, diagnose any defects and attend to corrections as necessary.

Tasks involved will be completed within reasonable time frames relating to typical workplace activities.

Resources required for assessment:

All the tools, equipment, machines and related material listed under the range statement for the unit

UNDERPINNING KNOWLEDGE AND SKILLS

Underpinning Knowledge	Underpinning Skills
• Linear & cubic measurements • Reading and interpretation of drawings, sketches and manuals • Refrigeration cycle • Principles of air conditioning • Types of tools, testing & measuring instruments used in Ref & AC • Testing procedures & adjustments in central air conditioning systems • Types of refrigerants their properties and their uses • Types of refrigerant lubricants • Method of charging of refrigerants • Basic principles of electrical/electronics Single and 3 phase electrical power supply • Testing procedure of water for pH value and hardness • Refrigerant recovery and recycling • Record keeping • Safety procedures to be followed	• Interpretation of measurements • Refer and Interpret manufacturer's manuals, specifications etc., • Measurement Voltage and Current using test equipment • Cutting, bending, swaging and flaring of tubes • Welding and brazing • Detect unusual noises and vibrations & attend to necessary corrections • Performance testing and adjustments in air conditioners for optimum performance • Pressure testing and evacuating & charging of refrigeration systems • Detection and repair of gas leaks • Select and fill refrigerant lubricants according to manufacturer's instructions • Charging of refrigerants • Check power supply and electrical/electronic components and rectify faults • Adhere to safe working procedures & practices • Test water for PH Value and hardness • Maintain records

UNIT TITLE	Install, Maintain & Repair Cold Rooms / Freezer Rooms / Ice Plants				
DESCRIPTOR	This unit covers the competencies required to install, maintain and repair different types and sizes of cold rooms/ freezer rooms/ ice plants using specified tools & test instruments and material and referring to manufacturer's specifications while ensuring safe working conditions and the safe use of tools, equipment and material.				
CODE	FNA02S2U07V1	Level	4	Credit	24

ELEMENTS OF COMPETENCIES	**PERFORMANCE CRITERIA**
1. Identify the selected design of cold room / freezer room / ice plant for installation	1.1. Client's requirements identified, noted and location of installation inspected 1.2. Specifications of selected system, checked to ensure matching with selected design of the unit 1.3. A list of equipment/items and material prepared required for the job

2. Install cold room/ freezer room / ice plant	2.1. Components of system selected according to requirements for the installation 2.2. Floor prepared and levelled to install cold room/ freezer room / ice plants according to lay out plans 2.3. Cold room / freezer room / ice plant installed according to specifications, following manufacturers specification 2.4. Refrigeration equipment including piping & electrical wiring installed following standard practises and safety procedures 2.5. System checked and tested before commissioning, as per specifications and manufacturers instructions, and under the supervision of the engineer 2.6. Commissioning data indicating system pressures, electrical data, humidity & temperatures outside and inside cold room, recorded and filed for future use

3. Maintain / repair cold room / freezer room	3.1. Cold room / freezer room / ice plant checked and extent of repair / or maintenance ascertained and recorded 3.2. Equipment / items and material and accessories listed as required for the job 3.3. All components of the electrical / electronic circuits checked according to standard practice and manufacturers specifications to ensure correct performance and defects rectified 3.4. All electro - mechanical safety cut outs checked and performance ensure according to manufacturers specifications 3.5. All mechanical devices such as drive belts etc. checked for correct performance according to manufacturers specifications 3.6. All components of the refrigeration circuit checked and defects rectified for correct performance according to manufacturers specifications 3.7. Body mounts checked and restored to the required condition 3.8. System pressure tested and gas leaks repaired and tested using specified test instrument 3.9. System evacuated using vacuum pump and gas re-charged by weight using specified equipment according to specifications 3.10. Door heaters, door gaskets and thermostat checked, serviced / or repaired where necessary to ensure proper functioning 3.11. Interior cooler space checked, cleaned and ensured dust / debris free 3.12. In case of ice plants, water source checked according to specifications 3.13. Plant operated, checked and tested to ensure satisfactory performance according to manufacturer's specifications 3.14. Commissioned the plant according to manufactures specifications, following safety procedures, under the supervision of the engineer and recorded readings / data obtained during commissioning of the plant and

RANGE STATEMENT

Work outlined in this unit may take place in an industrial or other commercial establishment where the refrigeration system is to be installed. It may also take place in a building already constructed with or without the central air conditioning, to be installed with a refrigeration system on or after construction or on refurbishment.

