STANDARD KEMAHIRAN PEKERJAAN KEBANGSAAN
(NATIONAL OCCUPATIONAL SKILLS STANDARD)

F432-003-2-2017

AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV)
INSTALLATION & MAINTENANCE OPERATION SUPERVISION

LEVEL 2

JPK

JABATAN PEMBANGUNAN KEMAHIRAN
KEMENTERIAN SUMBER MANUSIA, MALAYSIA

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Federal Government Administrative Centre
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NATIONAL OCCUPATIONAL SKILLS STANDARD

OPERASI PEMASANGAN & PENYENGGARAAN PENGHAWA DINGIN DAN PENGUDARAAN MEKANIKAL

AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV) INSTALLATION & MAINTENANCE OPERATION

LEVEL 2

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Abbreviation

1.	ABS	Acrylonitrile Butadiene Styrene
2.	AHU / AH	Air Handling Unit
3.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
4.	BTU	British Thermal Unit
5.	CIDB	Construction Industry Development Board
6.	CoCU	Curriculum of Competency Unit
7.	CP	Competency Profile
8.	CPC	Competency Profile Chart
9.	CU	Competency Unit
10.	DKM	Diploma Kemahiran Malaysia
11.	DLKM	Diploma Lanjutan Kemahiran Malaysia
12.	FCU	Fan Coil Unit
13.	GI	Galvanised Iron
14.	JHA	Job Hazard Analysis
15.	JSA	Job Safety Analysis
16.	M&E	Mechanical and Electrical
17.	MS	Malaysian Standard
18.	MS	Malaysian Standard
19.	MSDS	Material Safety Data Sheet
20.	NIOSH	National Institute of Occupational Safety & Health
21.	OSHA	Occupational Safety & Health Act
22.	PE	Polyethylene
23.	PPE	Personal Protective Equipment
24.	PTW	Permit To Work
25.	PU	Polyurethane
26.	QC	Quality Control
27.	R&D	Research & Development
28.	SKM	Sijil Kemahiran Malaysia
29.	SOP	Standard Operating Procedure
30.	ST / EC	Suruhanjaya Tenaga / Energy Commission
31.	STEC	Standard Technical Evaluation Committee
32.	UPVC	Unplasticized Polyvinyl Chloride

Glossary

1.	Air Handling Unit	A central unit consisting of a blower, heating and cooling elements, filter racks or chamber, dampers, humidifier, and other central equipment in direct contact with the airflow. This does not include the ductwork through the building.
2.	Centrifugal Fan	A centrifugal fan is a mechanical device for moving air or other gases.
3.	Chiller	A device that removes heat from a liquid via a vapor-compression or absorption refrigeration cycle. This cooled liquid flows through pipes in a building and passes through coils in air handlers, fan-coil units, or other systems, cooling and usually dehumidifying the air in the building. Chillers are of two types; air-cooled or water-cooled. Air-cooled chillers are usually outside and consist of condenser coils cooled by fan-driven air. Water-cooled chillers are usually inside a building, and heat from these chillers is carried by recirculating water to a heat sink such as an outdoor cooling tower.
4.	Coil	Equipment that performs heat transfer to air when mounted inside an air handling unit or ductwork. It is heated or cooled by electrical means or by circulating liquid or steam within it.
5.	Condenser	A component in the basic refrigeration cycle that ejects or removes heat from the system. The condenser is the hot side of an air conditioner or heat pump. Condensers are heat exchangers, and can transfer heat to air or to an intermediate fluid (such as water or an aqueous solution of ethylene glycol) to carry heat to a distant sink, such as ground (earth sink), a body of water, or air (as with cooling towers).
6.	Controller	A device that controls the operation of part or all of a system. It may simply turn a device on and off, or it may more subtly modulate the set point of components. Most controllers are automatic but have user input such as temperature set points, e.g. a thermostat. Controls may be analogue or digital.
7.	Damper	A plate or gate placed in a duct to control air flow by increasing friction in the duct.
8.	Dehumidifier	A dehumidifier is the equipment that extracts and removes humidity from the air. It works by cooling air to the point where water turns to liquid from vapour form and then the liquid is removed.
9.	Diffuser	A diffuser is placed over ductwork, and it separates air with vanes going in differing directions. It evenly distributes air flow in the desired directions.
10.	Duct	Specialized housing for the air flow.
11.	Fan Coil Unit	A small terminal unit that is often composed of only a blower and a heating and/or cooling coil, as is often used in hotels, condominiums, or apartments.
12.	Fresh Air Intake	An opening through which outside air is drawn into the building. This may be to replace air in the building that has been exhausted by the ventilation system, or to provide fresh air for combustion of fuel.
13.	Grille	A facing across a duct opening, often rectangular in shape, containing multiple parallel slots through which air may be delivered or withdrawn from a ventilated space. The grille directs the air flow in a particular direction and prevents the passage of large items.
14.	Heavy Commercial ACMV	Heavy Commercial is referring to high rise and industrial building with cooling capacity above 10 horse power (100,000 BTU / hour).
15.	Light Commercial ACMV	Light Commercial is referring to small and medium size building with cooling capacity below 10 horse power (100,000 BTU / hour).
16.	MS1525:2014	Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-

	Residential Buildings
17. Shop Drawing	A shop drawing is a drawing or set of drawings produced by the contractor, supplier, manufacturer, subcontractor, or fabricator. Shop drawings are typically required for prefabricated components.
18. Thermostat	A thermostat is a system that monitors and regulates a heating or cooling system. It can be used to set the desired temperature at which it keeps the environment either heated or cooled.

Acknowledgement

The Director General of DSD would like to extend his gratitude to the organisations and individuals who have been involved in developing this Standard including:

i. National Skills Development Council (NSDC)
ii. Standard Technical Committee (STC)
iii. Standard Technical Evaluation Committee (STEC)
iv. Standard Development Committee (SDC)
v. Facilitator
vi. Secretariat
vii. Related Organisation

STANDARD PRACTICE

NATIONAL OCCUPATIONAL SKILLS STANDARD (NOSS) FOR:

AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION

LEVEL 2

1. Introduction

Air Conditioning and Mechanical Ventilation System (ACMV) is a cooling system designed to give proper ventilation to a specific environment. ACMV System maybe a customized air conditioning system installed in any industrial, commercial or household setup. The ACMV system is responsible in controlling the amount of cool air going in to a specific venue reaching the target point as required and designed. This temperature regulation also includes other factors that may affect the quality of fresh air in an area like balanced distribution of oxygen, proper level of air humidity as well as elimination of foul odours, high thermic environment, air impurities, excess carbon dioxide and other floating bacteria that may exist in high humid surroundings.

Ventilation is the process in which the air that circulates the room or any space is changed by either natural or mechanical or forced method to sufficiently maintain the quality of indoor air. Mechanical Ventilation includes the use of exhaust and ceiling fans or the installation of mechanical ventilation system to control the flow rate of cool air coming through any enclosed area while achieving the perfect quality of air needed.

1.1. Occupation Overview

Air conditioning, which includes air cooling, ventilation and disinfection, provides a large number of opportunities for installation and maintenance services. These specialized technicians are responsible for the safe and efficient installation, maintenance and repair of air conditioning systems, which can be found in a wide range of buildings, such as homes, offices, factories, hospitals and hotels.

Some typical job duties of air conditioning technicians include reviewing blueprints, installing air conditioning systems, testing systems for proper functioning, performing emergency repairs, maintaining tools, ordering supplies, and making routine adjustments to maximize operational efficiency. They may also record data when inspecting systems, such as temperature of equipment, fuel consumption and hours of operation. Air conditioning technicians must recover and properly dispose of refrigerants when servicing air conditioning equipment since refrigerants can be harmful to the environment.

1.2. Rationale of NOSS Development

Between 2004 – 2010, the NOSS for ACMV were developed separately under five (5) sub-sectors namely Residential & Light Commercial, Piping, Ducting, Electrical and Maintenance. The existing NOSS has reached the point where the contents are required to be reviewed and revamped as per new format requirements.

1.3. Rationale of Occupational Structure and Occupational Area Structure

The NOSS development committee has come to a consensus that all the NOSS under ACMV should be integrated to reflect the current practice of the industry. The industry landscape for ACMV is very competitive in which a company is offering full-pledged services from designing to maintenance of ACMV system. Therefore, the manpower should be equipped with related skills in installation, piping, ducting, electrical and maintenance. The merging of the areas is depicted in the Occupational Area Structure (OAS) in the following page.

1.4. Regulatory / Statutory Body Requirements Related to Occupation

The industry is regulated by the followings regulatory/statutory body:

- Department of Occupational Safety & Health
  - Occupational Safety and Health Act 1994 (Act 514)
  - Factory & Machineries Act 1967 (Act 139)

- Energy Commission
  - Electricity Supply Act 1990

- Department of Environment
  - Environmental Quality Act 1974 (Amendment 2012)

- Construction Industry Development Board (CIDB)
  - Act 520 Construction Industry Development Board 1994

1.5. Occupational Pre-Requisite

The minimum requirements set forth by the industry for any interested individual to undertake the job or career in this area are as follows:

i. 18-year of age and above; and
ii. Physically and mentally fit.

2. Occupational Structure (OS)

Section	(F) Construction			
Group	(43) Specialized Construction Activities			
Area	Air-Conditioning And Mechanical Ventilation (ACMV)			
	Light Commercial	Heavy Commercial		
		Piping	Ducting	Maintenance
Level 5	ACMV Project Manager			ACMV Maintenance Manager
Level 4	ACMV Project Executive			ACMV Maintenance Executive
Level 3	Light Commercial ACMV Supervisor	ACMV Piping Supervisor	ACMV Ducting Supervisor	ACMV Maintenance Supervisor
Level 2	Light Commercial ACMV Installer	ACMV Piping Installer	ACMV Ducting Installer	ACMV Maintenance Technician
Level 1	No Level	No Level	No Level	No Level

Figure 1: Occupational Structure

3. Occupational Area Structure (OAS)

Section	(F) Construction			
Group	(43) Specialized Construction Activities			
Area	Air-Conditioning And Mechanical Ventilation (ACMV)			
	Light Commercial	Heavy Commercial		
		Piping	Ducting	Maintenance
Level 5	Air-Conditioning and Mechanical Ventilation Technical Operation & Management			
Level 4	Air-Conditioning and Mechanical Ventilation Technical Operation			
Level 3	Air-Conditioning and Mechanical Ventilation Installation & Maintenance Operation Supervision			
Level 2	Air-Conditioning and Mechanical Ventilation Installation & Maintenance Operation			
Level 1	No Level			

Figure 2: Occupational Area Structure

4. Definition of Competency Levels

The NOSS is developed for various occupational areas. Below is a guideline of each NOSS Level as defined by the Department of Skills Development, Ministry of Human Resources, Malaysia.

Level 1: Competent in performing a range of varied work activities, most of which are routine and predictable.

Level 2: Competent in performing a significant range of varied work activities, performed in a variety of contexts. Some of the activities are non-routine and required individual responsibility and autonomy.

Level 3: Competent in performing a broad range of varied work activities, performed in a variety of contexts, most of which are complex and non-routine. There is considerable responsibility and autonomy and control or guidance of others is often required.

Level 4: Competent in performing a broad range of complex technical or professional work activities performed in a wide variety of contexts and with a substantial degree of personal responsibility and autonomy. Responsibility for the work of others and allocation of resources is often present.

Level 5: Competent in applying a significant range of fundamental principles and complex techniques across a wide and often unpredictable variety of contexts. Very substantial personal autonomy and often significant responsibility for the work of others and for the allocation of substantial resources features strongly, as do personal accountabilities for analysis, diagnosis, planning, execution and evaluation.

5. Award of Certificate

The Director General may award, to any person upon conforming to the Standards the following skills qualifications as stipulated under the National Skills Development Act 2006 (Act 652):

- Malaysian Skills Certificate
- Malaysian Skills Diploma
- Malaysian Skills Advanced Diploma
- Statements of Achievement

6. Occupational Competencies

The Air-Conditioning and Mechanical Ventilation Installation & Maintenance Operation Level 2 personnel is competent in performing the following core competencies:

a. Light Commercial ACMV Installation
b. ACMV Piping Installation
c. ACMV Ducting Installation
d. ACMV Electrical Installation*
e. ACMV Service & Maintenance
f. Heavy Commercial ACMV Installation

*The competency unit of ACMV Electrical Installation is given the emphasis on the installation work of ACMV electrical component system and does not necessarily required electrical competent personnel.

7. Work Conditions

Generally, ACMV Installation & Maintenance personnel (Level 2) work in normal working hours from morning to evening depending on organisation nature of business. They may require working extra hours to fulfil internal and external requirements. They also may be needed to work in shift to accommodate work requirements. All personnel need to have valid CIDB Green Card and use / wear appropriate attire (Personal Protective Equipment) during the commencement of their jobs. They may work individually or group in a hazardous and hot environment. They must physical fit due to nature of job in specialised construction activities.

8. Employment Prospects

Malaysia's construction segment is expected to grow between 8% and 10% in 2016 in terms of projects undertaken, driven by government infrastructure projects, these projects ensure consistent growth in the local construction segment, which will contribute to the country's economy as well as its people through employment opportunities.

With new technologies available in today's marketplace older ACMV system is far less efficient than today's models, costing consumers more money to run, offering less comfort and also taking a larger toll on the environment. In an effort to 'go green' while saving money and providing better comfort levels for homes and workplaces, consumers are making the change to newer HVAC systems. Consumers are also more educated on how keeping ACMV system maintained will benefit them in the long run. With projections of system installations and maintenance on the rise, ACMV personnel are going to be sought after and job market related to ACMV is also expanding.

9. Up Skilling Opportunities

To become ACMV Installation & Maintenance (Level 2), one must first gain knowledge and competency as an installer through structured training or on-the job training. Employers may require a high school certificate or skills certificate for installer or technician position. After these personnel have gained experience and becomes highly skilled and knowledgeable, he or she may be eligible for a promotion to become a supervisor. The amount of time to be promoted depends on a number of variables, including the availability of a job opening and the competitive nature between workers for the leadership role. He or she is likely to succeed if he or she understands construction practices along with having a good technical ability.

