STANDARD KEMAHIRAN PEKERJAAN KEBANGSAAN
(NATIONAL OCCUPATIONAL SKILL STANDARD)

SOLAR PANEL MANUFACTURING OPERATION
(Thin Film Module)

LEVEL 3

JPK

Jabatan Pembangunan Kemahiran
Kementerian Sumber Manusia, Malaysia

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STANDARD PRACTICE

NATIONAL OCCUPATIONAL SKILLS STANDARD (NOSS) FOR;

SOLAR PANEL MANUFACTURING OPERATION

(Thin Film Module)

LEVEL 3

1. INTRODUCTION

This NOSS document outlines the standards and curriculum for Solar Manufacturing Operation (Level 3) in Green Technology Sector.

Solar module, also known as solar panel, photovoltaic module or photovoltaic panel is a packaged, connected assembly of solar modules or cells. Harnessing sunlight from the sun, the solar module/panel can generate electricity. Solar panels use light energy (photons) from the sun to generate electricity through the photovoltaic effect.

The majority of modules use wafer-based mono or poly crystalline silicon cells or thin-film cells based on cadmium telluride or silicon. The structural (load carrying) member of a module can either be the top layer or the back layer. Cells must also be protected from mechanical damage and moisture. Most solar panels are rigid; however, semi-flexible ones are available, based on thin-film cells. An array of solar module or panels, arranged as a component of a larger solar modules system is able to generate and supply electricity in commercial and residential applications.

Under the NKEA, the solar industry is one of the Malaysia's priority projects to generate clean energy. The solar industry will have the potential to create spin-off benefits to the economy, through the introduction of new and advanced solar technologies and the creation of potential downstream industries such as lighting, green building, home applications and solar heating. The solar industry alone is expected to create big numbers job opportunities in the country.

Under the 10th Malaysia Plan, the government expects to generate 215 megawatt (MW) peak from solar, thus increasing its solar contribution from 0.0013 per cent to 1.5 percent As a high technology-driven industry, solar manufacturing has the potential to contribute up to 4 per cent of the country's gross domestic product this year. The National Renewable Energy Policy & Action Plan aims to increase the generation of electricity from renewable sources of energy from less than 1% of total output in 2009 to 5.5% in 2015

The solar industry expanded by a record high of 75 per cent in 2012, reaching a worldwide production volume of 7,500 MW peak and booming into a RM115 billion businesses in 2011. The global market volume for solar-based products were forecast to increase to RM180 billion this year, and the market is expected to exceed RM500 billion in 2020.

Realizing the big opportunity created by this industry, this National Occupational Skills Standards (NOSS) document on Solar Modules Manufacturing Operation is developed to accelerate the training of more personnel in this industry. This NOSS document was developed based on cadmium telluride thin film solar module production employed by First Solar. The core competencies outlined in this document comprised Solar Sub Module Production, Solar Module Lay-Up & Sealing Process, Solar Module Lamination Process, Solar Module Performance Testing and Solar Module Packaging, while Solar Module Production Waste Handling is prepared as an elective competency.

Pre-requisite

The minimum requirements for those interested candidate to enrol on this course are as follows :

i. 17 years old and above
ii. Able to write and read in *Bahasa Malaysia* or English.
iii. Medically fit.

2. OCCUPATIONAL STRUCTURE

Solar Panel Manufacturing Operation comes under the sub-sector of Solar Panel Manufacturing. Figure 1 illustrates the Existing Occupational Structure which shows the Solar Panel Manufacturing area or job area comprising Installation and Maintenance, Manufacturing and R&D and Quality Control of Solar modules/panels.

The NOSS development expert panels concluded the Proposed Occupational Area Structure of Solar Panel Manufacturing Operation as illustrated in Figure 2.

With the new proposed occupational area structure, the expert panels decided that the entry level for Solar Panel Manufacturing Operation is at Level 3 due to their job responsibility to perform a significant range of varied work activities and performed in a variety of context, most of which are complex and non-routine. Generally they work by following instructions and job assignment schedules prepared as per terms of reference and at the same time they have to lead and supervise their subordinates. There is also considerable responsibility and autonomy and control or guidance of others is often required.

3. OCCUPATIONAL AREA STRUCTURE

SECTOR	GREEN TECHNOLOGY			
SUB SECTOR	RENEWABLE ENERGY			
NOSS TITLE	SOLAR PANEL MANUFACTURING CONTROL			
LEVEL/JOB AREA	INSTALLATION & MAINTENANCE OF SOLAR PANEL	MANUFACTURING OF SOLAR PANEL		R& D OF SOLAR PANEL
		Thin-Film Module Fabrication	Solar Cell Fabrication	
LEVEL 5	Solar Panel Construction Project Manager	Solar Panel Manufacturing Plant Manager	Solar Cell Fabrication Plant Manager	Solar Panel Products Test Engineer
LEVEL 4	Solar Panel Construction Foreman	Solar Panel Manufacturing Plant Assist Manager	Solar Panel Fabrication Plant Assist Manager	Solar Panel Quality Controller
LEVEL 3	Solar Panel Construction Crew Leader	Solar Panel Manufacturing Plant Senior Technician/supervisor	Solar Panel Fabrication Plant Senior Technician/supervisor	No Level
LEVEL 2	Solar Panel Construction Lead Installer	Solar Panel Manufacturing Plant Line Leader	Solar Panel Fabrication Plant Line Leader	No Level
LEVEL 1	Solar Panel Installer/ General Workers	Solar Panel Manufacturing Plant Line Operator	Solar Panel Fabrication Plant Line Operator	No Level

Figure 1.1 Occupational framework matrix for Solar Panel Manufacturing Control profession in Malaysia

4. OCCUPATIONAL AREA STRUCTURE

SECTOR		GREEN TECHNOLOGY			
SUB SECTOR		**RENEWABLE ENERGY**			
NOSS TITLE		**SOLAR PANEL MANUFACTURING CONTROL**			
LEVEL/JOB AREA	**INSTALLATION & MAINTENANCE OF SOLAR PANEL**	**MANUFACTURING OF SOLAR PANEL**			**R&D OF SOLAR PANEL**
		Thin-Film Module Fabrication	**Crystalline (CSi) Module fabrication**	**Solar Cell Fabrication**	
LEVEL 5	Solar products installation & maintenance management	Solar Panel Manufacturing Management		Solar Cell Manufacturing Management	
LEVEL 4	Solar products installation & maintenance management	Solar Panel Manufacturing Control		Solar Cell Manufacturing Control	
LEVEL 3	Solar products installation & maintenance operation	Solar Panel Manufacturing Operation (Thin Film Module)	Solar Panel Manufacturing Operation (Crystalline)	Solar Panel Manufacturing Operation (Solar cell)	No Level
LEVEL 2	No Level	No Level	No Level		No Level
LEVEL 1	No Level	No Level	No Level		No Level

Figure 2: Occupational area structure for Solar Panel Manufacturing Control profession in Malaysia

5. DESCRIPTION OF COMPETENCY LEVEL

The NOSS is developed for various occupational areas. Candidates for certification must be assessed and trained at certain levels to substantiate competencies. Below is a guideline of each NOSS Level as defined by the Department of Skills Development, Ministry of Human Resources, Malaysia.