The following types of equipment may be included within this refrigeration system

- Cold rooms
- Freezer room
- Ice plants – (Block ice / cube ice / ice flakes)

Tools, equipment and materials required may include:

- General electricians' and mechanics' tools
- Special Refrigeration & air conditioning tools and
- Hand and power tools equipment
- Refrigerants and dry nitrogen
- Arc and gas welding equipment
- Electrical testing and measuring instruments
- Personal safety equipment
- Material for repair of corrosions

Work is performed according to drawings, sketches, specifications and instructions as appropriate and to predetermined standards of quality and safety.

The standards expected of the performance include the following.

ASHRAE : American Society of Heating Refrigerating & Air conditioning Engineers
JIS : Japan International Standards
SMACNA : Sheet Metal & Air conditioning Contractor's National Association

The refrigerants and chemicals used should comply with the following:

- Sri Lanka Standards for Mechanical Refrigerating Systems used for Cooling and Heating prepared by Sri Lanka Standards Institution in collaboration with the National Ozone Unit of the Ministry of Environment & Natural Resources, and
- The National Policy for Cleaner Production for Sri Lanka drafted by the Ministry of Environment & Natural Resources.
- Ozone Action Programme of the United Nations Environment Programme

ASSESSMENT GUIDE

Forms of assessment

Continuous assessment coupled with gathered evidence of performance is suitable for this unit.

Assessment context

This unit may be assessed on the job, off the job, or a combination of on and off the job demonstrated by an individual working alone or as part of a team.

Critical aspects

The assessment must confirm that the candidate in able to;

- Select and use of correct tools, testing & measuring instruments
- Satisfactory performance of the plant
- Adherence to safety procedures & practices

Assessment conditions

The candidate will have access to:

- All tools, equipment, material and documentation required.
- The candidate will be permitted to refer to the following documents:
- Relevant workplace procedures
- Relevant product and manufacturing specifications
- Relevant drawings, manuals, codes, standards and reference material
- The candidate will be required to:
- Orally, or by other methods of communication, answer questions asked by the assessor.

- Identify superiors who can be approached for the collection of competency evidence where appropriate.
- Present evidence of credit for any off-job training related to this unit.

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, and that he/she possesses the required knowledge.

Special notes

During assessment, the individual will:

- Demonstrate safe work practices at all times;
- Communicate information about processes, events or tasks being undertaken to ensure a safe and efficient working environment;
- Take responsibility for the quality of his/her own work;
- Plan tasks in all situations and review task requirements as appropriate;
- Perform all tasks in accordance with standard operating procedures;
- Perform all tasks to specification;
- Use accepted engineering techniques, practices, processes and workplace procedures.

Candidates are required to operate the plant according to the correct sequence of operations, diagnose any defects and attend to corrections independently, as necessary.

Tasks involved will be completed within reasonable time frames relating to typical workplace activities.

Resources required for assessment may include:

Material, tools, equipment and machines listed within this unit.

UNDERPINNING KNOWLEDGE AND SKILLS

Underpinning Knowledge	Underpinning Skills
• Linear & cubic measurements	• Interpretation of measurements

• Reading and interpretation of drawings, sketches and manuals • Types of tools, testing & measuring instruments used in Ref & AC • Refrigeration cycle • Principles of Air conditioning • Testing procedures & adjustments in air conditioning systems • Type of refrigerants their properties uses • Types of refrigerant lubricants • Method of charging of Refrigerants • Basic principles on electrical/electronics Single and 3phase electrical power supply • Method of de-frosting • Refrigerant recovery and recycling • Requirement of purified water for ice plants and the effect of impurities • Different tubing used in ice plants, to prevent corrosion • Safely procedures to be followed	• Refer and Interpret manufacturer's manuals, specifications etc • Measurement of Voltage and Current using test equipment • Cutting, bending, swaging and flaring of tubes • Welding and brazing • Detection of unusual noises and vibrations and make necessary corrections • Pressure testing and evacuating & charging of refrigeration systems • Detection and repair of gas leaks • Select and fill refrigerant lubricants according to manufacturer's instructions • Charging of refrigerants • Performance testing and adjustments in Window & Split type Air conditioners • Check power supply and electrical/electronic components and correct faults • Check air repair de-frosting system • Adhere to safe working procedures & practices

UNIT TITLE	Install & Service Freezer Truck Freezer Units				
DESCRIPTOR	This unit covers the competencies required to install and service different types and sizes of freezer unit's infreezer trucks, using specified tools, testing & measuring instruments, and in conformity with manufacturer's specifications & instructions, while ensuring safe working conditions and the safe use of tools, equipment and materials.				
CODE	FNA02S2U08V1	Level	4	Credit	18