10. Organisation Reference for Sources of Additional Information

The following organisations can be referred as sources of additional information which can assist in defining the document's contents.

a. **Construction Industry Development Board (CIDB)**
Tingkat 35, Menara Dato' Onn
Pusat Dagangan Dunia Putra
No. 45, Jalan Tun Ismail
50480 Kuala Lumpur
Tel: 03-40477327
Fax: 03-40477310
Email: info@cidb.gov.my

b. **Department of Occupational Safety and Health (DOSH)**
Level 5 (Main Counter), Block D4, Complex D
Federal Government Administrative Centre, 62530 Putrajaya
Tel: 03-8886 5343
Fax: 03-8889 2443
http://www.dosh.gov.my

c. **Department of Environment**
Ministry of Natural Resources and Environment
Level 1 – 4, Podium 2 & 3, Wisma Sumber Asli
No.25, Persiaran Perdana, Precint 4
Federal Government Administrative Centre
62574 Putrajaya
Tel: 03-8871 2000 / 2200
Fax: 03-8889 1973/75
http://www.doe.gov.my

d. **MASHRAE Secretariat**
Unit 518 Block A, Kelana Business Centre
No. 97 Jalan SS7/2, Kelana Jaya, 47301 Petaling Jaya
Selangor Darul Ehsan
Tel: 011-10988558 or +603-7887 5886
Fax: 03-7887 5886
http://www.ashrae.org.my

e. **Energy Commission**
No. 12, Jalan Tun Hussein
Precinct 2
62100 Putrajaya
Tel: 03-8870 8500
Fax: 03-8888 8637
http://www.st.gov.my

11. Standard Technical Evaluation Committee

NO	NAME	POSITION & ORGANISATION
1.	Burhanuddin Bin Bahrum	Instructor Akademi Binaan Malaysia Wilayah Utara
2.	Kamarulzaman Bin Mohammad	Instructor Akademi Binaan Malaysia Wilayah Sarawak
3.	Azdikah Bin Abdukah	Instructor Akademi Binaan Malaysia Wilayah Sabah

12. Standard Development Committee

AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION

LEVEL 2

NO	NAME	POSITION & ORGANISATION
1.	En Peter Tan Chin Wah	Asset & Property Management Director Genesis Prominent Sdn Bhd
2.	En Zulramly Bin Baharudin	Technical Manager Houz Deport Sdn Bhd
3.	Dato' Andy Kwan Teck Hian	President Malaysian Air-Conditioning & Refrigeration Association (MACRA)
4.	En Gan Chok Ser	Technical Director Cooling Innovation Sdn Bhd Education Chairman Malaysian Air-Conditioning & Refrigeration Association (MACRA)
5.	En Abd Walid Bin Abd Hamid	Project Executive CEPSI Training & Services Resources
6.	Ir. Mazlan bin Mahmud	Project Director BMES Maintenance Services Sdn Bhd
7.	En Mike Lee Wai Hoong	Technical Director Blue Aire Services Sdn Bhd
8.	En Ahmad Suhaimi Bin Che Din	Senior Asisstant Director (Curriculum Development) Majlis Amanah Rakyat (MARA)
9.	En Kamarul Bahar Bin Abdul Rahim	Senior Instructor Perbadanan Hal Ehwal Bekas Angkatan Tentera (PERHEBAT) Kem Sungai Buloh
10.	En Mohd Syarafi Bin Rohseli	President Persatuan Pemerkasaan Pembangunan Kemahiran Dan Kompetensi Malaysia
11.	En Azrul Nizam Bin Abd Razak	Head of Mechanical & Electrical Unit Akademi Binaan Malaysia (ABM) Wilayah Tengah
FACILITATOR		
1.	En Abu Musa Bin Mohamad Isa	Facilitator Adimega Sdn Bhd

STANDARD CONTENT

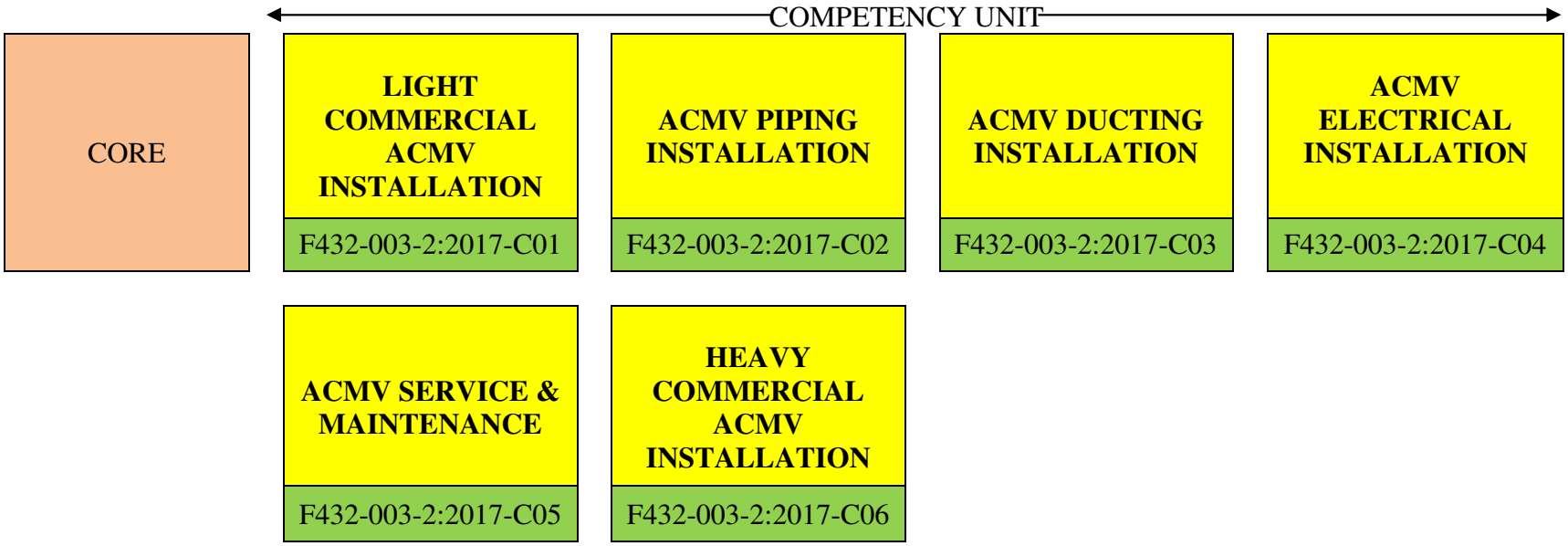
NATIONAL OCCUPATIONAL SKILLS STANDARD (NOSS) FOR:

AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION

LEVEL 2

13. Competency Profile Chart (CPC)

SECTION	(F) CONSTRUCTION		
GROUP	(432) ELECTRICAL, PLUMBING AND OTHER CONSTRUCTION INSTALLATION ACTIVITIES		
AREA	AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV)		
NOSS TITLE	AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION		
NOSS LEVEL	2 (TWO)	NOSS CODE	F432-003-2:2017



14. Competency Profile (CP)

SECTION	(F) CONSTRUCTION		
GROUP	(432) ELECTRICAL, PLUMBING AND OTHER CONSTRUCTION INSTALLATION ACTIVITIES		
AREA	AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV)		
NOSS TITLE	AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION		
NOSS LEVEL	2 (TWO)	NOSS CODE	F432-003-2:2017

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
1. Light Commercial ACMV Installation F432-003-2:2017-C01	Light Commercial is referring to small and medium size building with cooling capacity below 10 horse power (100,000 BTU / hour). Light Commercial ACMV Installation describes the competency in installing air conditioning equipment, refrigerant pipe, electrical wiring according to manufacturer specifications and client requirements in compliance with MS 1525:2014 and ASHRAE Guidelines. A competent person in this CU shall be able to identify installation work requirements, carry out installation initial preparation, carry out air conditioning equipment	1. Identify light commercial ACMV installation work requirements	1.1 Site location, work time frame and manpower determined according to work instructions 1.2 Work area, facilities and amenities safety complied according to site safety requirements 1.3 Related acts or regulation complied as per work requirements 1.4 Related Personal Protective Equipment (PPE) requirements complied as per work requirements
		2. Carry out light commercial ACMV installation initial preparation	2.1 Refrigerant piping penetration works prepared as per work instruction 2.2 Refrigerant piping installation works prepared as per work instruction 2.3 ACMV wiring installation works prepared as per work instruction 2.4 ACMV equipment installation works prepared as per work instruction 2.5 Wiring penetration works prepared as per work instruction 2.6 Installation access route surveyed as per

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
	installation, carry out air conditioning refrigerant pipe installation activities, carry out ACMV electrical wiring installation works, carry out air conditioning testing and commissioning, and carry out ACMV system service & maintenance activities. The outcome of this competency is the ability to carrying out Light Commercial ACMV installation works in compliance with work instructions, related standards and regulatory body requirements.		work instruction 2.7 Work area housekeeping carried out as per work instruction
		3. Install light commercial ACMV equipment	3.1 Air conditioning equipment installation location identified as per layout plan 3.2 Air conditioning bracket installed as per shop drawing 3.3 Air conditioning equipment installed as per shop drawing 3.4 Air conditioning refrigerant pipe final connection works carried out as per shop drawing 3.5 Work area housekeeping carried out as per work instruction
		4. Install light commercial ACMV refrigerant pipe	4.1 Refrigerant pipe bracket installed as per shop drawing 4.2 Refrigerant pipe insulation works carried out according to insulation method 4.3 Refrigerant pipe bending carried out as per shop drawing 4.4 Refrigerant piping installed as per shop drawing 4.5 Drain pipe installed as per shop drawing 4.6 Refrigerant swaging joint carried out as per shop drawing 4.7 Refrigerant flaring joint carried out as per shop drawing 4.8 Refrigerant pipe brazing joint carried out as per shop drawing 4.9 Work area housekeeping carried out as per work instruction

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
		5. Install light commercial ACMV electrical wiring	5.1 Air conditioning control wiring installed as per electrical drawing 5.2 Air conditioning power supply wiring installed as per electrical drawing 5.3 Wiring termination carried out as per electrical drawing 5.4 Work area housekeeping carried out as per work instruction
		6. Perform light commercial ACMV testing	6.1 Air conditioning refrigerant system leak test carried out as per testing procedure 6.2 Air refrigerant system vacuuming carried out as per testing procedure 6.3 Refrigerant system charging carried out as per testing procedure 6.4 Work area housekeeping carried out as per work instruction
		7. Perform light commercial ACMV system service and maintenance activities	7.1 Air conditioning routine service and maintenance works carried out as per maintenance schedule 7.2 ACMV trouble shooting carried out according to installation and operation manual 7.3 ACMV corrective maintenance works carried out according to service and operation manual 7.4 ACMV system recovery works carried out according to DOE requirement. 7.5 ACMV system service and maintenance checklist updated as per work instruction 7.6 Work area housekeeping carried out as per work instruction

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
			7.7 Tools and equipment stored at designated area as per work instruction
2. ACMV Piping Installation F432-003-2:2017-C02	ACMV Piping Installation describes the competency in assembling and setting up ACMV related pipes work in accordance with work specifications and related standards. A competent person in this CU shall be able to identify piping installation work requirements, carry out piping installation initial preparation, perform pipe fabrication works, perform pipe brackets works, perform valve fittings & pipe jointing works, install ACMV equipment piping, perform pipe pressure testing works and perform pipe insulation works. The outcome of this competency is the ability to fabricate, install, joint, insulate, and test ACMV piping in compliance with shop drawing and related standards.	1. Identify piping installation work requirements	1.1 Site location, work time frame and manpower determined according to work instructions 1.2 Work area, facilities and amenities safety complied according to site safety requirements 1.3 Related acts or regulation complied as per work requirements 1.4 Related Personal Protective Equipment (PPE) requirements complied as per work requirements
		2. Carry out piping installation initial preparation	2.1 Symbol, legend, size and pipe access route interpreted as per piping layout plan 2.2 Types of pipe materials and accessories identified as per piping layout plan 2.3 Types and function of tools and equipment identified as per work requirements 2.4 Piping penetration works prepared as per work instructions 2.5 Piping installation works prepared as per work instructions 2.6 Work area housekeeping carried out as per work instruction
		3. Perform pipe fabrication works	3.1 Piping routing identified as per piping layout plan 3.2 Pipe cutting carried out as per piping drawing and cutting method

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
			3.3 Pipe bending carried out as per piping drawing and cutting method 3.4 Pipe threading carried out as per piping drawing and threading method 3.5 Work area housekeeping carried out as per work instruction
		4. Perform pipe brackets works	4.1 Types of piping bracket and materials identified according to piping drawing and specifications 4.2 Piping bracket fabricated according to specifications and fabrication method 4.3 Piping bracket painting works carried out as per specifications and painting method 4.4 Piping bracket installed as per piping drawing and installation method 4.5 Pipe sleeve installed as per specifications and installation method 4.6 Fabricated pipes erected as per piping layout plan 4.7 Work area housekeeping carried out as per work instruction
		5. Perform valve fittings & pipe jointing works	5.1 Threaded valve connection carried out as per shop drawing 5.2 Flange valve connection carried out as per shop drawing 5.3 Threaded joint carried out as per shop drawing and specifications 5.4 Welding / brazing joint carried out as per shop drawing and specifications

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
			5.5 Coupling joint carried out as per shop drawing and specifications 5.6 Pipe valve fittings installed as per shop drawing and installation method 5.7 Work area housekeeping carried out as per work instruction
		6. Install ACMV equipment piping	6.1 Spring isolator and neoprene pad installed as per piping drawing and installation method 6.2 Make up tank piping installed as per piping drawing and installation method 6.3 Fan coil unit piping installed as per piping drawing and installation method 6.4 Air handling unit piping installed as per piping drawing and installation method 6.5 Pump piping installed as per piping drawing and installation method 6.6 Cooling tower piping installed as per piping drawing and installation method 6.7 Condensing unit piping installed as per piping drawing and installation method 6.8 Chiller pipe connection carried out as per piping drawing 6.9 Work area housekeeping carried out as per work instruction
		7. Perform pipe pressure testing works	7.1 Pipe flushing works requirements prepared as per work instructions 7.2 Piping pressurization system test carried out as per testing procedure

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
			7.3 Water piping air purging carried out as per testing procedure 7.4 Work area housekeeping carried out as per work instruction
		8. Perform pipe insulation works	8.1 Insulation method identified as per work requirements 8.2 Insulation works requirements prepared as per work instructions 8.3 Insulation works carried out as per work instruction and insulation method 8.4 Pipe painting work carried out as per piping drawing and specifications 8.5 Pipe labelling carried out according to work instruction and labelling requirements 8.6 Work area housekeeping carried out as per work instruction

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
3. ACMV Ducting Installation F432-003-2:2017-C03	ACMV Ducting Installation describes the competency in assembling and setting up conduits or passages to deliver and remove air in accordance with shop drawing and required standard. The needed airflows include supply air, return air, and exhaust air. Ducts also deliver ventilation air as part of the supply air. As such, air ducts are one method of ensuring acceptable indoor air quality as well as thermal comfort. A competent person in this CU shall be able to identify ducting installation work requirements, prepare ducting installation works requirements, perform ducting fabrication, perform wall opening frame works, install ACMV equipment, perform duct jointing, install ACMV ducting, install ACMV air side fittings, perform duct tapping off opening, perform ducting joint insulation and perform ducting finishing works.	1. Identify ducting installation work requirements	1.1 Site location, work time frame and manpower determined according to work instructions 1.2 Work area, facilities and amenities safety complied according to site safety requirements 1.3 Related acts or regulation complied as per work requirements 1.4 Related Personal Protective Equipment (PPE) requirements complied as per work requirements
		2. Prepare ducting installation works requirements	2.1 Symbol, legend, size and duct access route interpreted based on ducting layout plan 2.2 Types and function of ducting materials and accessories identified as per work requirements 2.3 Types and function of tools and equipment identified as per work requirements 2.4 Ducting materials, accessories, tools and equipment arranged as per work instructions 2.5 Work area housekeeping carried out as per work instruction
		3. Perform ducting fabrication	3.1 Type, size, quantity of materials and ducting route checked against ducting design drawing and ducting layout plan 3.2 Type of duct identified as per ducting design drawing and specifications

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
	The outcome of this competency is the ability to fabricate, install, joint and insulate ACMV ducting in compliance with shop drawing and related standards.		3.3 Sheet metal cutting carried out as per ducting design drawing and cutting method 3.4 Duct forming and jointing carried out as per ducting design drawing and forming method 3.5 Duct jointing and sheet metal thickness checked as per ducting design drawing and specifications 3.6 Work area housekeeping carried out as per work instruction
		4. Perform ducting frame installation works	4.1 Location and size of wall opening frame identified as per ducting layout plan 4.2 Temporary duct frame opening dismantled as per work instruction 4.3 New wall ducting frame installed as per ducting layout plan 4.4 Duct opening gap sealed as per required sealing method 4.5 Work area housekeeping carried out as per work instruction
		5. Install ACMV equipment	5.1 Spring isolator and neoprene pad installed as per installation and operation manual 5.2 Fan coil unit installed according to installation and operation manual 5.3 Air handling unit installed according to installation and operation manual 5.4 Pump set installed according to installation and operation manual 5.5 Cooling tower installed according to installation and operation manual

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
			5.6 Ventilation fan installed according to installation and operation manual 5.7 Variable air volume unit installed according to installation and operation manual 5.8 Chiller unit installed according to installation and operation manual 5.9 Work area housekeeping carried out as per work instruction
		6. Perform duct jointing	6.1 Type of duct jointing work identified as per ducting drawing and work instruction 6.2 Duct jointing work carried out according to jointing type and method 6.3 Gap joint sealed as per shop drawing and sealing method 6.4 Work area housekeeping carried out as per work instruction
		7. Install ACMV ducting	7.1 Ducting bracket installed as per ducting layout drawing 7.2 Fabricated duct assembled as per ducting drawing 7.3 Fabricated duct insulated according to work instruction and required insulation method 7.4 Fabricated ducting erected as per ducting layout drawing 7.5 Duct joints sealed as per required sealing method 7.6 Fabricated duct painted according to work instruction and project specifications