Malaysia Skills Certificate Level 1: Competent in performing a range of varied (Operation and Production Level) work activities, most of which are routine and predictable**.**

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

Malaysia Skills Certificate Level 3: Competent in performing a broad range of (Supervisory Level) 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 in often required.

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

Malaysia Skills Advanced Diploma Level 5 (Managerial Level): 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.

6. MALAYSIAN SKILL CERTIFICATION

Candidate who has successfully completed and fulfilled Malaysian Skill certification requirements of each competency unit shall be awarded Competency Certificate.

Those who has successfully completed all the core competencies and fulfilled Malaysian Skill certification requirements shall be awarded the *Sijil Kemahiran Malaysia* (SKM) in Logistic Service Operation at Level 3.

7. JOB COMPETENCIES

Solar Panel manufacturing personnel is competent in performing the following core competencies:

- Solar sub-module production
- Solar module Lay-Up & Sealing process
- Solar module lamination process
- Solar module performance testing
- Solar module packaging

Optionally, the Solar Panel manufacturing personnel is competent in performing the following elective competency:

- Solar module production waste handling

8. WORKING CONDITION

The Solar Panel Manufacturing Operation Level 3 personnel are responsible in handling all the process of manufacturing the solar panel including packaging and handling of solar products production waste. They normally need to coordinate, monitor and supervise their supervisor and workers under them.

Generally they work under normal working hour from morning to evening depending on the nature of business of the organisation. They might be required to work extra hours to fulfil internal and external requirement. They need to comply with Occupational Safety, Security, Health and Environment practices during the commencement of their jobs.

9. EMPLOYMENT PROSPECT

Current growth in solar panel industry needs more skilled workers in Solar Panel Manufacturing to ensure this industry expansion momentum could be sustained. Through the Economy Transformation Programmes (ETP), solar industry is one of the focused areas to spill-over Malaysian economy and will create job opportunities to the citizens.

In line with the initiatives to make Malaysia a solar modules/panels production centre in the region, Malaysia has developed various tax exemption programmes to attract international companies to invest or to set-up their manufacturing facilities in Malaysia which creates more job opportunities to the locals in this job area.

Thus, there is an encouraging demand for workforce in this sector including production of industry; solar panel manufacturing personnel can also be hired in service related to this industry.

9.1 Types of occupation for career advancement

Career advancement for Solar Panel Manufacturing Operation locally and internally is enormous. Among them are:

- Solar Scientific Research Executive
- Solar Power Engineering Executive
- Solar Power Plant Development Executive
- Solar Power Plant Construction Executive
- Solar Power Plant Operation Executive

9.2 Related industries

Other related industries with respect to employment opportunities are:

- Retailing
- Entrepreneur
- Construction
- Research
- Education and training

10. TRAINING, INDUSTRIAL/PROFESSIONAL RECOGNITION, OTHER QUALIFICATIONS AND ADVANCEMENT

Traditionally, personnel in solar panel production acquire their competency through on the job training and learning. There is no training and learning opportunity available as solar manufacturing is a new developing industry in Malaysia.

This NOSS provides the standard and formal structure to train potential personnel in solar module/panel manufacturing and production. Further certification may increase the chances of career development. Thus, with additional formal training and certification, an experienced personnel in this industry can advance to become certified personnel in solar module production process.

11. SOURCES OF ADDITIONAL INFORMATION

11.1 Local Organisation

- MINISTRY OF ENERGY,GREEN TECHNOLOGY AND WATER,
  Block E4/5 Parcel E,
  Federal Government Administrative
  Centre, 62668 Putrajaya Malaysia
  Tel : 03-8000 8000
  Fax: 03-8889 3712
  Website : www.kettha.gov.my

- MALAYSIAN GREEN TECHNOLOGY
  CORPORATION No.2, Jalan 9/10
  Persiaran Usahawan, Seksyen 9
  43650 Bandar Baru Bangi
  Selangor Darul Ehsan
  Tel: 03-8921 0800
  Fax: 03-8921 0801 / 0802
  website: www.greentechmalaysia.my

- SUSTAINABLE ENERGY DEVELOPMENT AUTHORITY (SEDA Malaysia))
  Galeria PjH, Aras 9,
  62100 Putrajaya, Malaysia.
  Tel : 603-8870 5800 (General Line)
  Fax: 603-8870 5900 (Fax)
  Website: seda.gov.my

- DEPARTMENT OF OCCUPATIONAL SAFETY AND HEALTH
  (MINISTRY OF HUMAN RESOURCE
  Level 2, 3 & 4, Block D3, Complex D
  Federal Government Administrative
  Centre 62530 W. P. Putrajaya
  Tel: 03-8886 5000
  Fax: 03-8889 2443
  Website: www.dosh.gov.my

- ADVANCED SOLAR VOLTAIC SDN BHD 8,
  Jalan 2/137B, Resource Industrial Centre,
  58200, Kuala Lumpur 58000, Malaysia
  Tel: 03- 79805419
  Fax: 03- 79816755
  Website: http://www.solarvoltaic.com

- ALFONS SOLAR SDN BHD
  P.O.Box 210, Keningau, Keningau 89008, Malaysia
  Tel: 087-338500
  Fax: 087- 331757
  Website: http://www.alfonssolar.co.nr

- SOLAR SENTINEL SDN BHD
  5-3-1, Jalan Setia Prima D,
  Shah Alam 40170, Malaysia
  Tel: 03-3341 8635
  Fax: 03- 3341 8635

- MALAYSIAN SOLAR RESOURCES SDN. BHD.
  Lot 74369, Lebuhraya Tun Razak,
  Gambang, Kuantan,
  Pahang, Malaysia
  Tel: 09- 5497632
  Fax: 09- 5461032
  Web Site: http://www.malaysiansolar.com

- DITROLIC SOLAR TECHNOLOGY SDN
  BHD SW-02-21 Cova Square,
  Jalan Teknologi,
  Kota Damansara, PJU5,
  47810 Petaling Jaya,
  Malaysia. Tel: 03-6142 3889
  Fax: 03-6142 3866

11.2 International Organisation

- SUNTECH AUSTRALIA
  Suite 1101, Level 11
  201 Miller Street
  North Sydney NSW 2060, Australia
  Tel: 612-8188 2450
  Fax: 612-8188 2440
  Website: www.suntech-power.com

- FIRST SOLAR, INC.
  350 West Washington Street, Suite 600
  Tempe, Arizona 85281 USA
  Tel: 419-662 6899
  Fax: 602-4149400
  Website: www.firstsolar.com

- SHANGHAI JA SOLAR PV TECHNOLOGY CO., LTD.
  NO.36, Jiang Chang San Road,
  Zhabei, Shanghai 200436, China
  Tel: 8621 6095 5888
  Fax: 8621 6095 5858
  Website: www.jasolar.com

- TRINA SOLAR
  No. 2 Trina Road, Trina PV
  Industrial Park, New
  District, Changzhou,
  Jiangsu, 213031, China
  Tel: 86 519 8548 2008
  Fax: 86 519 8517 6021
  Website: www.trinasolar.com

- Yingli Green Energy Holding Co.
  Ltd. 3399 North Chaoyang Avenue
  Baoding 071051, China
  Tel: 86 312 8922 208
  Fax: 86 312 8929 800
  Website: www.yinglisolar.com

12. 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.