ELEMENTS OF COMPETENCIES	**PERFORMANCE CRITERIA**

1. Install freezer unit	1.1. Insulated truck inspected to determine the viability of installing a freezer unit to full fill the clients requirements 1.2. Layout planes on installation of system read and interpreted according to manufacturers specifications 1.3. List of material, equipment and items prepared according to the requirement 1.4. Components of the system checked against specifications for suitability 1.5. Mounts and brackets required for the installations of the freezer unit fixed at correct locations according to specification 1.6. Evaporator unit and other refrigeration equipment including refrigeration piping installed according to manufacturers specification 1.7. Electrical circuits for the freezer unit installed and connected to the respective power systems as necessary following standard practices and safety procedures 1.8. Freezer unit operated and tested for proper functioning as specified in the installation manual 1.9. Necessary readings / data pertaining to the performance of the unit recorded

2. Service / repair refrigerant system of the freezer unit	2.1. Refrigerant in the system recovered using specified recovery equipment and following safety practices 2.2. Condition of the compressor checked for defects and defective parts serviced / or replaced, oil level checked and topped up where necessary according to specifications and manufactures instructions 2.3. Evaporated checked visually and pressure tested for leaks / clogs etc. and serviced / or replaced where necessary 2.4. Expansion valve checked for proper operation and serviced / or replaced as necessary 2.5. Condenser checked visually and pressure tested for leaks / clogs etc. and serviced / or replaced as necessary using specified test equipment, adhering to safety practices 2.6. Cooling / blower fans checked for perform, tested and serviced / or replaced as necessary according to manufacturers instructions, adhering to safety practices 2.7. Filter/receiver driers inspected and replaced as necessary according to manufacturers specifications 2.8. Refrigerant liquid lines and hoses pressure tested using specified test equipment adhering to safety practices and leaks repaired, and pressure tested after repair of leaks 2.9. Sight glass, oil separator, gas accumulator checked and replaced as necessary 2.10. System evacuated using dry nitrogen and vacuum pump and tested according to specifications 2.11. System gas charged with specified refrigerant using gas - charging equipment according to manufacturers specifications

3. Repair electrical / electronic control system of the freezer unit	3.1. Internal and external electrical / electronic control systems checked for operations and repaired where necessary according to manufacturer's instructions 3.2. Electronic climatic controls checked for satisfactory operation and replaced where necessary according to manufacturers instructions 3.3. Plant checked for specified performance against manufacturer's specifications and satisfactory performance ensured

RANGE STATEMENT

Work outlined in this unit may take place in a freezer truck where the refrigeration system is to be installed. It may also take place in a trunk already built for any other purpose with or without the freezer unit.

An automobile freezer unit is installed in an automobile where specific low temperatures under systemized control are necessary for the transport of vegetables, fish, meat, dairy products, fruits or ice cream etc.,

The following types of equipment may be included within this refrigeration system

- Freezer units driven by its own engine power
- Working with DC electrical supply, up to 24 V

Tools, equipment and materials required may include:

- General electricians' and mechanics' tools
- Special Refrigeration & air conditioning tools and equipment
- Hand and power tools
- Refrigerants and dry nitrogen

- Arc and gas welding equipment
- DC test equipment and multi meter
- Personal protective equipment

Work is performed according to drawings, sketches, specifications and instructions as appropriate and to predetermined standards of quality and safety.
The standards expected of the performance include the following.

ASHRAE - American Society of Heating Refrigerating & Air conditioning Engineers
JIS - Japan International Standards
SMACNA - Sheet Metal & Air conditioning Contractor's National Association

The refrigerants and chemicals used should comply with the following:

- Sri Lanka Standards for Mechanical Refrigerating Systems used for Cooling and Heating prepared by Sri Lanka Standards Institution in collaboration with the National Ozone Unit of the Ministry of Environment & Natural Resources, and
- The National Policy for Cleaner Production for Sri Lanka drafted by the Ministry of Environment & Natural Resources.
- Ozone Action Programme of the United Nations Environment Programme

ASSESSMENT GUIDE

Forms of assessment

Continuous assessment coupled with gathered evidence of performance is suitable for this unit.

Assessment context

This unit may be assessed on the job demonstrated by an individual working alone or as part of a team.