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
			7.7 Work area housekeeping carried out as per work instruction
		8. Perform duct tapping off opening	8.1 Duct tapping off opening carried out as per work instruction and ducting drawing 8.2 Branch off duct installed as per ducting drawing and installation method 8.3 Duct collar installed as per ducting drawing and installation method 8.4 Flexible duct installed as per ducting drawing and installation method 8.5 Supply and return air diffuser installed as per ducting drawing and installation method 8.6 Work area housekeeping carried out as per work instruction
		9. Install ACMV air side fittings and accessories	9.1 Air outlet opening carried as per ducting drawing and work instruction 9.2 Air outlet bracket installed as per ducting drawing and installation method 9.3 Fire damper installed as per ducting drawing and installation method 9.4 Fire damper insulated according to work instruction and required insulation method 9.5 Air outlet installed as per ducting drawing and installation method 9.6 Volume control damper installed as per ducting drawing and installation method 9.7 Supply and return air grille installed as per ducting drawing and installation method

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
			9.8 Duct splitter installed as per ducting drawing and installation method 9.9 Work area housekeeping carried out as per work instruction
		10. Perform ducting joint insulation	10.1 Method and type of insulation materials identified as per work instruction and specification 10.2 Ducting insulated according to required insulation method and ducting drawing 10.3 Insulated ducting joint checked according to inspection method and testing procedure 10.4 Work area housekeeping carried out as per work instruction
		11. Perform ducting finishing works	11.1 Visual inspection on ducting material, type, size and bracket carried out as per ducting specifications and ducting drawing 11.2 Ducting bracket leveling checked as per ducting drawing and work instruction 11.3 Ducting 'touch-up' painting carried out as per ducting drawing and work instruction 11.4 Fire rated coating works checked as per ducting drawing and work instruction 11.5 Ducting labelling carried out as per ducting drawing and work instruction 11.6 Work area housekeeping carried out as per work instruction

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
4. ACMV Electrical Installation F432-003-2:2017-C04	ACMV Electrical Installation describes the competency in assembling and setting up of ACMV electrical equipment for the purpose of distribution and utilization of electrical energy in compliance with work specifications and regulatory body requirements. The scope of work is limited to installation of ACMV electrical component system and does not necessarily required electrical competent personnel. A competent person in this CU shall be able to identify ACMV electrical installation work requirements, install ACMV electrical switch board panel, perform ACMV electrical switch board maintenance, perform ACMV electrical wiring activities, check ACMV electrical control components, check ACMV electrical motor performance and perform	1. Identify ACMV electrical installation work requirements	1.1 Site location, work time frame and manpower determined according to work instructions 1.2 Work area, facilities and amenities safety complied according to site safety requirements 1.3 Related acts or regulation complied as per work requirements 1.4 Related Personal Protective Equipment (PPE) requirements complied as per work requirements
		2. Install ACMV electrical switch board panel	2.1 ACMV electrical switch board components base installed as per electrical schematic drawing 2.2 ACMV electrical components and accessories (contactor, time delay relay, overload relay, etc.) installed as per electrical schematic drawing 2.3 ACMV electrical control and power circuit wiring carried out as per electrical schematic drawing 2.4 ACMV electrical switch board panel installed as per electrical schematic drawing 2.5 Work area housekeeping carried out as per work instruction

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
	ACMV electrical troubleshooting Activities. The outcome of this competency is the ability to carrying out wiring works, installation, maintenance and troubleshooting of ACMV electrical equipment and components in accordance with schematic drawing and electrical safety manual.	3. Perform ACMV electrical switch board maintenance	3.1 Condition of cable termination checked as per electrical schematic drawing 3.2 Condition of switch board components (selector switch, push button, contactor, indicator light, etc.) checked as per electrical schematic drawing 3.3 ACMV electrical switch board troubleshooting carried out as per electrical schematic drawing 3.4 ACMVE electrical switch board maintenance works (repair / replacement) carried out as per electrical schematic drawing 3.5 ACMV electrical switch board cleaning work carried out as per work instruction 3.6 Work area housekeeping carried out as per work instruction
		4. Perform ACMV electrical wiring activities	4.1 ACMV electrical cable tray and wire way installed as per ACMV electrical schematic drawing 4.2 ACMV electrical cable terminated as per ACMV electrical schematic drawing 4.3 ACMV electrical cable connection and termination to control devices carried out as per ACMV electrical schematic drawing 4.4 ACMV electrical cable, components and control devices testing conducted as per work instruction and testing procedure

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
			4.5 ACMV electrical cabling troubleshooting / repair / replacement carried out as per ACMV electrical schematic drawing 4.6 Work area housekeeping carried out as per work instruction
		5. Conduct preliminary load test on ACMV electrical control devices	5.1 Parts and function of ACMV electrical control devices identified as per ACMV electrical control devices manual 5.2 Motorised control valve functionality checked against preliminary load test checklist 5.3 Flow control switch functionality checked against preliminary load test checklist 5.4 Thermostat controller functionality checked against preliminary load test checklist 5.5 Damper actuator functionality checked against preliminary load test checklist 5.6 Pressure sensor switch functionality checked against preliminary load test checklist 5.7 Pressure differential switch functionality checked against preliminary load test checklist 5.8 ACMV electrical control devices troubleshooting carried out as per ACMV electrical control devices manual 5.9 Work area housekeeping carried out as per work instruction

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
		6. Conduct preliminary load test on ACMV electrical motor	6.1 Parts and function of ACMV electrical motor identified as per ACMV electrical motor manual 6.2 Windings resistance (Ω) checked against preliminary load test checklist 6.3 Winding insulation (mΩ) checked against preliminary load test checklist 6.4 Terminal motor connection checked against preliminary load test checklist 6.5 Motor phase sequence checked against preliminary load test checklist 6.6 Motor rotation checked against preliminary load test checklist 6.7 Rotation speed checked against preliminary load test checklist 6.8 Running load ampere checked against preliminary load test checklist 6.9 Motor inverter (VFD) checked against preliminary load test checklist 6.10 Work area housekeeping carried out as per work instruction
		7. Perform ACMV electrical troubleshooting activities	7.1 ACMV electrical drawing, work instruction, installation and operation manual Interpreted as per troubleshooting work requirement 7.2 Motor / components / devices functionality determined based on troubleshooting findings 7.3 Cable and terminal termination condition determined based on troubleshooting findings

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
			7.4 Repair / replacement of defective electric motor / components / devices and cable carried out as per ACMV electrical installation and operation manual 7.5 Work area housekeeping carried out as per work instruction
5. ACMV Service & Maintenance F432-003-2:2017-C05	ACMV Service & Maintenance describes the competency in maintaining functionality and serviceability of ACMV equipment according to Original Equipment Manufacturer's manual, company's SOP and regulatory body requirements. A competent person in this CU shall be able to identify service & maintenance work requirements, perform air conditioning equipment maintenance, perform ACMV air distribution system maintenance, perform mechanical ventilation system maintenance, perform ACMV cooling tower maintenance, perform ACMV piping system maintenance, perform condenser / chilled water pump and motor system maintenance, and	1. Identify service & maintenance work requirements	1.1 Site location, work time frame and manpower determined according to work instructions 1.2 Work area, facilities and amenities safety complied according to site safety requirements 1.3 Related acts or regulation complied as per work requirements 1.4 Related tools, equipment and materials for service & maintenance arranged as per work instruction 1.5 Related Personal Protective Equipment (PPE) requirements complied as per work requirements
		2. Perform air conditioning equipment maintenance	2.1 Air conditioning equipment parts / components identified as per equipment operation manual 2.2 Air conditioning equipment condition checked based on work instruction 2.3 Maintenance works carried out according to maintenance instruction checklist 2.4 Maintenance record updated according to company's format and procedure

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
	perform refrigeration system maintenance. The outcome of this competency is to maintain optimum level of ACMV equipment for serviceability and meet client requirements.		2.5 Work area housekeeping carried out as per work instruction
		3. Perform ACMV air distribution system maintenance	3.1 Air distribution system parts and components identified as per air distribution system operation manual 3.2 Air distribution system conditionchecked based on work instruction 3.3 Maintenance works (routine / preventive / corrective) carried out according to maintenance instruction checklist 3.4 Maintenance record updated according to company's format and procedure 3.5 Work area housekeeping carried out as per work instruction
		4. Perform mechanical ventilation system maintenance	4.1 Mechanical ventilation system parts and components identified as per mechanical ventilation system operation manual 4.2 Mechanical ventilation system condition checked based on work instruction and checklist 4.3 Maintenance works (routine / preventive / corrective) carried out according to work instruction and service manual 4.4 Maintenance record updated according to company's format and procedure 4.5 Work area housekeeping carried out as per work instruction

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
		5. Perform ACMV cooling tower maintenance	5.1 Cooling tower parts and components identified as per ACMV cooling tower operation manual 5.2 Cooling tower structure, water distribution, infill, fan motor, sprinkler head checked to determine condition and operability based on maintenance instruction checklist 5.3 Maintenance works (routine / preventive / corrective) carried out according to work instruction and service manual 5.4 Maintenance record updated according to company's format and procedure 5.5 Work area housekeeping carried out as per work instruction
		6. Perform ACMV piping system maintenance	6.1 Piping system parts and components identified as per ACMV piping system operation manual 6.2 Temperature, insulation and leakages checked to determine piping system condition based on manitenance instruction checklist 6.3 Maintenance works (routine / preventive / corrective) carried out according to work instruction and service manual 6.4 Maintenance record updated according to company's format and procedure 6.5 Work area housekeeping carried out as per work instruction

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
		7. Perform condenser / chilled water pump and motor maintenance	7.1 Condenser / chilled water pump and motor condition checked based on work instruction 7.2 Condenser / chilled water pump and motor parts and components identified as per condenser / chilled water pump and motor operation manual 7.3 Maintenance works (routine / preventive / corrective) carried out according to maintenance instruction checklist 7.4 Maintenance record updated according to company's format and procedure 7.5 Work area housekeeping carried out as per work instruction
		8. Perform air conditioning system maintenance	8.1 Air conditioning system parts and components identified as per air conditioning system operation manual 8.2 Air conditioning system condition checked against on maintenance instruction checklist 8.3 Maintenance works (routine / preventive / corrective) carried out according to work instruction and service manual 8.4 Maintenance record updated according to company's format and procedure 8.5 Work area housekeeping carried out as per work instruction

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
6. Heavy Commercial ACMV Installation F432-003-2:2017-C06	Heavy Commercial is referring to high rise and industrial building with cooling capacity above 10 horse power (100,000 BTU / hour). Heavy Commercial ACMV Installation describes the competency in installing air conditioning equipment, and electrical wiring according to M&E consultant specifications in compliance with MS 1525:2014 and ASHRAE Guidelines. A competent person in this CU shall be able identify installation work requirements, carry out installation initial preparation, install air conditioning equipment, perform ACMV electrical wiring works and carry out air conditioning testing. The outcome of this competency is the ability to carrying out Heavy Commercial ACMV installation works in compliance	1. Identify installation work requirements	1.1 Site location, work time frame and manpower determined according to work instructions 1.2 Work area, facilities and amenities safety complied according to site safety requirements 1.3 Related acts or regulation complied as per work requirements 1.4 Related Personal Protective Equipment (PPE) requirements complied as per work requirements
		2. Carry out installation initial preparation	2.1 Equipment opening access prepared as per work instruction 2.2 Equipment access route prepared as per work instruction 2.3 Equipment installation location prepared as per work instruction 2.4 Tools, equipment and materials storage area at site prepared as per work instruction 2.5 Work area housekeeping carried out as per work instruction
		3. Install air conditioning equipment	3.1 Fan Coil Unit (FCU) installed according to M&E consultant specification 3.2 Air Handling Unit (AHU) installed according to M&E consultant specification 3.3 Cooling tower installed according to M&E consultant specification 3.4 Chiller unit installed according to M&E consultant specification

CU TITLE & CU CODE	CU DESCRIPTOR	WORK ACTIVITIES	PERFORMANCE CRITERIA
	with work specifications and regulatory body requirements. The personnel who are to be competent in this competency must in prior have the following competencies:- i. ACMV Piping Installation ii. ACMV Ducting Installation		3.5 Chilled water / condenser water pump installed according to M&E consultant specification 3.6 Work area housekeeping carried out as per work instruction
		4. Perform ACMV electrical wiring works	4.1 Air conditioning control panel installed according to shop drawing and electrical safety manual 4.2 Air conditioning control wiring installed according to shop drawing and electrical safety manual 4.3 Air conditioning power supply wiring installed according to shop drawing and electrical safety manual 4.4 Wiring termination carried out according to shop drawing and electrical safety manual 4.5 Work area housekeeping carried out as per work instruction
		5. Perform air conditioning testing	5.1 Air conditioning refrigerant system testing (leak test, flushing, vacuuming, charging) carried out as per testing procedure and work instruction 5.2 Functionality of ACMV system (open circuit, closed circuit) tested according to testing procedure and work instruction 5.3 Testing checklist updated according to SOP 5.4 Work area housekeeping carried out as per work instruction

CURRICULUM OF COMPETENCY UNIT

NATIONAL OCCUPATIONAL SKILLS STANDARD (NOSS) FOR:

AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION

LEVEL 2

15. Curriculum of Competency Unit

15.1. Light Commercial ACMV Installation

SECTION	(F) CONSTRUCTION		
GROUP	(432) ELECTRICAL, PLUMBING AND OTHER CONSTRUCTION INSTALLATION ACTIVITIES		
AREA	AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV)		
NOSS TITLE	AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION		
COMPETENCY UNIT TITLE	LIGHT COMMERCIAL ACMV INSTALLATION		
LEARNING OUTCOMES	The outcome of this competency unit is to carrying out Light Commercial ACMV installation works in compliance with work instructions, related standards and regulatory body requirements. Upon completion of this competency unit, trainees shall be able to: 1. Identify light commercial ACMV installation work requirements 2. Carry out light commercial ACMV installation initial preparation 3. Install light commercial ACMV equipment 4. Install light commercial ACMV refrigerant pipe 5. Install light commercial ACMV electrical wiring 6. Perform light commercial ACMV testing 7. Perform light commercial ACMV system service and maintenance activities		
TRAINING PRE-REQUISITE	NIL		
CU CODE	F432-003-2:2017-C01	NOSS LEVEL	2

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
1. Identify light commercial ACMV installation work requirements	1.1 Introduction to ACMV • ACMV systems ▪ Air cool system ▪ Water cool system • ACMV equipment ▪ Split unit ▪ Wall mounted	1.1 Interpret work instruction 1.2 Comply with site safety requirements 1.3 Identify related tools, equipment and materials	ATTITUDE • Resourceful in gathering information • Systematic in organizing works	1.1 ACMV systems explained 1.2 Type and function of tools, equipment and materials listed and explained 1.3 Malaysian Standard- MS 1525:2014 Code of Practice on Energy Efficiency and Use of Renewable Energy for

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	▪ Ceiling cassette ▪ Ceiling exposed ▪ Ceiling concealed ▪ Package unit • Shop drawing • Layout drawing • Schematic diagram • Electrical drawing 1.2 Work instruction format and contents such as • Site location • Work time frame • Manpower 1.3 Site safety requirements such as • Work area • Facilities • Amenities 1.4 Related tools, equipment and materials such as • Tools ▪ Hand tools - Manifold gauge - Ratchet wrench - Pliers - Screw drivers - Flaring / swaging set - Copper tube	1.4 Comply with related acts or regulation (if required) 1.5 Comply with related standard 1.6 Comply with PPE		Non-Residential Buildings described and applied 1.4 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Guidelines and Standards described and applied 1.5 ACMV related acts or regulation listed and explained 1.6 Related Personal Protective Equipment (PPE) requirements listed and explained