This standard has been checked by the Standard Technical Evaluation Committee (STEC). Panel members of STEC are listed below:

NO	NAME	COMPANY
1.	En. Mohd Hanafiah Bin Abd Rauf	AUOSunPower Sdn Bhd
2.	En. Syed Eisa Bin Syed Ahmad	Malaysia Solar
3.	En. Mohd Idham Bin Mohammad	SEDA Malaysia

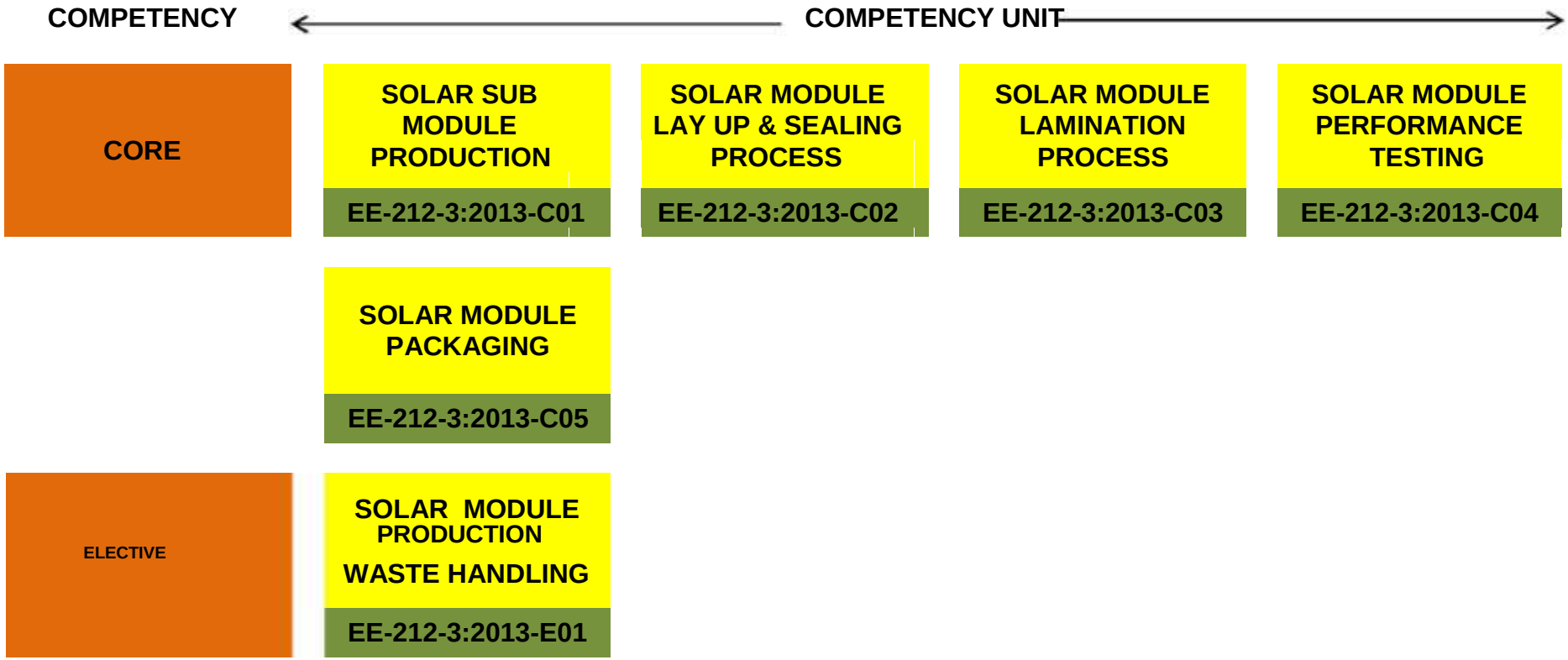
13. COMMITTEE MEMBERS FOR DEVELOPMENT OF STANDARD PRACTICE (SP), COMPETENCY PROFILE CHART (CPC), COMPETENCY PROFILE (CP) AND CURRICULUM OF COMPETENCY UNIT (CoCU)

SOLAR PANEL MANUFACTURING OPERATION LEVEL 3

PANEL EXPERTS		
1	En Shuhairi bin Che Pa	Technician First Solar (M) Sdn Bhd
2	En Mohd Jasmi bin Khodir	Technician First Solar (M) Sdn Bhd
3	En Muhammad Syahid bin Ahmad	Technician First Solar (M) Sdn Bhd
4	En Jaafar bin Sulaiman	Technician First Solar (M) Sdn Bhd
5	Pn Nik Marzuriani binti Nik Mohamed	Engineer SIRIM Berhad
6	Muhammad Firdaus Bin Abdullah	Technician First Solar (M) Sdn Bhd
7	Mohd Zaki Bin Ahmad	Engineer First Solar (M) Sdn Bhd
8	Syed Zulkhieree Syed Hussin	Senior Engineer AutoSun Power Sdn Bhd
FACILITATOR		
9	En Ah Faezal Husni Bin Arshad	Edusure Sdn Bhd
DOCUMENTER		
10	Pn Azlin binti Ahmad Zaini	Edusure Sdn Bhd
CO-FACILITATOR		
11	En Ismail bin Muhammed	Edusure Sdn Bhd

COMPETENCY PROFILE CHART (CPC)

SECTOR	GREEN TECHNOLOGY		
SUB SECTOR	RENEWABLE ENERGY		
JOB AREA	SOLAR PANEL MANUFACTURING (THIN FILM MODULE)		
NOSS TITLE	SOLAR PANEL MANUFACTURING OPERATION (THIN FILM MODULE)		
JOB LEVEL	3	JOB AREA CODE	EE-212-3:2013



COMPETENCY PROFILE (CP)

Sub Sector	**RENEWABLE ENERGY**
Job Area	**SOLAR PANEL MANUFACTURING (THIN-FILM MODULE FABRICATION)**
NOSS Title	**SOLAR MODULE MANUFACTURING OPERATION**
Level	**3**

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
1. Solar Sub-Module Production	*EE-212-3: 2013-C01*	Solar sub-module production is the process of preparing the glass sheet for coating processes before solar sub-module/panel is rolled out. The person who is competent in Solar Sub-Module Production shall be able to identify solar sub-module production operation requirement, check workplace condition, prepare sub-module/panel production materials, prepare Coater Machine, inspect glass surface condition, conduct first and second coating procedures, check solar sub-module/panel quality, Shut down coating machine, carry out house-keeping activities and shut down the coating machine. The outcome of this competency is to ensure the solar sub-module is produced according to the specified standard	1. Identify solar sub-module production operation requirement 2. Check workplace condition.	1.1 Solar sub-module production requirement accurately interpreted from WI. 1.2 Solar sub-module standards identified from WI to ensure compliance with solar sub module job requirement. 1.3 Solar sub-module production schedule obtained from the production supervisor. 1.4 Hazardous materials and processes used in solar sub-module production process identified in according with the legislative requirements. 1.5 Daily production target confirmed. 2.1 Work area checked and cleared of hazards according to site and legislative requirements. 2.2 Work condition such as lighting and ergonomic checked according to site and legislative requirements.