Critical aspects

The assessment must confirm that the candidate in able to;

- Select use of correct tools, testing & measuring instruments and material

- Ensure satisfactory performance of the freezer unit
- Ensure adherence to safety procedures & practices

Assessment condition

The candidate will have access to:

- All tools, equipment, material and documentation required.

The candidate will be permitted to refer to the following documents:

- Relevant workplace procedures.
- Relevant product and manufacturing specifications.
- Relevant drawings, manuals, codes, standards and reference material.

The candidate will be required to:

- Orally, or by other methods of communication, answer questions asked by the assessor.
- Identify superiors who can be approached for the collection of competency evidence where appropriate.
- Present evidence of credit for any off-job training related to this unit.

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, and that he/she possesses the required knowledge.

Special notes

During assessment, the individual will:

- Demonstrate safe work practices at all times;
- Communicate information about processes, events or tasks being undertaken to ensure a safe and efficient working environment;
- Take responsibility for the quality of work;
- Plan tasks in all situations and review task requirements as appropriate;
- Perform all tasks in accordance with standard operating procedures;
- Perform all tasks to specification;
- Use accepted engineering techniques, practices, processes and workplace procedures.

Candidates are required to operate the plant according to the correct sequence of

operations, diagnose any defects and attend to corrections independently, as necessary. .

Tasks involved will be completed within reasonable time frames relating to typical workplace activities.

Resources required for assessment

May include material, tools, equipment and machines listed within this unit.

UNDERPINNING KNOWLEDGE AND SKILLS

Underpinning Knowledge	Underpinning Skills

• Reading and interpretation of drawings, sketches and manuals on freezer trucks refrigeration systems • Calculation of capacity of the freezer units required for freezer trucks • Linear & cubic measurements • Types of tools, testing & measuring instruments used in Ref & AC work • Methods of fastening • Refrigeration cycle • Principles of Refrigeration • Types of tools, testing & measuring instruments used in Ref & AC • Type of refrigerants their properties & its applications • Types of refrigerant lubricants • Procedure in charging of refrigerants and equipment used • Testing procedures & adjustments in central air conditioning systems •	• Refer manufacturer's specifications/ instructions on installation & servicing of freezer truck freezer units • Select the required type and capacity of freezer unit • Interpretation of measurements • Use hand & electric tools required for installation/ repair of Ref. & AC work • Use different types of nuts & bolts, rivets etc. in installing freezer truck refrigeration systems and repairing of body work in freezer trucks • Detection of unusual noises and vibrations & relevant diagnostics • Measurement of Voltage and Current using electrical test equipment • Cutting, bending, swaging and flaring of tubes • Welding and brazing • Pressure testing and evacuating of refrigeration systems • Detection and repair of gas leaks •

• Basic principles of electricity and electronics • Single and 3 phase electrical power supply • Ratings of Automobile Batteries • Procedure on testing& charging of automobile batteries and equipment used • Types of belts and pulleys and their applications in Automobiles • Brine solutions and its uses • Methods of de-frosting • Working principles of air curtains • Refrigerant recovery and recycling •	• Gas re-charging • Select and fill refrigerant lubricants according to manufacturer's instructions • Performance testing and adjustments in Freezer truck freezer units • Check power supply and connect the freezer truck to outside power source • Test electrical/electronic control circuits/ components and correct faults • Select/check automobile batteries • Service/recharge automobile batteries • Select correct type of belts, pulleys etc., • Make necessary aligning and tensioning of belts & pulleys • Use brine solutions in freezer truck compartment • Check & repair defrosting system • Check & repair air curtains • Adhere to safe working procedures & practices

UNIT TITLE	Perform Refrigerant Recovery & Re - Cycling				
DESCRIPTOR	This unit covers the competencies required to perform refrigerant recovery using specified tools & equipment, complying with environmental standards & regulations, while ensuring safe working conditions and the safe use of tools, equipment and materials.				
CODE	FNA02S2U09V1	Level	2	Credit	4

ELEMENTS OF COMPETENCIES	**PERFORMANCE CRITERIA**
1. Couple the recovery unit to the equipment for recovery	1.1. Type of refrigerant to be recovered identified, according to available information 1.2. Appropriate system for connection of charging hoses, either with piercing valve or charging valve selected according to requirements 1.3. Recovery unit ensured to be free of any other type of refrigerant. Refrigerant in unit transferred to a separate cylinder, ensuring that no refrigerant escapes to atmosphere 1.4. Gauge manifold connected to system, according to standard colour codes of hoses of manifold gauge 1.5. Recovery unit coupled to equipment, following standard procedure for connections 1.6. Overfill protection device checked and safety of operation ensured
2. Recover Refrigerant	2.1. Recovery unit started, process monitored and full recovery of refrigerant, ensured 2.2. Recovery unit stopped, system disconnected according to standard procedure, ensuring that no refrigerant escapes to atmosphere 2.3. Type of recovered refrigerant checked and cylinder weighed