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	cutter - Tube bender - Reamer - Spanner set - Allen key - Adjustable spanner - Hammer / mallet - Test pen - Measuring tape - Hacksaw - Levels - Thermometer - Ammeter - Multimeter - Marking tools - Clamping tools - PVC cutter - Pipe / adjustable wrench - Cable stripper - Cable crimper - Extension cable ▪ Power tools - Hand drill - Jigsaw - Grinder • Equipment ▪ Vacuum pump ▪ Vacuum gauge s			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	▪ Coring machine ▪ Water jet ▪ Oxy acetylene set ▪ Arc welding set ▪ Lifting equipment ▪ Temporary structure ▪ Temporary lighting ▪ Pipe cutting machine • Materials ▪ Filler ▪ Glue ▪ Close cell insulation tube ▪ PVC pipe ▪ Copper tube / pipe ▪ Masking tape ▪ Duct tape ▪ Insulation tape ▪ High tension tape ▪ Rag ▪ Refrigerant ▪ Wire ▪ Cable 1.5 Related acts or regulation such as • Occupational Safety and Health Act 1994 (Act 514)			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Electricity Supply Act 1990 • Factory & Machineries Act 1967 (Act 139) • Environmental Quality Act 1974 (Amendment 2012) • Act 520 Construction Industry Development Board 1994 1.6 Related standard such as • Malaysian Standard- MS 1525:2014 Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings • American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Guidelines and			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	Standards 1.7 PPE such as • Respirator gas mask • Dust mask • Gloves • Safety boot / shoes • Goggles • Safety helmet • Safety harness			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
2. Carry out light commercial ACMV installation initial preparation	2.1 Types and usage of copper tube / pipe 2.2 Types and method of handling refrigerant such as • R22 • R410a • R134a • R407C • R32 2.3 Copper tube / pipe specification such as • Size • Thickness 2.4 Site safety requirements such as • Working at height (temporary structure) • Confined space 2.5 Installation initial preparation works such as • Refrigerant piping penetration • Refrigerant piping installation • ACMV wiring installation • ACMV equipment	2.1 Attend work briefing 2.2 Locate installation access route 2.3 Comply with site requirements 2.4 Comply with site safety requirements 2.5 Prepare refrigerant piping penetration works 2.6 Prepare refrigerant piping installation works 2.7 Prepare wiring penetration works 2.8 Prepare ACMV wiring installation works 2.9 Prepare ACMV equipment installation works 2.10 Carry out work area housekeeping	<u>ATTITUDE</u> • Attentive to details in preparing work requirements • Systematic in organizing work • Timely in completing tasks • Cost conscious <u>SAFETY</u> • Cautious when handling ACMV chemical and refrigerant • Wear related PPE during work <u>ENVIRONMENT</u> • Ensure compliance with environmental regulations	2.1 Types and usage of copper tube / pipe listed and explained 2.2 Types and method of handling refrigerant listed and explained 2.3 Site safety requirements compliance justified 2.4 Light commercial ACMV installation initial preparation works carried out 2.5 Work area housekeeping carried out

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	installation • Wiring penetration • Installation access route 2.6 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
3. Install light commercial ACMV equipment	3.1 Introduction to light commercial ACMV equipment • Type and function • Operation • Maintenance 3.2 Light commercial ACMV equipment installation guidelines such as • ACMV bracket installation • ACMV equipment installation • ACMV refrigerant pipe final connection 3.3 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	3.1 Interpret light commercial ACMV equipment installation layout plan 3.2 Locate light commercial ACMV equipment installation area 3.3 Perform light commercial ACMV bracket installation works 3.4 Perform light commercial ACMV equipment installation works 3.5 Perform light commercial ACMV refrigerant pipe final connection works 3.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Alert during installation work • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	3.1 Light commercial ACMV equipment installation layout plan details explained 3.2 Light commercial ACMV bracket installation carried out 3.3 Light commercial ACMV equipment installation carried out 3.4 Light commercial ACMV refrigerant pipe final connection works carried out 3.5 Work area housekeeping carried out

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
4. Install light commercial ACMV refrigerant pipe	4.1 ACMV refrigerant and drain pipe layout drawing specification such as • Symbol • Legend • Colour code 4.2 Type of jointing method and guidelines • Refrigerant swaging joint • Refrigerant flaring joint • Refrigerant pipe brazing joint 4.3 Refrigerant and drain pipe installation guidelines • Refrigerant pipe bracket installation • Refrigerant pipe insulation • Refrigerant pipe bending • Refrigerant piping installation • Drain pipe installation 4.4 Work area housekeeping requirements such as	4.1 Locate air conditioning refrigerant and drain pipe installation route 4.2 Perform refrigerant pipe bracket installation works 4.3 Perform refrigerant pipe bending 4.4 Perform refrigerant pipe brazing joint 4.5 Perform refrigerant pipe insulation works 4.6 Perform refrigerant swaging joint 4.7 Perform refrigerant flaring joint 4.8 Perform refrigerant piping installation works 4.9 Perform drain pipe installation works 4.10 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Alert during installation work • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	4.1 ACMV refrigerant and drain pipe layout drawing details explained 4.2 Type of jointing method and guidelines explained and followed 4.3 Refrigerant and drain pipe installation guidelines explained and followed 4.4 Refrigerant pipe bracket installation carried out 4.5 Refrigerant pipe insulation works carried out 4.6 Refrigerant pipe bending carried out 4.7 Refrigerant piping installation carried out 4.8 Drain pipe installation carried out 4.9 Work area housekeeping carried out

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• 5S Concept • Housekeeping procedure			
5. Install light commercial ACMV electrical wiring	5.1 Types of ACMV electrical wiring drawings such as • Schematic drawing • Single line drawing • Installation line drawing 5.2 ACMV control wiring installation guidelines 5.3 ACMV power supply wiring installation guidelines 5.4 ACMV Wiring termination guidelines 5.5 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	5.1 Interpret ACMV electrical wiring drawings 5.2 Locate air conditioning electrical wiring installation route 5.3 Perform air conditioning power supply wiring installation 5.4 Perform air conditioning control wiring installation 5.5 Perform wiring termination 5.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Alert during installation work • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling ACMV electrical wiring works • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	5.1 Types of ACMV electrical wiring drawings listed and explained 5.2 ACMV control wiring installation guidelines described and followed 5.3 ACMV power supply wiring installation guidelines described and followed 5.4 ACMV Wiring termination guidelines described and followed 5.5 ACMV control wiring installation carried out 5.6 ACMV power supply wiring installation carried out 5.7 ACMV wiring termination carried out 5.8 Work area housekeeping carried out

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
6. Perform light commercial ACMV testing	6.1 ACMV testing requirements • Purpose • Procedure • Testing instruments / devices such as ▪ Electronic leak detector ▪ Micron gauge ▪ Infrared thermometer 6.2 ACMV refrigerant system leak test method and procedure 6.3 ACMV Air refrigerant system vacuuming method and procedure 6.4 ACMV refrigerant system charging method and procedure 6.5 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	6.1 Interpret ACMV testing requirements 6.2 Perform ACMV refrigerant pipe flushing 6.3 Perform ACMV refrigerant system leak test 6.4 Perform ACMV air refrigerant system vacuuming 6.5 Perform ACMV refrigerant system charging 6.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Accurate in recording testing result • Alert during testing work • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	6.1 ACMV testing requirements listed and described 6.2 ACMV refrigerant system leak test carried out as per testing procedure 6.3 ACMV air refrigerant system vacuuming carried out as per testing procedure 6.4 ACMV refrigerant system charging carried out as per testing procedure 6.5 Work area housekeeping carried out

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
7. Perform light commercial ACMV system service and maintenance activities	7.1 Definition of ACMV service and maintenance 7.2 ACMV service activities such as • Oiling • Replenishment • Inspection 7.3 ACMV maintenance activities • Corrective • Preventive 7.4 ACMV system recovery activities 7.5 ACMV system service and maintenance schedule format and contents 7.6 Type and purpose of ACMV system service and maintenance such as • Air conditioning routine service and maintenance • ACMV trouble shooting • ACMV corrective maintenance 7.7 ACMV system service and maintenance	7.1 Interpret ACMV service and maintenance schedule 7.2 Perform ACMV routine service and maintenance works 7.3 Perform ACMV troubleshooting 7.4 Perform ACMV corrective maintenance works 7.5 Perform ACMV system recovery 7.6 Perform ACMV system service and maintenance reports 7.7 Carry out work area housekeeping 7.8 Carry out tool and equipment storage	<u>ATTITUDE</u> • Thorough in ACMV servicing and maintenance work • Alert during testing work • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	7.1 ACMV service and maintenance schedule described 7.2 ACMV service activities listed and explained 7.3 ACMV routine service and maintenance works carried out 7.4 ACMV troubleshooting carried out 7.5 ACMV corrective maintenance works carried out 7.6 ACMV system service and maintenance reports prepared according to format 7.7 Work area housekeeping carried out 7.8 Tools and equipment stored at designated area

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	reporting format and procedure 7.8 Work area housekeeping requirements such as • 5S concept • Housekeeping procedure • Tool and equipment storage			

Employability Skills

Core Abilities

- Basic Working Communication
- Personal Behaviour Skill
- Work Place Ethics Awareness
- Safety Health And Environment Awareness

Social Values & Social Skills

- Communication skills
- Conceptual skills
- Interpersonal skills
- Learning skills
- Leadership skills
- Multitasking and prioritising
- Self-discipline
- Teamwork

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14 Electricity Supply Act 1990
15 Environmental Quality Act 1974 (Amendment 2012)
16 Factory & Machineries Act 1967 (Act 139)
17 Uniform Building By-Law 1984 (UBBL)

15.2. ACMV Piping Installation

SECTION	(F) CONSTRUCTION
GROUP	(432) ELECTRICAL, PLUMBING AND OTHER CONSTRUCTION INSTALLATION ACTIVITIES
AREA	AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV)
NOSS TITLE	AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION
COMPETENCY UNIT TITLE	ACMV PIPING INSTALLATION
LEARNING OUTCOMES	The outcome of this competency unit is to fabricate, install, joint and insulate ACMV piping in compliance with shop drawing and related standards. Upon completion of this competency unit, trainees shall be able to: 1. Identify piping installation work requirements 2. Carry out piping installation initial preparation 3. Perform pipe fabrication works 4. Perform pipe brackets works 5. Perform valve fittings & pipe jointing works 6. Install ACMV equipment piping 7. Perform pipe pressure testing works 8. Perform pipe insulation works
TRAINING PRE-REQUISITE	NIL
CU CODE	F432-003-2:2017-C02 / NOSS LEVEL: 2

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
1. Identify piping installation work	1.1 Introduction to ACMV piping • Types and function of pipes • Characteristic of pipes 1.2 Work instruction format and contents such as	1.1 Interpret work instruction 1.2 Comply with site safety requirements 1.3 Comply with related acts or regulation (if required) 1.4 Comply with PPE	ATTITUDE • Resourceful in gathering information • Systematic in organizing works	1.1 Work area, facilities and amenities safety requirements listed and explained 1.2 Related acts or regulation described and complied 1.3 Related Personal Protective Equipment (PPE) requirements listed and complied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Site location • Work time frame • Manpower 1.3 Site safety requirements such as • Work area • Facilities • Amenities 1.4 Related acts or regulation such as • Occupational Safety and Health Act 1994 (Act 514) • Electricity Supply Act 1990 • Factory & Machineries Act 1967 (Act 139) • Environmental Quality Act 1974 (Amendment 2012) • Act 520 Construction Industry Development Board 1994 1.5 PPE such as • Face mask • Dust mask • Gloves			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Safety boot / shoes • Goggles • Safety helmet • Safety harness (if required)			
2. Carry out piping installation initial preparation	2.1 Shop drawing and piping layout plan specifications such as • Symbol • Legend • Size • Pipe access route 2.2 Types of pipe materials and accessories such as • Pipe materials such as ▪ Galvanised Iron (GI) ▪ Copper ▪ Black Steel ▪ Unplasticized Polyvinyl Chloride (UPVC) ▪ Acrylonitrile Butadiene Styrene (ABS) • Fittings such as ▪ Elbow joint	2.1 Interpret shop drawing and piping layout plan 2.2 Identify types of pipe materials, fittings and accessories 2.3 Identify types of tools and equipment 2.4 Prepare piping penetration works 2.5 Prepare piping installation works 2.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Attentive to details in preparing work requirements • Systematic in organizing work • Timely in completing tasks • Cost conscious <u>SAFETY</u> • Cautious when handling tools, equipment & materials • Wear related PPE during work <u>ENVIRONMENT</u> • Ensure compliance with environmental regulations	2.1 Symbol, legend, size and pipe access route explained according to drawing / piping layout plan 2.2 Types of pipe materials and accessories listed and explained 2.3 Types and function of tools and equipment listed and explained 2.4 Piping penetration works preparation explained and demonstrated 2.5 Piping installation works preparation explained and demonstrated 2.6 Work area housekeeping executed

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	▪ Tee joint ▪ Coupler ▪ Reducer ▪ Bracket • Accessories such as ▪ Valve ▪ Thermometer ▪ Pressure gauge ▪ Y-strainer ▪ Auto air vent 2.3 Types of tools and equipment such as • Tool such as ▪ Grinder ▪ Measuring device ▪ Pipe bender ▪ Drilling machine • Equipment such as ▪ Welding set ▪ Oxy acetylene ▪ Threading machine ▪ Bending machine ▪ Pipe cutting machine 2.4 Work area housekeeping requirements such as			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• 5S Concept • Housekeeping procedure			
3. Perform pipe fabrication works	3.1 Piping drawing specification such as • Symbol • Legend • Colour code 3.2 Pipe cutting technique 3.3 Pipe threading technique 3.4 Pipe bending technique 3.5 Operation of pipe cutting, bending and threading machine 3.6 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	3.1 Interpret piping drawing 3.2 Locate piping route 3.3 Select types of piping 3.4 Perform pipe cutting 3.5 Perform pipe bending 3.6 Perform pipe threading 3.7 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Alert during fabrication works • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	3.1 Piping drawing specifications described 3.2 Pipe cutting technique applied 3.3 Pipe threading technique applied 3.4 Piping routing surveyed as per work instruction 3.5 Work area housekeeping executed

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
4. Perform pipe brackets works	4.1 Types and function of bracket • L shape • U shape • Hanger bracket 4.2 Pipe bracket materials such as • Mild steel • Galvanized iron • Stainless steel 4.3 Piping bracket installation method and guidelines such as • Floor • Wall • Ceiling 4.4 Piping bracket painting guidelines 4.5 Pipe sleeve installation technique 4.6 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	4.1 Interpret piping drawing 4.2 Determine types of bracket to be fabricated 4.3 Select types of bracket materials 4.4 Utilise related tools, equipment and machine 4.5 Fabricate piping bracket 4.6 Perform piping bracket painting works 4.7 Perform piping bracket installation works 4.8 Locate pipe sleeve 4.9 Prepare pipe sleeve 4.10 Install pipe sleeve 4.11 Erect fabricated pipes 4.12 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Alert during fabrication works • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	4.1 Types and function of bracket listed and explained 4.2 Pipe bracket materials listed and described 4.3 Piping bracket installation method and guidelines applied 4.4 Piping bracket painting guidelines applied 4.5 Pipe sleeve installation technique applied 4.6 Piping bracket installation demonstrated 4.7 Fabricated pipes erected as per shop drawing / piping layout plan 4.8 Work area housekeeping executed

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
5. Perform valve fittings & pipe jointing works	5.1 Types and function of valve fittings • Threaded valve • Flange valve 5.2 Types and function of pipe jointing such as • Mechanical joint (coupling and threaded joint) • Welded joint 5.3 Pipe valve fitting installation manual 5.4 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	5.1 Interpret shop drawing 5.2 Perform threaded valve connection 5.3 Perform flange valve connection 5.4 Perform welding / brazing valve joint 5.5 Install pipe valve fitting 5.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	5.1 Types and function of valve fittings listed and explained 5.2 Types and function of pipe jointing listed and explained 5.3 Threaded valve connection executed 5.4 Flange valve connection executed 5.5 Threaded joint executed 5.6 Condensate pipe joint executed 5.7 Welding / brazing joint method applied 5.8 Coupling joint executed 5.9 Pipe fittings installation method applied and executed
6. Install ACMV equipment piping	6.1 Vibration assembly installation guidelines 6.2 Spring isolator installation guidelines 6.3 Make up tank piping installation guidelines 6.4 Fan coil unit piping installation guidelines	6.1 Interpret ACMV piping drawing 6.2 Perform spring isolator and neoprene pad installation 6.3 Perform make up tank piping installation 6.4 Perform fan coil unit piping installation works 6.5 Perform air handling	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials	6.1 Vibration assembly installation guidelines applied and executed 6.2 Spring isolator installation guidelines applied and executed 6.3 Make up tank piping installation guidelines applied and executed 6.4 Fan coil unit piping installation guidelines applied and executed