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				2.3 Climatic condition such as humidity and temperature identified according to sub-module/panel production standard operating procedures. 2.4 Work area ventilation system functionality confirmed to a specified level as required by the standard operating procedures. 2.5 Unsafe working conditions identified and reported to safety officer.
			3. Prepare sub-module production materials	3.1 Sub-module production materials identified form Technical Sheet to ensure product profile is in accordance with the production requirement. 3.2 Glass for sub-module production prepared in accordance with requirements specified in Technical Data Sheet. 3.3 Glass for sub-module production cleaned and free from dust and contaminants to ensure sub-module of required standard. 3.4 Defective glass identified and segregated according to sampling and inspection procedures.

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				3.5 Chemical solutions for sub-module production prepared in accordance with requirements specified in Technical Data Sheet.
			4. Prepare Coater Machine	4.1 Coater machine set up and tested prior calibration for functionality in accordance with the manufacturers' specification, standard operating procedures 4.2 Calibration of the coater machine carried out as manufacturers' specification. 4.3 Grounding procedures implemented to prevent ignition from static electricity. 4.4 Faults rectified or reported to superior for further action. 4.5 Chemical solutions for coating sub modules production placed according to manufacturer operation manual. 4.6 Safety procedures observed in accordance to standard operating procedures.
			5. Inspect glass surface condition	5.1 Glass surface condition checked to ensure free form dirt, grease and other contaminants. 5.2 Dirt and other contaminants swept off the surface.

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				5.3 Grease and oil is removed by cleaning solvent.
			6. Carry out first coating process	6.1 Coater machine operated in accordance with standard operating procedures. 6.2 Temperature and the pressure of coater machine monitored according to manufacturer operation manual. 6.3 Temperature and the pressure of coater machine adjusted to recommended level according to manufacturer operation manual. 6.4 Loading of glass to be coated monitored according to manufacturer operation manual 6.5 Personal Protective Equipment (PPE) applied 6.6 Grinding process of the glass monitored according to manufacturer operation manual. 6.7 Grinder adjusted or replaced when grinded glass quality does not conform quality standard as per Standard Operation Procedures 6.8 Washing process of the glass monitored (specifically on the cleaning and drying of

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				grinded glass) according to manufacturer operation manual. 6.9 Laser marking process on the glass monitored according to manufacturer operation manual. 6.10 First coating process of glass carried out with sputtering of chemical at high temperature and in vacuum condition according to manufacturer specification and machine requirement 6.11 Quality (thickness and roughness) of the first coated glass inspected as per Technical Sheet Specification.
			7. Carry out second coating procedures	7.1 Pre-Wash of the first coating to remove any excess monitored according to manufacturer operation manual. 7.2 Chloride spray of the glass monitored according to Technical Data Sheet specification and manufacturer operation manual. 7.3 Chloride sprayed module dried and cured in Baking oven monitored as per manufacturer operational manual

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				7.4 Laser scribing process, Negative Photo Resist process, Metalizer process, Edge Delete process and Post Metal Heat Treatment of the glass monitored according to Technical Data Sheet specification and manufacturer operation manual. 7.5 Data sheet recording process carried out according to work instruction.
			8. Inspect solar -module quality	8.1 Solar module inspected against scratches, chippings, cracks and void visually according to the instruction. 8.2 Non conformance or defects are segregated for rework as per work instruction. 8.3 Inspection results reported according to work instruction.
			9. Shut down coating machine	9.1 Coating machine shut down in sequence according to coater machine operation procedures. 9.2 Coater machine's parts inspected and cleaned according to manufacturer's specification. 9.3 Defective equipment's parts sent for maintenance or repair if applicable.

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
			10. Carry out housekeeping activities.	10.1 Waste and unwanted materials disposed at designated areas in according to legislative requirements. 10.2 Defective coated materials for rework placed at designated areas in according to standard operating procedures.
2. Solar Module Lay Up & Sealing Process	*EE-212-3: 2013-C02*	Lay Up and Sealing of Solar Module is the process of laying up two sheets of coated glass and sealing off the solar module. The person who is competent in Lay Up and Sealing of Solar module Operation shall be able to identify solar module Lay Up & Sealing process requirement, check workplace condition, prepare lay-up and sealing of solar module. materials, prepare bussing machine, conduct solar module Lay-up and sealing procedures, check product quality from any defects, shut down Lay-up and Sealing machine and carry out housekeeping activities. The outcome of this competency is to ensure the process of Lay Up and sealing of solar module is	1. Identify solar module Lay Up & Sealing process requirement	1.1 Solar module lay-up & sealing requirement interpreted from Working Instruction (WI). 1.2 Solar module lay-up & sealing standards identified from WI according to standard operating procedures. 1.3 Solar module lay-up & sealing schedule obtained from the production supervisor. 1.4 Hazardous materials and processes used in module lay-up & sealing identified according to standard operating procedures.

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
		carried out according to the specified standard.	2. Inspect workplace condition	2.1 Work area checked and cleared of hazards according to site and legislative requirements. 2.2 Work condition such as lighting and ergonomic checked according to work and legislative requirements. 2.3 Climatic condition such as humidity and temperature confirmed according to sub-modules production standard operating procedures. 2.4 Work area ventilated system functionality confirmed to minimise airborne dust to a specified level according to standard operating procedures. 2.5 Unsafe working conditions identified and reported to safety officer.
			3. Prepare lay-up and sealing solar module materials	3.1 Lay-up and sealing process materials (double side tape, Buss bar, Sealing edge tape, Cover glass) prepared in accordance with requirements specified in Technical Data Sheet. 3.2 Copper foil cleaned and free from dust and contaminants in accordance with requirements specified in Technical Data Sheet.