3. Re-cycle Refrigerant	3.1. Recovered refrigerant cylinder and empty cylinder coupled to recycling machine, observing standard procedure and safety practices 3.2. Re-cycling machine started, and process monitored ensuring proper operation 3.3. Hoses disconnected cylinder re-weighed and weight of re-cycled refrigerant recorded 3.4. Re-cycling of all recovered refrigerant ensured

RANGE STATEMENT

Recovery and re-cycling of refrigerants outlined in this unit connected with air conditioning and refrigeration equipment takes place in a workshop where repairs or installation of refrigeration & air conditioning systems are carried out.

Tools, equipment and materials required may include:

- Refrigerant recovery machine
- Refrigerant re-cycling machine
- Piercing pliers/tapping valve
- Valve keys
- Gauge manifold with hoses
- Weighing scale
- Empty refrigerant cylinders
- Personal protective equipment and safety gear
- Relevant service manuals

The standards expected of the performance include the following.

ASHRAE - American Society of Heating Refrigerating & Air conditioning Engineers
JIS - Japan International Standards
SMACNA - Sheet Metal & Air conditioning Contractor's National Association

The refrigerants and chemicals used should comply with the following:

- Sri Lanka Standards for Mechanical Refrigerating Systems used for Cooling and Heating prepared by Sri Lanka Standards Institution in collaboration with the National Ozone Unit of the Ministry of Environment & Natural Resources, and
- The National Policy for Cleaner Production for Sri Lanka drafted by the Ministry of Environment & Natural Resources.
- Ozone Action Programme of the United Nations Environment Programme

ASSESSMENT GUIDE

Forms of assessment

Continuous assessment coupled with gathered evidence of performance is suitable for this unit.

Assessment context

This unit may be assessed on the job demonstrated by an individual working alone or as part of a team.

Critical aspects

The assessment must confirm that the candidate in able to;

- Ensure adherence to safety procedures & practices
- Ensure full recovery & re-cycling of the refrigerant recovered from the system
- Adhere to conditions of the "Environment Protection Acts" (EPA)

Assessment conditions

The candidate will have access to:

- All tools, equipment, material and documentation required.

The candidate will be permitted to refer to the following documents:

- Relevant workplace procedures.
- Relevant product and manufacturing specifications.
- Relevant drawings, manuals, codes, standards and reference material.

The candidate will be required to:

- Orally, or by other methods of communication, answer questions asked by the

assessor. Identify superiors who can be approached for the collection of competency evidence where appropriate.
- Present evidence of credit for any off-job training related to this unit.

Assessors must be satisfied that the candidate can competently and consistently perform all elements of the unit as specified by the criteria, and that he/she possesses the required knowledge.

Special notes

During assessment, the individual will:

- Demonstrate safe work practices at all times;
- Communicate information about processes, events or tasks being undertaken to ensure a safe and efficient working environment;
- Take responsibility for the quality of work;
- Plan tasks in all situations and review task requirements as appropriate;
- Perform all tasks in accordance with standard operating procedures;
- Perform all tasks to specification;
- Use accepted engineering techniques, practices, processes and workplace procedures.

Candidates are required to operate the plant according to the correct sequence of operations, diagnose any defects and attend to corrections independently, as necessary.

Tasks involved will be completed within reasonable time frames relating to typical workplace activities.

Resources required for assessment

May include material, tools, equipment and machines listed within this unit.

UNDERPINNING KNOWLEDGE AND SKILLS

Underpinning Knowledge	Underpinning Skills
• Read and interpret manufacturer's manuals, specifications etc., • Basic refrigeration and air conditioning principles • Refrigeration Cycle • Types of Refrigerants, their properties and applications • Knowledge of Ozone Depleting substances (Refrigerants) and conditions of the " Environment Protection Acts " (EPA) • Functions of the gauge manifold and colour code of hoses • Function of service valves • Working principles of the recycling and re-covery machine • Refrigerant recovery and recycling • Safety procedures to be followed	• Refer to manufacturer's specifications/ instructions on installation of air conditioners • 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 • Recovery and re-cycling of refrigerants using recovery & re-cycling machines and allied accessories • Safe handling and use of refrigerants, gauges, tools & equipment