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	6.5 Air handling unit piping installation guidelines 6.6 Pump piping installation guidelines 6.7 Cooling tower piping installation guidelines 6.8 Condensing unit piping installation guidelines 6.9 Chiller pipe connection guidelines 6.10 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	unit piping installation works 6.6 Perform pump piping installation works 6.7 Perform cooling tower piping installation works 6.8 Perform condensing unit piping installation works 6.9 Perform chiller pipe connection works 6.10 Ensure penetration hole is sealed off 6.11 Carry out work area housekeeping	• Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	6.5 Air handling unit piping installation guidelines applied and executed 6.6 Pump piping installation guidelines applied and executed 6.7 Condensing unit piping installation guidelines applied and executed 6.8 Chiller pipe connection guidelines applied and executed

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
7. Perform pipe pressure testing works	7.1 Pipe pressure testing requirements • Purpose • Procedure • Testing devices such as ▪ Pressure gauge ▪ Hydraulic pressure test kit ▪ Hydraulic pressure pump 7.2 Pipe flushing method and procedure 7.3 Piping pressurization system 7.4 Water piping air purging 7.5 Piping pressure test method and procedure 7.6 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	7.1 Prepare pipe flushing work 7.2 Perform pressurization piping system test 7.3 Perform water piping air purging 7.4 Record pipe pressure testing result 7.5 Carry out work area housekeeping	<u>ATTITUDE</u> • Accurate in recording testing result • Alert during testing work • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling pressurized piping system • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	7.1 Pipe pressure testing requirements listed and explained 7.2 Pipe flushing works preparation executed 7.3 Pipe flushing method and procedure explained and applied 7.4 Piping pressurization system explained 7.5 ACMV pressurization piping system tested 7.6 Water piping air purging method explained and applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
8. Perform pipe insulation works	8.1 Method of insulation 8.2 Type and function of Insulation materials such as • Polyurathane (PU) • Closed cell 8.3 Pipe labelling • Labelling location • Types of label ▪ Colour ▪ Wording ▪ Symbol 8.4 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	8.1 Interpret work instruction 8.2 Prepare insulation works 8.3 Prepare insulation material 8.4 Perform insulation works 8.5 Perform pipe painting work 8.6 Perform pipe labelling 8.7 Carry out work area housekeeping	ATTITUDE • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work SAFETY • Cautious when handling tools, equipment and materials • Wear related PPE during installation work ENVIRONMENT • Ensure compliance with related environmental regulations	8.1 Insulation method explained and applied 8.2 Type and function of Insulation materials listed and explained 8.3 Insulation works executed 8.4 Pipe labelling carried out

Employability Skills

Core Abilities

- Basic Working Communication
- Personal Behaviour Skill
- Work Place Ethics Awareness
- Safety Health And Environment Awareness

Social Values & Social Skills

- Communication skills
- Conceptual skills
- Interpersonal skills
- Learning skills
- Leadership skills
- Multitasking and prioritising
- Self-discipline
- Teamwork

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15 Environmental Quality Act 1974 (Amendment 2012)
16 Factory & Machineries Act 1967 (Act 139)
17 Uniform Building By-Law 1984 (UBBL)

15.3. ACMV Ducting Installation

SECTION	(F) CONSTRUCTION		
GROUP	(432) ELECTRICAL, PLUMBING AND OTHER CONSTRUCTION INSTALLATION ACTIVITIES		
AREA	AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV)		
NOSS TITLE	AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION		
COMPETENCY UNIT TITLE	ACMV DUCTING INSTALLATION		
LEARNING OUTCOMES	The outcome of this competency unit is to fabricate, install, joint and insulate ACMV ducting in compliance with shop drawing and related standards. Upon completion of this competency unit, trainees shall be able to: 1. Identify ducting installation work requirements 2. Prepare ducting installation works requirements 3. Perform ducting fabrication 4. Perform ducting frame installation works 5. Install ACMV equipment 6. Perform duct jointing 7. Install ACMV ducting 8. Perform duct tapping off opening 9. Install ACMV air side fittings and accessories 10. Perform ducting joint insulation 11. Perform ducting finishing works		
TRAINING PRE-REQUISITE	NIL		
CU CODE	F432-003-2:2017-C03	NOSS LEVEL	2

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
1. Identify ducting installation	1.1 Introduction to ACMV ducting 1.2 Work instruction format and contents such as • Site location • Work time frame	1.1 Interpret work instruction 1.2 Comply with site safety requirements 1.3 Comply with related acts or regulation (if required)	<u>ATTITUDE</u> • Resourceful in gathering information • Systematic in organizing works	1.1 Work instruction format and contents explained 1.2 Work area, facilities and amenities safety requirements described and complied 1.3 Related acts or regulation listed and complied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Manpower 1.3 Site safety requirements such as • Work area • Facilities • Amenities 1.4 Related acts or regulation (if required) such as • Occupational Safety and Health Act 1994 (Act 514) • Electricity Supply Act 1994 • Factory & Machineries Act 1967 (Act 139) • Environmental Quality Act 1974 (Amendment 2012) • Act 520 Construction Industry Development Board 1994 1.5 PPE such as • Face mask • Dust mask • Gloves • Safety boot / shoes	1.4 Comply with PPE		1.4 Related Personal Protective Equipment (PPE) requirements listed and applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Goggles • Safety helmet • Safety harness (if required)			
2. Prepare ducting installation works requirements	2.1 Ducting layout plan • Symbol • Legend • Size • Duct access route 2.2 Types of ducting materials and accessories such as • Ducting materials such as ▪ Galvanised Iron (GI) sheet ▪ Stainless steel ▪ Aluminum foil / tape ▪ Fiber glass ▪ Polyethylene (PE) foam ▪ Adhesive • Types of fitting such as ▪ Bracket ▪ Hanger ▪ Isolator • Types of joints such as ▪ Slip joint	2.1 Interpret ducting layout plan 2.2 Identify types of ducting materials and accessories 2.3 Identify types of tools and equipment 2.4 Prepare ducting installation works 2.5 Carry out work area housekeeping	<u>ATTITUDE</u> • Attentive to details in preparing work requirements • Systematic in organizing work • Timely in completing tasks • Cost conscious <u>SAFETY</u> • Cautious when handling tools, equipment & materials • Wear related PPE during work <u>ENVIRONMENT</u> • Ensure compliance with environmental regulations	2.1 Symbol, legend, size and duct access route explained 2.2 Types and function of ducting materials and accessories listed and explained 2.3 Types and function of tools and equipment listed and explained 2.4 Ducting materials, accessories, tools and equipment preparation executed

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	▪ G-clip ▪ Brazing joint ▪ Arc welding • Accessories such as ▪ Damper ▪ Diffuser ▪ Reducer ▪ Silencer ▪ Flexible duct 2.3 Types of tools and equipment such as • Tool such as ▪ Sheet metal cutter ▪ Grinder ▪ Measuring device ▪ Drilling machine ▪ Mallet ▪ Jigsaw ▪ Chisel ▪ Snipper ▪ Hammer ▪ Ladder • Equipment such as ▪ Welding set ▪ Oxy acetylene ▪ Bending machine 2.4 Ducting installation			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	works 2.5 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure			
3. Perform ducting fabrication	3.1 Ducting layout plan specification such as • Symbol • Legend • Colour code • Quantity 3.2 Ducting design drawing specification such as • Materials • Size • Types of joint • Type of insulation 3.3 Sheet metal cutting technique 3.4 Duct forming technique 3.5 Fabricated duct packing method 3.6 Work area housekeeping requirements such as	3.1 Interpret ducting layout plan and ducting design drawing 3.2 Locate duct route 3.3 Prepare material quantity 3.4 Select type of duct 3.5 Perform sheet metal cutting 3.6 Perform duct forming and jointing 3.7 Carry out work area housekeeping	ATTITUDE • Do it right the first time • Alert during fabrication works • Timely in completing tasks • Cost conscious • Systematic in organizing work SAFETY • Cautious when handling tools, equipment and materials • Wear related PPE during fabrication work ENVIRONMENT • Ensure compliance with related environmental regulations	3.1 Ducting layout plan specification listed and explained 3.2 Ducting design drawing specification listed and explained 3.3 Sheet metal cutting technique described and applied 3.4 Duct forming technique described and applied 3.5 Fabricated duct packing method described and applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• 5S Concept • Housekeeping procedure			
4. Perform ducting frame installation works	4.1 Wall opening frame installation • Types of ducting frame • Size of ducting frame • Materials 4.2 Duct opening gap sealing method 4.3 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	4.1 Interpret ducting layout plan 4.2 Identify wall opening frame location and size 4.3 Dismantle temporary duct frame opening 4.4 Install new wall ducting frame 4.5 Seal duct opening gap 4.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	4.1 Wall opening frame installation described and executed 4.2 Duct opening gap sealing method described and applied 4.3 Work area housekeeping executed

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
5. Install ACMV equipment	5.1 ACMV equipment installation and operation manual 5.2 Air handling unit installation method 5.3 Fan Coil Unit installation method 5.4 Ventilation fan installation method 5.5 Variable air volume unit installation method 5.6 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	5.1 Interpret ACMV ducting drawing 5.2 Install spring isolator and neoprene pad 5.3 Install fan coil unit 5.4 Install air handling unit 5.5 Install pump set 5.6 Install cooling tower 5.7 Install ventilation fan 5.8 Install Variable air volume unit 5.9 Install chiller unit 5.10 Carry out work area housekeeping	ATTITUDE • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work SAFETY • Cautious when handling tools, equipment and materials • Wear related PPE during installation work ENVIRONMENT • Ensure compliance with related environmental regulations	5.1 ACMV equipment installation and operation manual described and applied 5.2 Air handling unit installation method described and applied 5.3 Fan Coil Unit installation method described and applied 5.4 Ventilation fan installation method described and applied 5.5 Variable air volume unit installation method described and applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
6. Perform duct jointing	6.1 Types, function and method of duct joint such as • Transverse duct (TDC) joint • Flexible joint • Corner piece joint • Mild steel ducting joint • Welded joint 6.2 Gap joint sealing method 6.3 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	6.1 Interpret ducting drawing 6.2 Select types of joint work 6.3 Perform duct joint 6.4 Perform seal gap joint 6.5 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during jointing works <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	6.1 Types, function and method of duct joint described and applied 6.2 Gap joint sealing method described and applied 6.3 Duct jointing carried out according to required jointing method described and applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
7. Install ACMV ducting	7.1 Ducting layout drawing details such as • Symbol • Legend • Colour code • Quantity 7.2 Ducting bracket installation method 7.3 Fabricated duct assembly method and guidelines 7.4 Fabricated duct insulation method 7.5 Fabricated ducting erection method and guidelines 7.6 Kitchen exhaust duct painting requirements 7.7 Duct joint sealing method 7.8 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	7.1 Interpret ducting layout drawing 7.2 Install ducting bracket 7.3 Assemble fabricated duct 7.4 Insulate fabricated duct 7.5 Erect fabricated ducting 7.6 Install and join fabricated duct 7.7 Seal duct joint 7.8 Paint fabricated duct (if required) 7.9 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	7.1 Ducting layout drawing details listed and explained 7.2 Ducting bracket installation method described and applied 7.3 Fabricated duct assembly method and guidelines described and applied 7.4 Fabricated duct insulation method described and applied 7.5 Fabricated ducting erection method and guidelines described and applied 7.6 Kitchen exhaust duct painting requirements described and applied 7.7 Duct joint sealing method described and applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
8. Perform duct tapping off opening	8.1 Duct tapping off opening method 8.2 Branch off duct installation method 8.3 Duct collar installation method 8.4 Flexible duct installation method 8.5 Supply / return air diffuser installation method 8.6 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	8.1 Interpret ducting drawing 8.2 Perform duct tapping off opening 8.3 Install branch off duct 8.4 Install duct collar 8.5 Install flexible duct 8.6 Install supply / return air diffuser 8.7 Carry out work area housekeeping	ATTITUDE • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work SAFETY • Cautious when handling tools, equipment and materials • Wear related PPE accordingly ENVIRONMENT • Ensure compliance with related environmental regulations	8.1 Duct tapping off opening method described and applied 8.2 Branch off duct installation method described and applied 8.3 Duct collar installation method described and applied 8.4 Flexible duct installation method described and applied 8.5 Supply / return air diffuser installation method described and applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
9. Install ACMV air side fittings and accessories	9.1 Air outlet bracket installation method 9.2 Fire damper installation method 9.3 Fire damper insulation method 9.4 Air outlet installation method 9.5 Volume control damper installation method 9.6 Supply and return air grille installation method 9.7 Duct splitter installation method 9.8 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	9.1 Interpret ducting drawing 9.2 Perform air outlet opening 9.3 Install air outlet bracket 9.4 Install fire damper 9.5 Insulate fire damper 9.6 Install air outlet 9.7 Install volume control damper 9.8 Install supply and return air grille 9.9 Install duct splitter 9.10 Carry out work area housekeeping	ATTITUDE • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work SAFETY • Cautious when handling tools, equipment and materials • Wear related PPE during installation work ENVIRONMENT • Ensure compliance with related environmental regulations	9.1 Air outlet bracket installation method described and applied 9.2 Fire damper installation method described and applied 9.3 Fire damper insulation method described and applied 9.4 Air outlet installation method described and applied 9.5 Volume control damper installation method described and applied 9.6 Supply and return air grille installation method described and applied 9.7 Duct splitter installation method described and applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
10. Perform ducting joint insulation	10.1 Ducting joint insulation method 10.2 Duct insulations materials such as • Polyurathane (PU) • Closed cell • Fiber glass • Rockwool 10.3 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	10.1 Interpret ducting drawing and specification 10.2 Insulate ducting joint 10.3 Carry out work area housekeeping	ATTITUDE • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work SAFETY • Cautious when handling tools, equipment and materials • Wear related PPE during insulation work ENVIRONMENT • Ensure compliance with related environmental regulations	10.1 Ducting joint insulation method described and applied 10.2 Duct insulations materials listed and explained

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
11. Perform ducting finishing works	11.1 Ducting bracket leveling method 11.2 Ducting painting method 11.3 Fire Rated coating method and guidelines 11.4 Ducting labelling method and guidelines 11.5 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	11.1 Interpret ducting drawing and specifications 11.2 Check ducting bracket leveling 11.3 Carry out ducting "touch up" painting 11.4 Check fire rated coating works 11.5 Check ducting labelling 11.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	11.1 Ducting bracket leveling method described and applied 11.2 Ducting painting method described and applied 11.3 Fire Rated coating method and guidelines described and applied 11.4 Ducting labelling method and guidelines described and applied

Employability Skills

Core Abilities

- Basic Working Communication
- Personal Behaviour Skill
- Work Place Ethics Awareness
- Safety Health And Environment Awareness

Social Values & Social Skills

- Communication skills
- Conceptual skills
- Interpersonal skills
- Learning skills
- Leadership skills
- Multitasking and prioritising
- Self-discipline
- Teamwork

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14 Electricity Supply Act 1990
15 Environmental Quality Act 1974 (Amendment 2012)
16 Factory & Machineries Act 1967 (Act 139)
17 Uniform Building By-Law 1984 (UBBL)