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				3.3 Defective materials identified and segregated according to sampling and inspection procedures.
			4. Prepare bussing machine.	4.1 Bussing machine set up and tested in accordance with the manufacturers' specification, standard operating procedures and legislative requirements. 4.2 Bussing machine calibration carried out as manufacturers' specification. 4.3 Faults rectified and reported to superior for further action. 4.4 Safety procedures determined in accordance with standard safety requirements
			5. Carry out solar module lay-up and sealing activity	5.1 Solar module condition checked against dirt, grease and other contaminants according to standard operating procedures. 5.2 Dirt and other contaminants cleaned according to recommended method specified. 5.3 Bussing machine operated in accordance with standard operating procedures. 5.4 Personal and respiratory protective equipment applied

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				in accordance standard safety requirements. 5.5 Lay-up and sealing material (such as double side tape, Copper foil tape, Buss bar, and Sealing edge tape) placed and aligned to machine according to manufacturer operation manual. 5.6 Cover glass placed and aligned to module as per requirement and according to manufacturer operation manual. 5.7 Temperature and the pressure of bussing machine condition monitored according to manufacturer operation manual. 5.8 Temperature and the pressure of bussing machine adjusted when working temperature and pressure does not conform the working standard requirement 5.9 Sealed module inspected on as per specification. 5.10 Lay-up and sealing activity recorded according to company operating procedures

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
			6. Inspect solar module quality	6.1 Sealed module visually checked according to product specification. 6.2 Non conformance or defects segregated for rework as per work instruction. 6.3 Check results recorded and reported according to company standard procedures
			7. Shut down Lay-up and Sealing machine.	7.1 Lay-up and Sealing machine shut down in sequence according to machine operation procedures. 7.2 Lay-up and Sealing machine parts inspected and cleaned according to manufacturer's specification. 7.3 Defective equipment's parts sent for maintenance or repair if required
			8. Carry out housekeeping activities.	8.1 Non-conformance module for disposal sent to designated areas according to standard operating procedures. 8.2 Non-conformance module for rework sent to designated areas according to standard operating procedures 8.3 Work area restored as per job area requirement

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
3. Solar Module Lamination Process	*EE-212-3: 2013-C03*	Solar module lamination is the process of laminating solar module with specified laminating material using laminator machine The person who is competent in Solar Module Lamination Operation shall be able to identify solar module lamination operation requirement, prepare laminator machine, conduct solar module lamination procedures, check product quality from any defects and shut down the lamination machine The outcome of this competency is to ensure the process of laminating off solar module is carried out according to the specified standard on solar module lamination standard.	1. Identify solar module lamination process requirement 2. Prepare laminator machine	1.1 Solar module lamination operation requirement accurately interpreted from WI. 1.2 Panel lamination operation standards identified from WI according to standard operating procedures. 1.3 Panel lamination operation schedule obtained from the production supervisor. 1.4 Hazardous materials and processes used in solar module production process identified in according with the legislative requirements. 2.1 Laminator machine set up and tested prior calibration for functionality in accordance with the manufacturers' specification, standard operating procedures 2.2 Laminator temperature checked and set up as manufacturers' specification 2.3 Laminator pressing time per module is checked and set up as manufacturers' specification. 2.4 Laminator surface checked by visual inspection for dust and debris. 2.5 Laminator machine checked

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				and test run as manufacturers' specification. 2.6 Laminator machines' faults rectified or reported to superior for further action. 2.7 Safety procedures observed in accordance standard operating procedures.
			3. Carry out solar module lamination process	3.1 Laminator machine operated in accordance with standard operating procedures. 3.2 Solar module laminated as per job requirement and according to manufacturer operation manual. 3.3 Solar module lamination operation monitored according to Technical Data Sheet specification and manufacturer operation manual. 3.4 Lamination machine temperature and pressure condition monitored according to Technical Data Sheet specification and manufacturer operation manual. 3.5 Lamination machine temperature and pressure adjusted according to Technical Data Sheet specification and manufacturer operation

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				manual. 3.6 Lamination operation process recorded according to work instruction. 3.7 Solar sealing edge tape remnant trimmed as per job requirement and according to manufacturer operation manual. 3.8 Positive and negative cable assembled according to International Electro-technical Commission (IEC) standard and specification.
			4. Inspect laminated solar module quality	4.1 Solar module defects inspected according to product specification 4.2 Non conformance or defects segregated for rework as per work instruction. 4.3 Product quality results recorded and reported according to standard operation procedures.
			5. Shut down lamination machine	5.1 Lamination machine shut down in sequence according to lamination machine operation procedures. 5.2 Lamination machine's parts inspected and cleaned according to manufacturer's specification. 5.3 Defective equipment's parts

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				are sent for maintenance or repair if applicable
4. Solar Module Performance Testing	*EE-212-3: 2013-C04*	Solar Module performance testing is the process of testing the solar module produced meet the standard the specified performance using specified testing procedures. The person who is competent in solar module performance testing shall be able to identify solar module performance testing requirement, check workplace condition, prepare material for performance testing, carry out solar module simulator test, conduct solar module leakage test, carry out solar module washing process, check solar module quality and carry out housekeeping activities The outcome of this competency is to ensure the solar module produced meet the performance standard as per company requirement	1. Identify solar module performance testing requirement 2. Inspect workplace condition	1.1 Solar module performance testing requirement accurately interpreted from WI according to standard operating procedure. 1.2 Performance testing standards identified from WI to ensure compliance with solar module job requirement. 1.3 Solar module performance testing schedule obtained from the production supervisor. 1.4 Hazardous materials and processes used in performance testing of solar module process identified in according with standard operating procedure. 2.1 Work area checked and cleared of hazards according to site and legislative requirements. 2.2 Work condition such as lighting and ergonomic is checked according to site and standard operating procedure. 2.3 Climatic condition such as humidity and temperature

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				confirmed according to solar module performance testing standard requirements. 2.4 Work area ventilation system functionality confirmed to a specified level as required by the standard operating procedures. 2.5 Unsafe working conditions identified and reported to safety officer.
			3. Prepare material for performance testing	3.1 Solar module performance testing materials identified in accordance with the production requirement. 3.2 Solar module for performance testing prepared in accordance with requirements specified in Technical Data Sheet. 3.3 Chemical solutions prepared for leakage test
			4. Prepare solar module simulator test machine.	4.1 Simulator machine set up and tested for functionality in accordance with the manufacturers' specification, and standard operating procedures. 4.2 Flash count of the simulator machine checked according to manufacturers' specification. 4.3 Solar panel simulator

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				machine calibrated as per requirement 4.4 Solar panel simulator machine tested against standard solar panel on voltage as per requirement. 4.5 Solar panel simulator machine tested against standard solar panel on current generated as per requirement. 4.6 Solar panel simulator machine tested against standard solar panel on efficiency as per requirement. 4.7 Solar panel simulator machine tested against standard solar panel on lamp intensity as per requirement. 4.8 Testing result evaluated and reported to superior for further action. 4.9 Safety procedures applied in accordance to legislative requirements
			5. Carry out solar module simulator test	5.1 Simulator machine operated according to manufacturers' specification. 5.2 Solar module to be tested placed according to performance testing requirement and manufacturer operation