15.4. ACMV Electrical Installation

SECTION	(F) CONSTRUCTION
GROUP	(432) ELECTRICAL, PLUMBING AND OTHER CONSTRUCTION INSTALLATION ACTIVITIES
AREA	AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV)
NOSS TITLE	AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION
COMPETENCY UNIT TITLE	ACMV ELECTRICAL INSTALLATION
LEARNING OUTCOMES	The outcome of this competency unit is to carrying out wiring works, installation, maintenance and troubleshooting of ACMV electrical equipment and components in accordance with schematic drawing and electrical safety manual. Upon completion of this competency unit, trainees shall be able to: 1. Identify ACMV electrical installation work requirements 2. Install ACMV electrical switch board panel 3. Perform ACMV electrical switch board maintenance 4. Perform ACMV electrical wiring activities 5. Conduct preliminary load test on ACMV electrical control devices 6. Conduct preliminary load test on ACMV electrical motor 7. Perform ACMV electrical troubleshooting activities
TRAINING PRE-REQUISITE	NIL
CU CODE	F432-003-2:2017-C04 / NOSS LEVEL: 2

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
1. Identify ACMV electrical installation work requirements	1.1 Introduction to ACMV electrical installation 1.2 Work instruction format and contents such as • Site location • Work time frame • Manpower	1.1 Interpret work instruction 1.2 Comply with site safety requirements 1.3 Comply with related acts or regulation (if required) 1.4 Comply with PPE	ATTITUDE • Resourceful in gathering information • Systematic in organizing works	1.1 Work instruction format and contents explained 1.2 Work area, facilities and amenities safety requirements described and complied 1.3 Related acts or regulation listed and complied 1.4 Related Personal Protective Equipment (PPE)

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	1.3 Site safety requirements such as • Work area • Facilities • Amenities 1.4 Related acts or regulation (if required) such as • Occupational Safety and Health Act 1994 (Act 514) • Electricity Supply Act 1990 • Factory & Machineries Act 1967 (Act 139) • Environmental Quality Act 1974 (Amendment 2012) • Act 520 Construction Industry Development Board 1994 1.5 PPE such as • Dust mask • Gloves • Safety boot / shoes • Goggles • Safety helmet			requirements listed and applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Safety harness (if required)			
2. Install ACMV electrical switch board panel	2.1 ACMV electrical schematic wiring procedure and guidelines 2.2 Fundamentals of ACMV electrical wiring such as • Series circuit • Parallel circuit • Complex circuit 2.3 ACMV electrical installation method such as • Trunking • Conduit • Cable tray • Casing • Wire way 2.4 Types of electrical control panel wiring such as • Direct On Line (DOL) starter • Star Delta • Auto transformer • Soft starter	2.1 Interpret ACMV electrical schematic drawing 2.2 Install electrical switch board components base 2.3 Install ACMV electrical components and accessories 2.4 Carry out ACMV electrical control and power circuit wiring 2.5 Install ACMV electrical switch board panel 2.6 Test electrical cable and components 2.7 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	2.1 ACMV electrical schematic wiring procedure and guidelines described and applied 2.2 Fundamentals of ACMV electrical wiring described and applied 2.3 ACMV electrical installation method described and applied 2.4 Types of electrical control panel wiring described and applied 2.5 Type of ACMV electrical cable listed and explained 2.6 Electrical cable and components testing executed 2.7 ACMV electrical cable troubleshooting executed 2.8 Electrical switch board panel installation executed

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	2.5 Type of ACMV electrical cable such as • Control cable • Power cable 2.6 Electrical cable and components testing such as • Continuity • Insulation • Incoming power supply (ACMV board) 2.7 ACMV electrical cable troubleshooting such as • Replace (if required) 2.8 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
3. Perform ACMV electrical switch board maintenance	3.1 ACMV electrical switch board maintenance checklist format and contents 3.2 Cable termination condition checking parameter 3.3 ACMV electrical switch board troubleshooting such as • Repair • Replace (if required) 3.4 ACMV electrical switch board cleaning manual 3.5 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	3.1 Interpret ACMV electrical schematic drawing 3.2 Check condition of cable termination 3.3 Check condition of switch board components 3.4 Carry out ACMV electrical switch board troubleshooting 3.5 Carry out ACMV electrical switch board cleaning work 3.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during maintenance work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	3.1 ACMV electrical switch board maintenance checklist format and contents listed and explained 3.2 Cable termination condition checking parameter described and applied 3.3 ACMV electrical switch board troubleshooting executed 3.4 ACMV electrical switch board cleaning manual described and applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
4. Perform ACMV electrical wiring activities	4.1 ACMV electrical schematic wiring procedure and guidelines 4.2 ACMV electrical installation method such as • Trunking • Conduit • Cable tray • Casing • Wire way 4.3 Type of ACMV electrical cable such as • Control cable • Power cable 4.4 Electrical cable and components testing such as • Continuity • Insulation • Incoming power supply (ACMV board) 4.5 ACMV electrical cable troubleshooting such as • Replace (if required)	4.1 Interpret ACMV electrical schematic drawing 4.2 Install ACMV electrical cable tray and wire way 4.3 Lay and terminate ACMV electrical cable 4.4 Carry out ACMV electrical cable connection and termination to control devices 4.5 Carry out ACMV electrical cable, components and control devices testing 4.6 Carry out ACMV electrical cable troubleshooting (if required) 4.7 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	4.1 ACMV electrical schematic wiring procedure and guidelines described and applied 4.2 ACMV electrical installation method described and applied 4.3 ACMV electrical cable tray and wire way installation executed 4.4 Type of ACMV electrical cable described and applied 4.5 Electrical cable and components testing executed 4.6 ACMV electrical cable troubleshooting executed 4.7 ACMV electrical cable, components and control devices testing executed

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	4.6 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure			
5. Conduct preliminary load test on ACMV electrical control devices	5.1 ACMV electrical control devices checking parameters such as • Motorised control valve functionality • Flow control switch functionality • Thermostat controller functionality • Damper actuator functionality • Pressure sensor switch functionality • Pressure differential switch functionality 5.2 ACMV electrical control devices troubleshooting such as	5.1 Interpret ACMV electrical control devices manual 5.2 Check motorised control valve functionality 5.3 Check flow control switch functionality 5.4 Check thermostat controller functionality 5.5 Check Damper actuator functionality 5.6 Check Pressure sensor switch functionality 5.7 Check Pressure differential switch functionality 5.8 Carry out ACMV electrical control devices troubleshooting 5.9 Carry out work area	ATTITUDE • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work SAFETY • Cautious when handling tools, equipment and materials • Wear related PPE during work ENVIRONMENT • Ensure compliance with related environmental regulations	5.1 ACMV electrical control devices checking parameters described and applied 5.2 ACMV electrical control devices troubleshooting executed 5.3 ACMV electrical control devices condition and functionality checking executed

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Damper actuator • Flow control switch • Control valve • Pressure differential sensor • Pressure differential switch (if required) • Thermostat Control Component 5.3 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	housekeeping		

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
6. Conduct preliminary load test on ACMV electrical motor	6.1 ACMV electrical motor checking parameters such as • Windings resistance (Ω) • Winding insulation (mΩ) • Terminal motor connection • Motor phase sequence • Motor rotation • Rotation speed • Running load ampere • Motor inverter (VFD) 6.2 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	6.1 Interpret ACMV electrical motor manual 6.2 Check windings resistance (Ω) 6.3 Check winding insulation (mΩ) 6.4 Check terminal motor connection 6.5 Check motor phase sequence 6.6 Check motor rotation 6.7 Check rotation speed 6.8 Check running load ampere 6.9 Check motor inverter (VFD) 6.10 Update preliminary load test checklist 6.11 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	6.1 ACMV electrical motor checking parameters described and applied 6.2 ACMV electrical motor condition and functionality checking executed 6.3 Work area housekeeping carried out

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
7. Perform ACMV electrical troubleshooting activities	7.1 Motor / components and cable functionality such as • Motor cable • Terminal Cable • Printed Circuit Board 7.2 ACMV electrical repair / replacement of defective motor / printed circuit board and cable manual 7.3 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	7.1 Interpret work instruction, installation and operation manual 7.2 Interpret ACMV electrical drawing 7.3 Determine motor / components / devices functionality 7.4 Determine cable and terminal termination condition 7.5 Carry out repair / replacement of defective electric motor / components / devices and cable 7.6 Update ACMV electrical troubleshooting record 7.7 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	7.1 ACMV motor / components and cable functionality checking executed 7.2 ACMV electrical troubleshooting executed 7.3 ACMV electrical troubleshooting record updated 7.4 Work area housekeeping carried out

Employability Skills

Core Abilities

- Basic Working Communication
- Personal Behaviour Skill
- Work Place Ethics Awareness
- Safety Health And Environment Awareness

Social Values & Social Skills

- Communication skills
- Conceptual skills
- Interpersonal skills
- Learning skills
- Leadership skills
- Multitasking and prioritising
- Self-discipline
- Teamwork

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13 Occupational Safety and Health Act 1994 (Act 514)
14 Electricity Supply Act 1990
15 Environmental Quality Act 1974 (Amendment 2012)
16 Factory & Machineries Act 1967 (Act 139)
17 Uniform Building By-Law 1984 (UBBL)

15.5. ACMV Service & Maintenance

SECTION	(F) CONSTRUCTION
GROUP	(432) ELECTRICAL, PLUMBING AND OTHER CONSTRUCTION INSTALLATION ACTIVITIES
AREA	AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV)
NOSS TITLE	AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION
COMPETENCY UNIT TITLE	ACMV SERVICE & MAINTENANCE
LEARNING OUTCOMES	The outcome of this competency unit is to maintain optimum level of ACMV equipment for serviceability and meet client requirements. Upon completion of this competency unit, trainees shall be able to: 1. Identify service & maintenance work requirements 2. Perform air conditioning equipment maintenance 3. Perform ACMV air distribution system maintenance 4. Perform mechanical ventilation system maintenance 5. Perform ACMV cooling tower maintenance 6. Perform ACMV piping system maintenance 7. Perform condenser / chilled water pump and motor maintenance 8. Perform air conditioning system maintenance
TRAINING PRE-REQUISITE	NIL
CU CODE	F432-003-2:2017-C05 / NOSS LEVEL: 2

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
1. Identify service & maintenance work requirements	1.1 Work instruction format and contents such as • Site location • Work time frame • Manpower 1.2 Site safety requirements such as • Work area • Facilities	1.1 Interpret work instruction 1.2 Comply with site safety requirements 1.3 Comply with related acts or regulation (if required) 1.4 Comply with PPE	ATTITUDE • Resourceful in gathering information • Systematic in organizing works	1.1 Work instruction format and contents explained 1.2 Work area, facilities and amenities safety requirements described and complied 1.3 Related acts or regulation listed and complied 1.4 Related Personal Protective Equipment (PPE) requirements listed and

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Amenities 1.3 Related acts or regulation (if required) such as • Occupational Safety and Health Act 1994 (Act 514) • Electricity Supply Act 1990 • Factory & Machineries Act 1967 (Act 139) • Environmental Quality Act 1974 (Amendment 2012) • Act 520 Construction Industry Development Board 1994 1.4 PPE such as • Face mask • Dust mask • Gloves • Overall • Safety boot / shoes • Goggles • Safety helmet • Safety harness (if required)			applied

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
2. Perform air conditioning equipment maintenance	2.1 Air conditioning equipment operation and service manual 2.2 Type and function of air conditioning equipment parts / components such as • Air filters • Cooling & condenser coil ▪ Shell and tube ▪ Tube in tube • Condensate drainage system • Direct drive / belt drive blower system ▪ Blower wheel ▪ Blower shaft ▪ Blower pulley ▪ Blower belting ▪ Blower bearing ▪ Blower motor • Compressor ▪ Hermetic type ▪ Semi hermetic type • Electrical air conditioning equipment control panel 2.3 Type and purpose of	2.1 Interpret maintenance instruction checklist 2.2 Identify air conditioning equipment parts / components 2.3 Check air conditioning equipment condition based on work instruction 2.4 Carry out maintenance works according to work instruction and service manual 2.5 Update maintenance record 2.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during maintenance work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	2.1 Air conditioning equipment operation and service manual described and applied 2.2 Type and function of air conditioning equipment parts / components listed and explained 2.3 Type and purpose of maintenance works listed and explained 2.4 Maintenance record format and contents described and applied 2.5 Air conditioning equipment condition checking executed 2.6 Maintenance works executed according to work instruction and service manual 2.7 Maintenance record updated 2.8 Work area housekeeping carried out

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	maintenance works such as • Routine maintenance ▪ Monthly ▪ Bimonthly ▪ Quarterly ▪ Half yearly ▪ Yearly • Preventive maintenance • Corrective maintenance ▪ Repair ▪ Replace 2.4 Maintenance record format and contents 2.5 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
3. Perform ACMV air distribution system maintenance	3.1 ACMV air distribution system operation and service manual 3.2 Type and function of air distribution parts / components such as • Duct insulation • Duct sensor • Thermostat • Fire damper • Non return damper • Air duct flexible joint • Air volume damper • Air duct support • Air diffuser • Return grille 3.3 Maintenance works according to work instruction and service manual • Routine maintenance • Preventive maintenance • Corrective maintenance ▪ Adjustment ▪ Repair ▪ Replace	3.1 Interpret maintenance instruction checklist 3.2 Identify air distribution parts / components 3.3 Check air distribution system condition based on work instruction 3.4 Carry out maintenance works according to work instruction and service manual 3.5 Update maintenance record 3.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during maintenance work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	3.1 ACMV air distribution system operation and service manual described and applied 3.2 Type and function of air distribution parts / components listed and explained 3.3 Air distribution system condition checking executed 3.4 Maintenance works executed according to work instruction and service manual 3.5 Maintenance record updated 3.6 Work area housekeeping carried out

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	3.4 Maintenance record format and contents 3.5 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure			
4. Perform mechanical ventilation system maintenance	4.1 Mechanical ventilation system operation and service manual 4.2 Type and function of mechanical ventilation parts / components such as • Fire damper • Fresh air intake grille • Exhaust system component (fan / motor) • Air pressurisation system • Electrical mechanical ventilation control panel • Fresh air / intake component • Air filter	4.1 Interpret maintenance instruction checklist 4.2 Identify mechanical ventilation parts / components 4.3 Check mechanical ventilation system condition based on work instruction 4.4 Carry out maintenance works according to work instruction and service manual 4.5 Update maintenance record 4.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during maintenance work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	4.1 Mechanical ventilation system operation and service manual described and applied 4.2 Type and function of mechanical ventilation parts / components listed and explained 4.3 Type and purpose of maintenance listed and explained 4.4 Mechanical ventilation system condition checking executed 4.5 Maintenance works carried out according to work instruction and service manual 4.6 Maintenance record updated 4.7 Work area housekeeping carried out

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	▪ Pre filter ▪ Secondary filter ▪ Bag filter (non-washable) 4.3 Type and purpose of maintenance work such as • Routine maintenance • Preventive maintenance • Corrective maintenance ▪ Adjustment ▪ Repair ▪ Replace 4.4 Maintenance record format and contents 4.5 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure			

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
5. Perform ACMV cooling tower maintenance	5.1 ACMV cooling tower operation and service manual 5.2 Type and function of cooling tower parts / components such as • Cold water basin • Hot dip tray • Butterfly valve • Cold water basin filter • Sprinkler head assembly • Float valve • Cooling tower fan drive package assembly • Infill • Fibre Reinforced Plastic (FRP) body 5.3 Cooling tower condition checking parameters such as • Cooling tower structure • Water distribution • Cooling tower infill • Cooling tower fan motor operation • Sprinkler head	5.1 Interpret maintenance instruction checklist 5.2 Identify cooling tower parts / components 5.3 Check cooling tower condition 5.4 Carry out maintenance works according to work instruction and service manual 5.5 Update maintenance record 5.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during maintenance work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	5.1 ACMV cooling tower operation and service manual described and applied 5.2 Type and function of cooling tower parts / components listed and explained 5.3 Cooling tower condition checking parameters described and applied 5.4 Maintenance works carried out according to work instruction and service manual 5.5 Maintenance record updated according to company's format and procedure 5.6 Work area housekeeping carried out as per work instruction