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				manual. 5.3 Solar module positive and negative cable fixed to the respective polarity according to performance testing requirement. 5.4 Solar module test result on voltage/current/efficiency data analysed as per specification and according to performance testing requirement. 5.5 Failed solar module segregated for rework as per standard operation procedures. 5.6 Passed solar module qualified for leakage test according to performance testing requirement. 5.7 Test results reported according to standard operating procedures. 5.8 PPE requirement applied during testing process
			6. Carry out solar module leakage test.	6.1 Leakage solution tank prepared in accordance with standard operating procedures. 6.2 Solar module to be tested placed and submerged according to performance testing requirement and manufacturer operation

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				manual. 6.3 Solar module leakage current data analyzed and compared to the standard solar module given according to performance testing requirement and manufacturer operation manual. 6.4 Test results recorded and reported according to standard operating procedures.
			7. Carry out solar module washing process	7.1 Solar module washed in accordance with standard manufacturer operation manual. 7.2 Solar module dried in accordance with standard manufacturer operation manual. 7.3 Solar module labelled in accordance with standard manufacturer operation manual. 7.4 Solar module cable taping carried out in accordance with standard manufacturer operation manual. 7.5 Module washing process monitored according to Technical Data Sheet specification and manufacturer operation

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				manual.
			8. Inspect solar module quality	8.1 Solar module defects inspected according to product specification 8.2 Non conformance or defects segregated for rework as per work instruction. 8.3 Solar module quality results recorded and reported according to standard operation procedures.
			9. Carry out housekeeping activities	9.1 Non- conformance solar module for disposal or rework determined according to standard operating procedures 9.2 Non- conformance solar module for rework sent to designated areas as per job requirement 9.3 Non- conformance solar module for disposal sent to designated areas in according with standard operating procedures 9.4 Work area restored in accordance with standard operating procedures

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
5. Solar module Packaging Operation	*EE-212-3: 2013-C05*	Solar module packaging operation is the process of packaging the solar module produced using specified packaging material for shipment and export. . The person who is competent in solar module packaging operation shall be able to identify solar module packaging operation requirement, check work area condition, prepare materials for packaging process, conduct solar module packaging process, check solar module packaging quality and carry out housekeeping activities The outcome of this competency is to ensure the packaging of solar produced meet the packaging standard according to the company requirement	1. Identify solar module packaging operation requirement 2. Inspect work area condition	1.1 Solar module packaging operation requirement accurately interpreted from WI. 1.2 Solar module packaging standards identified from WI to ensure compliance with job requirement. 1.3 Critical activities in handling module packaging operation identified in according with the legislative requirements. 2.1 Work area checked and cleared of hazards according to site and legislative requirements. 2.2 Work condition (such as lighting and ergonomic is) checked according to site and legislative requirements. 2.3 Climatic condition (such as humidity and temperature) confirmed according to modules production standard operating procedures. 2.4 Work area ventilation system functionality confirmed to a specified level as required by the standard operating procedures. 2.5 Unsafe working conditions identified and reported to safety officer.

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
			3. Prepare packaging materials	3.1 Solar module packaging materials identified accordance with the job requirement. 3.2 Solar module packaging box prepared in accordance with the job requirement. 3.3 Solar module packaging separator paper prepared in accordance with the job requirement. 3.4 Solar module packaging wrapper prepared in accordance with the job requirement. 3.5 Solar module packaging sticker labelling prepared in accordance with the job requirement.
			4. Carry out solar module packaging process	4.1 Packaging box placed manually at robot dock 4.2 Solar module placed into boxes with respective wattages shown in accordance with the job requirement. 4.3 Packaging box remove manually from robot dock 4.4 Solar module inspected according to the packaging datasheet 4.5 Solar module packaging sticker labelled in accordance with the job

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				requirement. 4.6 Solar module packaging quality checked against defects using visual inspection 4.7 Non conformance or defects segregated for rework as per work instruction. 4.8 Packaging data sheet recorded according to work instruction. 4.9 Solar module packaging stored before shipment.
			5. Carry out housekeeping activities	5.1 Waste and unwanted material segregated for rework or disposal according to job requirement and legislative requirements 5.2 Waste and unwanted materials disposed at designated areas in according to legislative requirements. 5.3 Work area condition restored in accordance with standard housekeeping practices.
6. Solar Module Production Waste Handling	*EE-212-3: 2013-E01*	Solar module production waste handling is the process of segregating type of waste produced and disposing it according the legislative and company requirement. .	1. Identify solar module production waste handling requirement	1.1 Solar module production waste handling requirement accurately interpreted from WI. 1.2 Solar module production waste handling standards identified from WI to ensure

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
		The person who is competent in module production waste handling shall be able to identify module production waste handling requirement, prepare PPE for safety purpose as per requirement, prepare solar module production waste handling work area, carry out solar module production waste handling, carry out waste result analysis and document waste result analysis The outcome of this competency is to ensure the industrial wastes in solar module manufacturing are disposed according to the legislative and company requirement.		compliance with solar module job requirement. 1.3 Solar module production waste handling schedule obtained from the production supervisor. 1.4 Hazardous materials waste produced in solar module production identified in according with the legislative requirements.
			2. Prepare personnel protective equipment (PPE) for handling waste	2.1 Solar module production waste handling PPE identified. 2.2 Personnel protective equipment (such as mask respirator, face shield, glove and safety boot) arranged according to OSHA requirement and company standard.
			3. Prepare waste handling work area.	3.1 Work area checked and cleared of hazards according to site and legislative requirements. 3.2 Work condition such as lighting and ergonomic checked according to site and legislative requirements. 3.3 Climatic condition such as humidity and temperature identified according to solar modules production standard

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				operating procedures. 3.4 Work area ventilation system functionality confirmed to a specified level as required by the standard operating procedures. 3.5 Unsafe working conditions identified and reported to safety officer in accordance with standard operating procedures.
			4. Handle solar module production waste	4.1 Solar module solid waste segregated in accordance to in accordance with standard operating procedures and legislative requirement. 4.2 Scheduled waste and non-schedule waste identified according to legislative requirement in accordance with standard operating procedures. 4.3 Scheduled waste solar module disposed as per ISO14000 requirement and in accordance with standard operating procedures. 4.4 Unscheduled waste solar module sent to Waste Treatment Plant (WTP) in accordance with standard operating procedures 4.5 Personal and respiratory protective equipment applied

CU Title	CU Code	CU Descriptor	CU Work Activities	Performance Criteria
				in accordance with legislative requirements and in accordance with standard operating procedures.
			5. Carry out waste result analysis	5.1 Analysis result collected from laboratory. 5.2 Waste analysis result from WTP recorded, checked and compared with DoE Standard and Regulation in accordance with standard operating procedures. 5.3 Result analysis informed to the respective person for further action in accordance with standard operating procedures.
			6. Document waste result analysis	6.2 All result analysis and documentation endorsed by management for approval and consideration in accordance with standard operating procedures. 6.3 Waste result analysis document filed in accordance with standard operating procedures