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	operation 5.4 Type and purpose of maintenance work such as • Routine maintenance • Preventive maintenance • Corrective maintenance ▪ Repair ▪ Replace 5.5 maintenance record format and contents 5.6 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure			
6. Perform ACMV piping system maintenance	6.1 ACMV piping system operation and service manual 6.2 Type and function of piping system parts / components such as • Valves ▪ Gate valve ▪ Butterfly valve ▪ Globe valve ▪ Balancing valve	6.1 Interpret maintenance instruction checklist 6.2 Identify piping system parts / components 6.3 Check piping system condition based on work instruction 6.4 Carry out maintenance works according to work instruction and service manual	ATTITUDE • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work SAFETY • Cautious when handling tools, equipment and	6.1 ACMV piping system operation and service manual described and applied 6.2 Type and function of piping system parts / components listed and explained 6.3 ACMV piping system checking parameters described and applied 6.4 Type and purpose of maintenance works described

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	▪ Check valve • Strainer • Thermometer • Pressure gauge • Flow switch • Rubber expansion joint 6.3 ACMV piping system checking parameters such as • Temperature • Insulation • Leakages 6.4 Type and purpose of maintenance work such as • Routine maintenance • Preventive maintenance • Corrective maintenance ▪ Repair ▪ Replace 6.5 Maintenance record format and contents 6.6 Work area housekeeping requirements such as • 5S Concept	6.5 Update maintenance record 6.6 Carry out work area housekeeping	materials • Wear related PPE during maintenance work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	and applied 6.5 Maintenance works carried out according to work instruction and service manual 6.6 Maintenance record updated according to company's format and procedure 6.7 Work area housekeeping carried out as per work instruction

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Housekeeping procedure			
7. Perform condenser / chilled water pump and motor maintenance	7.1 Condenser / chilled water pump and motor operation and service manual 7.2 Type and function of condenser / chilled water pump and motor parts / components such as • Coupling • Rubber bush • Fan motor • Neoprene pad • Spring isolator • Mechanical seal • Bearing 7.3 Condenser / chilled water pump and motor checking parameters such as • Pump motor body • Leakages • Vibration • Alignment • Running ampere • Pump panel terminal box connection	7.1 Interpret maintenance instruction checklist 7.2 Identify condenser / chilled water pump and motor parts / components 7.3 Check condenser / chilled water pump and motor condition based on work instruction 7.4 Carry out maintenance works according to maintenance instruction checklist 7.5 Update maintenance record 7.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during maintenance work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	7.1 Condenser / chilled water pump and motor operation and service manual described and applied 7.2 Type and function of condenser / chilled water pump and motor parts / components listed and explained 7.3 Condenser / chilled water pump and motor checking parameters described and applied 7.4 Type and purpose of maintenance work listed and explained 7.5 Maintenance works (routine / preventive / corrective) carried out according to work instruction and service manual 7.6 Maintenance record updated according to company's format and procedure 7.7 Work area housekeeping carried out as per work instruction

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	7.4 Type and purpose of maintenance work such as • Routine maintenance • Preventive maintenance • Corrective maintenance ▪ Repair ▪ Replace 7.5 Maintenance record format and contents 7.6 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure			
8. Perform air conditioning system maintenance	8.1 Air conditioning system operation and service manual 8.2 Type and function of air conditioning system parts / components such as • Metering devices • Compressors ▪ Scroll compressor ▪ Rotary compressor	8.1 Interpret maintenance instruction checklist 8.2 Identify air conditioning system parts / components 8.3 Check air conditioning system condition 8.4 Carry out maintenance works 8.5 Update maintenance record	<u>ATTITUDE</u> • Do it right the first time • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and	8.1 Air conditioning system operation and service manual described and explained 8.2 Type and function of air conditioning system parts / components listed and explained 8.3 Air conditioning system checking parameters described and applied 8.4 Type and purpose of

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	▪ Reciprocating compressor ▪ Screw compressor ▪ Centrifugal compressor • Refrigerant pipe • Evaporator • Condenser • Refrigerant accessories ▪ Filter dryer / core dryer ▪ Sight glass ▪ Isolation valve 8.3 Air conditioning system checking parameters such as • Refrigerant operation • Pressure • Temperature • High low pressure switch • Freezestat 8.4 Type and purpose of maintenance work such as • Routine maintenance • Preventive	8.6 Carry out work area housekeeping	materials • Wear related PPE during maintenance work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	maintenance work listed and explained 8.5 Maintenance works carried out according to work instruction and service manual 8.6 Maintenance record updated according to company's format and procedure 8.7 Work area housekeeping carried out as per work instruction

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	maintenance • Corrective maintenance ▪ Repair ▪ Replace 8.5 Maintenance record format and contents 8.6 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure			

Employability Skills

Core Abilities

- Basic Working Communication
- Personal Behaviour Skill
- Work Place Ethics Awareness
- Safety Health And Environment Awareness

Social Values & Social Skills

- Communication skills
- Conceptual skills
- Interpersonal skills
- Learning skills
- Leadership skills
- Multitasking and prioritising
- Self-discipline
- Teamwork

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16 Factory & Machineries Act 1967 (Act 139)
17 Uniform Building By-Law 1984 (UBBL)

15.6. Heavy Commercial ACMV Installation

SECTION	(F) CONSTRUCTION		
GROUP	(432) ELECTRICAL, PLUMBING AND OTHER CONSTRUCTION INSTALLATION ACTIVITIES		
AREA	AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV)		
NOSS TITLE	AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION		
COMPETENCY UNIT TITLE	HEAVY COMMERCIAL ACMV INSTALLATION		
LEARNING OUTCOMES	The outcome of this competency unit is to carrying out Heavy Commercial ACMV installation works in compliance with work specifications and regulatory body requirements. Upon completion of this competency unit, trainees shall be able to: 1. Identify installation work requirements 2. Carry out installation initial preparation 3. Install air conditioning equipment 4. Perform ACMV electrical wiring works 5. Perform air conditioning testing		
TRAINING PRE-REQUISITE	The personnel who are to be competent in this competency must in prior have the following competencies:- i. ACMV Piping Installation (F432-003-2:2017-C02) ii. ACMV Ducting Installation (F432-003-2:2017-C03)		
CU CODE	F432-003-2:2017-C06	NOSS LEVEL	2

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
1. Identify installation work requirements	1.1 Introduction to Heavy Commercial ACMV system 1.2 Work instruction format and contents such as • Site location • Work time frame	1.1 Interpret work instruction 1.2 Comply with site safety requirements 1.3 Comply with related acts or regulation (if required) 1.4 Comply with PPE	ATTITUDE • Resourceful in gathering information • Systematic in organizing works	1.1 Heavy Commercial ACMV systems explained 1.2 Type and function of tools, equipment and materials listed and explained 1.3 Malaysian Standard- MS 1525:2014 Code of Practice on Energy Efficiency and

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Manpower 1.3 Site safety requirements such as • Work area • Facilities • Amenities 1.4 Related acts or regulation (if required) such as • Occupational Safety and Health Act 1994 (Act 514) • Electricity Supply Act 1990 • Factory & Machineries Act 1967 (Act 139) • Environmental Quality Act 1974 (Amendment 2012) • Act 520 Construction Industry Development Board 1994 1.5 PPE such as • Respirator gas mask (if required) • Dust mask • Gloves			Use of Renewable Energy for Non-Residential Buildings described and applied 1.4 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Guidelines and Standards described and applied 1.5 ACMV related acts or regulation listed and explained 1.6 Related Personal Protective Equipment (PPE) requirements listed and explained

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• Safety boot / shoes • Goggles • Safety helmet • Safety harness (if required)			
2. Carry out installation initial preparation	2.1 Equipment layout drawing details such as • Location • Types of equipment • Equipment specifications 2.2 Installation initial preparation works such as • Equipment opening access • Equipment access route • Equipment installation location • Tools, equipment and materials storage area at site 2.3 Work area housekeeping requirements such as • 5S Concept • Housekeeping	2.1 Interpret work instruction and equipment layout drawing 2.2 Identify equipment quantity and specifications based on equipment layout drawing 2.3 Identify equipment installation location 2.4 Prepare equipment opening and access route 2.5 Prepare tools, equipment and materials storage area at site 2.6 Carry out work area housekeeping	<u>ATTITUDE</u> • Attentive to details in preparing work requirements • Systematic in organizing work • Timely in completing tasks • Cost conscious <u>SAFETY</u> • Cautious when handling ACMV chemical and refrigerant • Wear related PPE during work <u>ENVIRONMENT</u> • Ensure compliance with environmental regulations	2.1 Equipment layout drawing details listed and explained 2.2 Installation initial preparation works described 2.3 Equipment opening access prepared as per work instruction 2.4 Equipment access route prepared as per work instruction 2.5 Equipment installation location prepared as per work instruction 2.6 Tools, equipment and materials storage area at site prepared as per work instruction

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	procedure			
3. Install air conditioning equipment	3.1 Equipment layout drawing details such as • Location • Types of equipment • Equipment specifications 3.2 Fan Coil Unit (FCU) installation method and guidelines 3.3 Air Handling Unit (AHU) installation method and guidelines 3.4 Cooling tower installation method and guidelines 3.5 Make up tank installation method and guidelines 3.6 Chiller unit installation method and guidelines	3.1 Interpret work instruction and equipment layout drawing 3.2 Confirm equipment quantity and specifications based on equipment layout drawing 3.3 Confirm equipment installation location 3.4 Install Fan Coil Unit (FCU) 3.5 Install Air Handling Unit (AHU) 3.6 Install cooling tower 3.7 Install make up tank 3.8 Install chiller unit 3.9 Install chilled water / condenser water pump set 3.10 Carry out work area	<u>ATTITUDE</u> • Do it right the first time • Alert during installation work • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	3.1 Equipment layout drawing details described and applied 3.2 Fan Coil Unit (FCU) installation method and guidelines described and applied 3.3 Air Handling Unit (AHU) installation method and guidelines described and applied 3.4 Cooling tower installation method and guidelines described and applied 3.5 Make up tank installation method and guidelines described and applied 3.6 Chiller unit installation method and guidelines described and applied 3.7 Chilled water / condenser water pump set installation method and guidelines

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	3.7 Chilled water / condenser water pump set installation method and guidelines 3.8 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	housekeeping		described and applied 3.8 Work area housekeeping carried out as per work instruction
4. Perform ACMV electrical wiring works	4.1 ACMV electrical schematic wiring procedure and guidelines 4.2 Fundamentals of ACMV electrical wiring such as • Series circuit • Parallel circuit • Complex circuit 4.3 ACMV electrical installation method such as • Trunking • Conduit • Cable tray • Casing • Wire way 4.4 Types of electrical control panel wiring	4.1 Interpret ACMV electrical schematic drawing 4.2 Install ACMV electrical cable tray and wire way 4.3 Install ACMV equipment control panel 4.4 Lay control and power supply wiring to ACMV equipment 4.5 Carry out ACMV electrical cable connection and termination to control devices 4.6 Carry out electrical cable, components and control devices	<u>ATTITUDE</u> • Do it right the first time • Alert during installation work • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling ACMV electrical wiring works • Cautious when handling tools, equipment and materials • Wear related PPE during installation work	4.1 ACMV electrical schematic wiring procedure and guidelines described and applied 4.2 Fundamentals of ACMV electrical wiring described and applied 4.3 ACMV electrical installation method described and applied 4.4 Types of electrical control panel wiring listed and explained 4.5 Type of ACMV electrical cable listed and explained 4.6 Electrical cable and components testing executed 4.7 Air conditioning control panel installed according to shop drawing and electrical safety manual

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	such as • Direct On Line (DOL) starter • Star Delta • Auto transformer • Soft starter 4.5 Type of ACMV electrical cable such as • Control cable • Power cable 4.6 Electrical cable and components testing such as • Continuity • Insulation • Incoming power supply (ACMV board) 4.7 ACMV electrical cable troubleshooting such as • Replace (if required) 4.8 Work area housekeeping requirements such as • 5S Concept • Housekeeping procedure	testing 4.7 Carry out ACMV electrical cable troubleshooting (if required) 4.8 Carry out work area housekeeping	<u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	4.8 Air conditioning control wiring installed according to shop drawing and electrical safety manual 4.9 Air conditioning power supply wiring installed according to shop drawing and electrical safety manual 4.10 Wiring termination carried out according to shop drawing and electrical safety manual

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
5. Perform air conditioning testing	5.1 Air conditioning refrigerant piping system testing such as • Leak test • Flushing • Vacuuming • Charging 5.2 Functionality test of ACMV system equipment and control devices such as • Open circuit ▪ Condenser water pump ▪ Cooling tower ▪ Flow switch ▪ Motorized valve • Closed circuit ▪ Chilled water pump ▪ Flow switch ▪ Thermostat ▪ Motorized valve ▪ Air vent 5.3 Preliminary testing and commissioning checklist format and content 5.4 Work area housekeeping requirements such as	5.1 Interpret preliminary testing and commissioning checklist 5.2 Test air conditioning refrigerant piping system 5.3 Test functionality of ACMV system equipment and control devices 5.4 Update preliminary testing and commissioning checklist 5.5 Carry out work area housekeeping	<u>ATTITUDE</u> • Accurate in recording testing result • Alert during testing work • Timely in completing tasks • Cost conscious • Systematic in organizing work <u>SAFETY</u> • Cautious when handling tools, equipment and materials • Wear related PPE during installation work <u>ENVIRONMENT</u> • Ensure compliance with related environmental regulations	5.1 Air conditioning refrigerant system testing procedure described and applied 5.2 Functionality of ACMV system equipment and control devices tested according to testing procedure and work instruction 5.3 Testing checklist updated according to SOP 5.4 Work area housekeeping carried out as per work instruction

WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	ATTITUDE/ SAFETY/ ENVIRONMENT	ASSESSMENT CRITERIA
	• 5S Concept • Housekeeping procedure			

Employability Skills

Core Abilities

- Basic Working Communication
- Personal Behaviour Skill
- Work Place Ethics Awareness
- Safety Health And Environment Awareness

Social Values & Social Skills

- Communication skills
- Conceptual skills
- Interpersonal skills
- Learning skills
- Leadership skills
- Multitasking and prioritising
- Self-discipline
- Teamwork

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12 Occupational Safety and Health Act 1994 (Act 514)
13 Electricity Supply Act 1990
14 Environmental Quality Act 1974 (Amendment 2012)
15 Factory & Machineries Act 1967 (Act 139)
16 Uniform Building By-Law 1984 (UBBL)

16. Delivery Mode

The following are the **recommended** training delivery modes:-

KNOWLEDGE	SKILL
• Lecture • Group discussion • E-learning, self-paced • E-learning, facilitate • Case study or Problem based learning (PBL) • Self-paced learning, non-electronic • One-on-one tutorial • Shop talk • Seminar	• Demonstration • Simulation • Project • Scenario based training (SBT) • Role play • Coaching • Observation • Mentoring

17. Tools, Equipment and Materials (TEM)

AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION

LEVEL 2

CU No.	CU CODE	COMPETENCY UNIT TITLE
CU1	F432-003-2:2017-C01	Light Commercial ACMV Installation
CU2	F432-003-2:2017-C02	ACMV Piping Installation
CU3	F432-003-2:2017-C03	ACMV Ducting Installation
CU4	F432-003-2:2017-C04	ACMV Electrical Installation
CU5	F432-003-2:2017-C05	ACMV Service & Maintenance
CU6	F432-003-2:2017-C06	Heavy Commercial ACMV Installation

* Items listed refer to TEM's **minimum requirement** for skills delivery only.