CURRICULUM of COMPETENCY UNIT

Sub Sector	RENEWABLE ENERGY
Job Area	SOLAR PANEL MANUFACTURING (THIN-FILM MODULE FABRICATION)
Competency Unit Title	SOLAR SUB-MODULE PRODUCTION
Learning Outcome	Solar sub-module production is the process of preparing the glass sheet for coating processes before solar sub-module is rolled out. The person who is competent in this CU shall be able to produce solar sub-module according to the specified standard. Upon completion of this competency unit, trainees will be able to: • Identify solar sub-module production operation requirements • Inspect solar sub-module workplace condition • Prepare solar sub-module production materials • Prepare Coater Machine • Inspect glass surface condition • Carry out first solar sub-module coating process • Carry out second solar sub-module coating process • Inspect solar sub-module quality • Shut down coating machine • Carry out housekeeping activities

Competency Unit ID	*EE-212-3: 2013-C01*	**Level**	3	**Training Duration**	540	**Credit Hours**	54

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
1. Identify solar sub-module production requirements.	i. Definition on solar sub-module production process. ii. Solar sub-module production requirement. iii. Solar sub- module			8	Lecture & Group Discussion	i. Solar sub-module production interpreted accurately requirement ii. Solar sub

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	standard and specification. iv. Definition on hazardous materials used in production. v. Safety requirement for sub-solar module production process					module standards identified iii. Solar sub-module production schedule obtained. iv. Hazardous materials and processes used in solar sub-module production identified
		i. Interpret Solar sub-module production requirement ii. Identify Solar sub-module standards iii. Obtain solar sub module production schedule. iv. Identify hazardous materials and processes used in sub -solar module production	*Attitude* i. Thorough and precise in interpreting production requirements. *Environment* i. Adopt 3R concept	27	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
2. Inspect solar sub-module workplace condition	i. Common work area hazard at production system and its risk. ii. Conducive work environment. iii. Ergonomic procedure at work. iv. Introduction to safety and health environment. v. Work place safety signage. vi. Workplace layout vii. Personnel Protective Equipment (PPE) requirement			8	Lecture & Group Discussion	i. Work area checked and cleared of hazards ii. Work condition such as lighting and ergonomic checked. iii. Climatic condition such as humidity and temperature checked iv. Work area ventilation system functionality confirmed to a specified level as required v. Unsafe working conditions identified and reported to safety officer.
		i. Check and clear work area hazards. ii. Check lighting and ergonomic condition iii. Identify humidity and temperature condition iv. Confirm work area ventilation system functionality v. Identify unsafe working conditions		27	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Resourceful and meticulous in identifying hazardous objects ii. Adhere to safe work area principles. *Environment* i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere of safety environment ii. Ensure workplace is safe			
3. Prepare solar sub-module production materials	i. Content on technical sheet. ii. Procedures for glass cleaning • Method, material • Glass defect iii. Procedures for coating chemical solution preparation			24	Lecture & Group Discussion	i. Solar sub-module production materials identified from Technical Sheet ii. Glass arranged for solar sub-module production

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		i. Identify solar sub-module production materials ii. Arrange glass for solar sub-module production iii. Clean solar sub-module glass from dust and contaminants. iv. Identify and segregate defective glass. v. Pour chemical solutions	*Attitude* i. Resourceful and meticulous in identifying solar sub-module module production materials requirement ii. Adhere to safe work area principles. *Environment* i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects	57	Demonstration & Observation	iii. Solar sub-module glass cleaned from dust and contaminants. iv. Defective glass identified and segregated. v. Chemical solutions for solar sub-module production arranged.

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Safety i. Adhere to safety environment requirement. ii. Ensure workplace is safe			
4. Prepare Coater Machine	i. Introduction to coating machine operation and process. • functionality • calibration grounding procedure ii. Common coating process error. iii. Coating chemical indicator level			16	Lecture & Group Discussion	i. Coater machine set up ii. Calibration coater machine carried out. iii. Coater machine tested iv. Test run result evaluated v. Minor coater machine faulty component rectified vi. Major coater machine faulty reported component vii. Coating chemical solutions placed to coater machine viii. Safety procedures solar sub-module applied
		i. Set up Coater machine ii. Carry out Calibration coater machine. iii. Test run coater machine iv. Evaluate test run result v. Rectify minor coater machine faulty component vi. Report major coater		38	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		machine faulty component vii. Place coating chemical solutions to coater machine viii. Apply safety procedures solar sub-module.	*Attitude* i. Precise and focus in setting up and calibration of the machine. requirement ii. Handle Coater machine with care iii. Adhere to safe work area principles. *Environment* i. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety procedure. ii. Ensure workplace is safe			

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
5. Inspect glass surface condition	i. Criteria for glass coating. ii. Methods of glass cleaning			16	Lecture & Group Discussion	i. Glass surface condition checked to ensure free form dirt, grease and other contaminants. ii. Dirt and contaminants swept off from the surface iii. Grease and oil removed using cleaning solvent
		i. Check glass surface condition ii. Sweep off dirt and other contaminants from the surface. iii. Remove grease using cleaning solvent.	*Attitude* i. Resourceful and meticulous in inspection	38	Demonstration & Observation	
6. Carry out first coating process	i. SOP application on coater machine operation. ii. Importance of temperature and pressure in coating process. • Norminal working temperature for running coating			32	Lecture & Group Discussion	i. Coater machine operated ii. Temperature and the pressure of coater machine monitored. iii. Temperature and the pressure of coater machine

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	machine iii. Temperature and pressure control interface. iv. Loading of glass process and procedure (SOP). v. PPE requirement during coating process. vi. Grinding process and procedure. vii. Grinder parts and operation. viii. Washing process and procedure. ix. Laser marking process and procedure. x. First coating process and procedure. • Sputtering of chemical at high temperature and in vacuum condition. xi. First coating quality inspection and procedure • Thickness and roughness of the first coated glass					adjusted iv. Loading of glass to be coated monitored v. Personal Protective (PPE) Equipment applied vi. Grinding process of the glass monitored. vii. Grinder adjusted or replaced when grinded glass quality does not conform quality standard viii. Washing process of the glass monitored (specifically on the cleaning and drying of grinded glass) ix. Laser marking process on the glass monitored x. First coating process of

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		i. Operate coater machine ii. Monitor temperature and pressure iii. Adjust temperature and pressure iv. Monitor loading of glass to be coated v. Apply proper Protective (PPE) Equipment vi. Monitor grinding process of the glass. vii. Adjust or replace grinder when grinded glass quality does not conform quality standard viii. Monitor washing process of the glass (specifically on the cleaning and drying of grinded glass) ix. Monitor laser marking process on the glass x. Perform glass first coating process xi. Inspect first coating quality		76	Demonstration & Observation	glass performed xi. First coating quality inspected

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Precise and focus in setting up and calibration of the machine. requirement ii. Handle coater machine with care iii. Adhere to safe work area principles. *Environment* i. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety procedure. ii. Ensure workplace is safe			
7. Carry out solar sub-module second coating process	i. Pre-wash - of the first coating ii. Chloride spray of the glass. • Drying and curing chloride sprayed solar sub-module e in baking oven.			24	Lecture & Group Discussion	i. First coating pre-wash activity explained. ii. Glass chloride spray process explained. iii. Drying and curing of chloride sprayed