No	ITEM*	RATIO (TEM : Trainees)	CU1	CU2	CU3	CU4	CU5	CU6
A. Tools			**Tick (√) where relevant**					
1	Refrigerant and drain pipe	As required	✓				✓	
2	Electronic leak detector	1:10	✓				✓	
3	Micron gauge	1:10	✓				✓	
4	Infrared thermometer	1:10					✓	
5	Manifold gauge	1:1	✓				✓	
6	Ratchet wrench	1:1	✓				✓	
7	Pliers	1:1	✓			✓	✓	✓
8	Screw drivers	1:1	✓			✓	✓	✓
9	Flaring / swaging set	1:1	✓				✓	
10	Copper tube cutter	1:1	✓				✓	
11	Tube bender	1:1	✓				✓	
12	Reamer	1:1	✓				✓	
13	Spanner set	1:1	✓	✓	✓	✓	✓	✓

No	ITEM*	RATIO (TEM : Trainees)	CU1	CU2	CU3	CU4	CU5	CU6
14	Allen key	1:1	✓			✓	✓	✓
15	Adjustable spanner	1:1	✓	✓	✓	✓	✓	✓
16	Hammer / mallet	1:1	✓	✓	✓	✓	✓	✓
17	Test pen	1:1	✓			✓	✓	✓
18	Measuring tape	1:1	✓	✓	✓	✓	✓	✓
19	Hacksaw	1:1	✓	✓	✓	✓	✓	✓
20	Thermometer	1:1	✓	✓			✓	
21	Clamp on meter (Amprobe)	1:5				✓	✓	✓
22	Multimeter	1:1	✓			✓	✓	✓
23	Insulation tester	1:5					✓	
24	Vice grip plier	1:1				✓	✓	
25	PVC cutter	1:1	✓				✓	
26	Pipe / adjustable wrench	1:1	✓				✓	
27	Cable stripper	1:1	✓			✓	✓	✓
28	Cable crimper	1:1	✓			✓	✓	✓
29	Hand drill	1:2	✓	✓	✓	✓	✓	✓
30	Grinder	1:10	✓	✓	✓	✓	✓	
31	Vacuum pump	1:5	✓				✓	
32	Vacuum gauge	1:5	✓				✓	
33	Duct insulation materials	As required					✓	
34	Duct sensor	1:25					✓	
35	Thermostat	1:25					✓	
36	Fire damper	1:25					✓	
37	Non return damper	1:25					✓	
38	Air duct flexible joint	1:25					✓	
39	Air volume damper	1:25					✓	
40	Air duct support	1:25					✓	
41	Air diffuser	1:25					✓	
42	Return grille	1:25					✓	
43	Fire damper	1:25					✓	

No	ITEM*	RATIO (TEM : Trainees)	CU1	CU2	CU3	CU4	CU5	CU6
44	Fresh air intake grille	1:25					✓	
45	Exhaust system component (fan / motor)	1:25					✓	
46	Electrical mechanical ventilation control panel	1:25					✓	
47	Air filter	1:25					✓	
48	Butterfly valve	1:25		✓			✓	
49	Gate valve	1:25		✓			✓	
50	Globe valve	1:25					✓	
51	Balancing valve	1:25		✓			✓	
52	Check valve	1:25					✓	
53	Y-strainer	1:25		✓			✓	
54	Glass thermometer	1: 25					✓	
55	Pressure gauge	1: 25		✓			✓	
56	Flow switch	1: 25					✓	
57	High and low pressure switch	1: 25					✓	
58	Rubber expansion joint	1: 25					✓	
59	Coupling	1: 25					✓	
60	Rubber bush	1: 25					✓	
61	Fan motor	1: 25					✓	
62	Neoprene pad	1: 25		✓	✓		✓	
63	Spring isolator	1: 25		✓	✓		✓	
64	Mechanical seal	1: 25					✓	
65	Bearing	1: 25					✓	
66	Metering devices	1: 25					✓	
67	Scroll compressor	As required					✓	
68	Rotary compressor	As required					✓	
69	Reciprocating compressor	As required					✓	
70	Screw compressor	As required					✓	
71	Centrifugal compressor	As required					✓	
72	Evaporator	As required					✓	

No	ITEM*	RATIO (TEM : Trainees)	CU1	CU2	CU3	CU4	CU5	CU6
73	Condenser	As required					✓	
74	Filter dryer	1:25					✓	
75	Filter core set	1:25					✓	
76	Sight glass	1:25					✓	
77	Isolation valve (refrigerant)	1:25					✓	
78	Water jet	1:10	✓				✓	
79	Oxy acetylene set	1:5	✓	✓	✓		✓	
80	Arc welding set	1:5	✓	✓	✓		✓	
81	Temporary structure	As required	✓	✓	✓	✓	✓	✓
82	Temporary lighting	As required	✓	✓	✓	✓	✓	✓
83	Extension cable	As required	✓	✓	✓	✓	✓	✓
84	Glue	1:1	✓				✓	
85	Close cell insulation tube	As required	✓	✓			✓	
86	PVC pipe	As required	✓				✓	
87	Copper tube / pipe	As required	✓				✓	
88	Masking tape	1:1	✓				✓	
89	Duct tape	1:1	✓				✓	
90	Insulation tape	1:1	✓			✓	✓	
91	High tension tape	1:1	✓				✓	
92	Rags	As required	✓	✓	✓	✓	✓	✓
93	R22	As required	✓				✓	
94	R410a	As required	✓				✓	
95	R134a	As required	✓				✓	
96	R407C	As required	✓				✓	
97	R32	As required	✓				✓	
98	Weighing scale	1:5	✓				✓	
99	Wire	As required	✓				✓	
100	Cable	As required	✓				✓	
101	Respirator gas mask	As required	✓	✓	✓	✓	✓	✓
102	Dust mask	1:1	✓	✓	✓	✓	✓	✓

No	ITEM*	RATIO (TEM : Trainees)	CU1	CU2	CU3	CU4	CU5	CU6
103	Gloves	1:1	✓	✓	✓	✓	✓	✓
104	Safety boot / shoes	1:1	✓	✓	✓	✓	✓	✓
105	Goggles	1:1	✓	✓	✓	✓	✓	✓
106	Safety helmet	1:1	✓	✓	✓	✓	✓	✓
107	Safety harness	1:10	✓	✓	✓	✓	✓	✓
108	Split unit (wall mounted, cassette, expose, ceiling concealed)	1:5	✓					
109	Package unit	1:25	✓					
110	Levels	1:1	✓	✓	✓	✓		✓
111	Ammeter	1:1	✓					
112	Marking tools	1:1	✓	✓	✓	✓		✓
113	Vice grip plier	1:1	✓	✓	✓	✓		✓
114	Coring machine	1:25	✓	✓				
115	Filler	1:1	✓					
116	Galvanised Iron (GI)	As required		✓	✓			
117	Copper	As required		✓				
118	Black Steel	As required		✓	✓			
119	Unplasticized Polyvinyl Chloride (UPVC)	As required		✓				
120	Acrylonitrile Butadiene Styrene (ABS)	As required		✓				
121	Elbow joint	As required		✓				
122	Tee joint	As required		✓				
123	Coupler	As required		✓				
124	Reducer	As required		✓				
125	Bracket	As required		✓				
126	Motorized valve	As required		✓				✓
127	Auto air vent	As required		✓				✓
128	Polyurathane (PU)	As required		✓	✓			
129	Pipe cutting machine	1:5		✓				
130	Grinder	1:5		✓	✓			✓
131	Measuring device	1:1		✓	✓			
132	Pipe bender	1:5		✓				

No	ITEM*	RATIO (TEM : Trainees)	CU1	CU2	CU3	CU4	CU5	CU6
133	Drilling machine	1:5		✓	✓			
134	Threading machine	As required		✓				
135	Threaded valve	As required		✓				
136	Flange valve	As required		✓				
137	L shape bracket	As required		✓	✓			
138	U shape bracket	As required		✓				
139	Hanger bracket	As required		✓	✓			
140	Pipe sleeve	As required		✓				
141	Vibration assembly	As required		✓	✓			
142	Make up tank	1:5		✓				✓
143	Fan Coil Unit (FCU)	1:5		✓	✓			✓
144	Air Handling Unit (AHU)	1:5		✓	✓			✓
145	Pump	1:5		✓	✓			
146	Cooling tower	1:5		✓	✓			✓
147	Condensing unit	1:10		✓	✓			
148	Chiller	As required		✓	✓			✓
149	Hydraulic pressure test kit	1:1		✓				
150	Hydraulic pressure pump	1:1		✓				
151	Pipe / adjustable wrench	1:1		✓	✓			
152	Seal tape	As required		✓				
153	Sealing thread	As required		✓				
154	Duct elbow joint	As required		✓				
155	Duct tee joint	As required		✓				
156	Duct reducer	As required		✓				
157	Duct bracket	As required		✓				
158	Closed cell	As required		✓				
159	Welding set	1:5		✓				
160	Snipper	1:1			✓			
161	Chisel	1:1			✓			
162	Ducting frame	As required			✓			
163	Duct seal tape	As required			✓			

No	ITEM*	RATIO (TEM : Trainees)	CU1	CU2	CU3	CU4	CU5	CU6
164	Insulation tester (Mega ohm meter)	1:5				✓		✓
165	Phase rotation meter	1:5				✓		✓
166	Tachometer	1:5				✓		✓
167	Jigsaw	1:10				✓		✓
168	High test tape	1:1				✓		
169	Trunking	As required				✓		✓
170	Conduit	As required				✓		✓
171	Cable tray	As required				✓		✓
172	Casing	As required				✓		✓
173	Wire way	As required				✓		✓
174	Contactor	1:1				✓		✓
175	Push button	1:1				✓		✓
176	Thermal overload relay	1:1				✓		✓
177	Indicator light	1:1				✓		✓
178	Timer delay relay	1:1				✓		✓
179	Selector switch	1:1				✓		✓
180	Auto transformer	1:1				✓		✓
181	Soft starter	1:5				✓		✓
182	Miniature Circuit Breaker (MCB)	1:1				✓		✓
183	Residual Current Circuit Breaker (RCCB)	1:1				✓		✓
184	Control panel board	1:1				✓		✓
185	Damper actuator	1:5				✓		✓
186	Control valve	1:5				✓		✓
187	Pressure differential sensor	1:5				✓		✓
188	Pressure differential switch (if required)	1:5				✓		✓
189	Thermostat Control Component	1:5				✓		✓
190	Motor inverter (VFD)	1:5				✓		✓
191	Control cable	As required				✓		✓
192	Power cable	As required				✓		✓
193	Flow control switch	1:5						✓

No	ITEM*	RATIO (TEM : Trainees)	CU1	CU2	CU3	CU4	CU5	CU6
194	Chilled water / condenser water pump set	1:5						✓
B. Equipment			**Tick (√) where relevant**					
1	Lifting equipment	1:25	✓	✓	✓	✓	✓	✓
C. Materials			**Tick (√) where relevant**					
1	Copy of Occupational Safety and Health Act 1994 (Act 514)	1.1	✓	✓	✓	✓	✓	✓
2	Copy of Electricity Supply Act 1990	1.1	✓	✓	✓	✓	✓	✓
3	Copy of Factory & Machineries Act 1967 (Act 139)	1.1	✓	✓	✓	✓	✓	✓
4	Copy of Environmental Quality Act 1974 (Amendment 2012)	1.1	✓	✓	✓	✓	✓	✓
5	Copy of Act 520 Construction Industry Development Board 1994	1.1	✓	✓	✓	✓	✓	✓
6	Copy of Malaysian Standard- MS 1525:2014 Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings	1.1	✓	✓	✓	✓	✓	✓
7	Copy of American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Guidelines and Standards	1.1	✓	✓	✓	✓	✓	✓
8	Copy of ACMV system service and maintenance schedule format and contents	1.1	✓	✓	✓	✓	✓	✓
9	Copy of ACMV system service and maintenance reporting format and procedure	1.1	✓	✓	✓	✓	✓	✓
10	Maintenance instruction checklist	1.1		✓			✓	
11	Schematic diagram	1.1	✓	✓		✓	✓	✓
12	Electrical drawing	1.1	✓			✓	✓	✓

No	ITEM*	RATIO (TEM : Trainees)	CU1	CU2	CU3	CU4	CU5	CU6
13	Single line drawing	1.1	✓			✓	✓	✓
14	Shop drawing	1:5	✓	✓		✓		
15	Layout drawing	1:5	✓	✓				
16	Piping layout plan	1.1	✓	✓				
17	Piping drawing	1.1	✓	✓				
18	Duct drawing	1.1			✓			
19	Duct layout drawing	1.1			✓			
20	ACMV equipment layout drawing	1:5						✓

18. Training Hour Summary

The following table shows the nominal training hours based on recommendations made by the Standard Development Committee (SDC). For purpose of Malaysian Skills Certification through accredited centre training, the program duration is subject to Malaysian Skills Certification System.

AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATION & MAINTENANCE OPERATION LEVEL 2

CU CODE	COMPETENCY UNIT TITLE	WORK ACTIVITIES	RELATED KNOWLEDGE (HOURS)	RELATED SKILLS (HOURS)	TRAINING DURATION (HOURS)	SKILLS CREDIT
F432-003-2:2017-C01	Light Commercial ACMV Installation	1. Identify installation work requirements	4	8	240	24
		2. Carry out installation initial preparation	4	8		
		3. Install air conditioning equipment	18	42		
		4. Install air conditioning refrigerant pipe	14	34		
		5. Install ACMV electrical wiring	18	42		
		6. Perform air conditioning testing	6	13		
		7. Perform ACMV system service and maintenance activities	9	20		
F432-003-2:2017-C02	ACMV Piping Installation	1. Identify piping installation work requirements	2	4	120	12
		2. Carry out piping installation initial preparation	2	4		
		3. Perform pipe fabrication works	7	17		
		4. Perform pipe brackets	4	8		

CU CODE	COMPETENCY UNIT TITLE	WORK ACTIVITIES	RELATED KNOWLEDGE (HOURS)	RELATED SKILLS (HOURS)	TRAINING DURATION (HOURS)	SKILLS CREDIT
		works				
		5. Perform valve fittings & pipe jointing works	9	21		
		6. Install ACMV equipment piping	4	8		
		7. Perform pipe pressure testing works	5	13		
		8. Perform pipe insulation works	4	8		
F432-003-2:2017-C03	ACMV Ducting Installation	1. Identify ducting installation work requirements	2	4	120	12
		2. Prepare ducting installation works requirements	2	4		
		3. Perform ducting fabrication	7	17		
		4. Perform ducting frame installation works	2	4		
		5. Install ACMV equipment	5	13		
		6. Perform duct jointing	5	13		
		7. Install ACMV ducting	5	13		
		8. Perform duct tapping off opening	2	4		
		9. Install ACMV air side fittings and accessories	2	4		
		10. Perform ducting joint insulation	2	4		
		11. Perform ducting finishing works	2	4		

CU CODE	COMPETENCY UNIT TITLE	WORK ACTIVITIES	RELATED KNOWLEDGE (HOURS)	RELATED SKILLS (HOURS)	TRAINING DURATION (HOURS)	SKILLS CREDIT
F432-003-2:2017-C04	ACMV Electrical Installation	1. Identify ACMV electrical installation work requirements	4	8	240	24
		2. Install ACMV electrical switch board panel	4	8		
		3. Perform ACMV electrical switch board maintenance	6	13		
		4. Perform ACMV electrical wiring activities	18	42		
		5. Conduct preliminary load test on ACMV electrical control devices	16	37		
		6. Conduct preliminary load test on ACMV electrical motor	14	34		
		7. Perform ACMV electrical troubleshooting activities	11	25		
F432-003-2:2017-C05	ACMV Service & Maintenance	1. Identify service & maintenance work requirements	2	4	120	12
		2. Perform air conditioning equipment maintenance	7	17		
		3. Perform ACMV air distribution system maintenance	5	13		

CU CODE	COMPETENCY UNIT TITLE	WORK ACTIVITIES	RELATED KNOWLEDGE (HOURS)	RELATED SKILLS (HOURS)	TRAINING DURATION (HOURS)	SKILLS CREDIT
		4. Perform mechanical ventilation system maintenance	5	13		
		5. Perform ACMV cooling tower maintenance	3	7		
		6. Perform ACMV piping system maintenance	4	10		
		7. Perform condenser / chilled water pump and motor system maintenance	4	10		
		8. Perform air conditioning system maintenance	5	11		
F432-003-2:2017-C06	Heavy Commercial ACMV Installation	1. Identify installation work requirements	8	18	360	36
		2. Carry out installation initial preparation	9	20		
		3. Install air conditioning equipment	43	101		
		4. Perform ACMV electrical wiring works	32	76		
		5. Perform air conditioning testing	16	38		
TOTAL HOURS (CORE COMPETENCY)			360	840	1200	120