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	iii. Laser scribing process. iv. Negative Photo Resist process, v. Metalizer process, vi. Edge delete process vii. Post metal heat treatment					module in baking oven explained iv. Laser scribing process described v. Negative photo resist process described vi. Metalizer process described vii. Edge delete process described viii. Post metal heat treatment process described ix. Data sheet recording process carried out.
		i. Monitor first coating pre-wash activity ii. Monitor glass chloride spray process. iii. Monitor drying and curing of chloride sprayed module in baking oven iv. Monitor Laser scribing process v. Monitor Negative Photo Resist process vi. Monitor metalizer process vii. Monitor Edge Delete process viii. Monitor Post Metal Heat Treatment process ix. Carry out data sheet recording process.		57	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Precise and focus in operating the machine. requirement ii. Handle coater machine with care iii. Adhere to safe work area principles. *Environment* i. Adhere to SOP on hazardous machineries and object ii. Adhere to manufacturer safety procedure. *Safety* i. Adhere to manufacturer safety procedure. ii. Ensure workplace is safe			
8. Inspect solar sub-module quality	i. Inspection method and procedure • Defects, acceptable, rejectable specification and unknown			16	Lecture & Group Discussion	i. Solar sub-module coated glass quality checked against scratches, chippings,

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	(defects not stated in checklist). • Statistical process control ii. Method segregation of defects iii. Quality inspection record and report procedure					cracks and void ii. Non conformance or defected of solar sub-module glass segregated iii. Quality inspection results of solar sub-module glass reported
		i. Check solar sub-module coated glass quality against scratches, chippings, cracks and void ii. Segregate non conformance or defected solar sub-module glass iii. Report solar sub-module coated glass quality.	*Attitude* i. Resourceful and meticulous in inspection	38	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
9. Shut down coating machine	i. Coater machine shut down procedure(SOP) • Panel clearance • Cool down ii. Coater machine's parts to be inspected and clean. iii. Defective parts and maintainance requirement iv. Reporting procedures			8	Lecture & Group Discussion	i. Coater machine shut down procedure follow ii. Coater machine parts condition inspect iii. Defective parts condition check iv. Major defective coater machine's parts reported for maintenance or repair. v. Coater machine's parts cleaned
		i. Follow coater machine shut down procedure ii. Inspect coater machine parts condition iii. Check defective parts condition iv. Report major defective coater machine's parts for maintenance or repair. v. Clean coater machine's parts		19	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Focus in shutting down the machine. ii. Handle machine with care *Safety* i. Adhere to manufacturer safety procedure.			
10. Carry out housekeeping activities.	i. Type of waste and unwanted materials from solar sub-module glass production activities. ii. Waste disposal procedures. iii. Waste designated areas • 5S Program			8	Lecture & Group Discussion	i. Waste and unwanted materials disposed from solar sub-module glass production activities at designated areas. ii. Defective coated materials placed at designated areas for rework
		i. Dispose waste and unwanted materials ii. Place defective coated materials at designated areas for rework		27	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Resourceful and meticulous in segregating waste type *Environment* i. Adhere to SOP on hazardous disposal ii. Ensure workplace is safe *Safety* i. Adhere to safety requirement ii. Wear PPE			

Employability Skills

Core Abilities	Social Skills
01.01 Identify and gather information 02.01 Interpret and follow manuals, instructions and SOPs 02.03 Communicate clearly 02.04 Prepare brief reports and checklist using standard forms 03.03 Accept responsibility for own work and work area 06.03 Identify and highlights problems 01.04 Analyse information 02.08 Prepare pictorial and graphics information 04.01 Organize own work activities 02.10 Prepare reports and instructions 02.03 Convey information and ideas to people 03.11 Provide consultation and counselling 03.12 Provide coaching/on-the-job training	1. Communication skills 2. Conceptual skills 3. Interpersonal skills 4. Learning skills 5. Leadership skills 6. Multitasking and prioritising 7. Self-discipline 8. Teamwork

Tools, Equipment and Materials (TEM)

ITEMS	RATIO (TEM : Trainees)
1. Sample of Work Instruction on Solar sub-module production of solar module	1:5
2. Coater Machine 1 operating manual	1:5
3. Coater Machine 2 operating manual	1:5
4. Coater Machine 1	1:10
5. Coater Machine 2	1:10
6. Hand tools	1:1
7. Sample of defected solar sub- module from produced from Coater Machine 1	1:5
8. Sample of specification conforming solar sub- module from produced from Coater Machine 1	1:5
9. Sample of defected solar sub- module from produced from Coater Machine 1	1:5
10. Sample of specification conforming solar sub- module from produced from Coater Machine 2	1:5
11. Sample of solar module rework guidelines	1:1
12. Solar sub-module production Inspection results reporting format	1:1
13. Personal Protective Equipment (PPE)	1:1

References

REFERENCES

1. Markvart, T, Castaner, L. (2004), Solar Cells: Materials, Manufacture and Operation Elsevier, 2004, 556 pages ISBN, 9780080541419
2. I.M. Dharmadasa (2013), Advances in Thin Film Solar Cells, Pan Stanford Publishing ISBN 9789814316071
3. Arvin Shah (2010), Thin Film Silicon Solar Cells, Taylor and Francis Group ISBN 9782940222360
4. Daniel Abou-Ras, Thomas Kirchartz, Uwe Rau (2009) Advanced Characterization Technique for Thin Film Solar Cells, Wiley-VCH Verlag GmbH & Co ISBN 9783527410033

CURRICULUM of COMPETENCY UNIT (CoCU)

Sub Sector	RENEWABLE ENERGY						
Job Area	SOLAR PANEL MANUFACTURING (THIN-FILM MODULE FABRICATION)						
Competency Unit Title	SOLAR MODULE LAY-UP AND SEALING PROCESS						
Learning Outcome	Lay Up and Sealing of Solar Module is the process of laying up two sheets of coated glass and sealing off the solar sub-module/panel. The outcome of this competency is to ensure the process of lay up and sealing of solar sub-module/panel is carried out according to the specified standard. The person who is competent in this CU shall be able to carry out the process of laying up two sheets of coated glass and sealing off the solar module through the process of lay up and sealing of solar module. Upon completion of this competency unit, trainees will be able to: - • Identify module lay up & sealing process requirement, • inspect workplace condition, • Prepare lay-up and sealing solar module materials, • Prepare bussing machine, • Carry out solar module lay-up and sealing activity, • Inspect solar module quality • Shut down lay-up and sealing machine • Carry out housekeeping activities.						
Competency Unit ID	*EE-212-3: 2013-C02*	**Level**	3	**Training Duration**	270	**Credit Hours**	27

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
1. Identify Solar Module Lay Up & Sealing process requirement	i. Fundamental of lay up process. ii. Lay up process. requirement iii. Sealing process. iv. Sealing process requirement v. The importance of			8	Lecture & Group Discussion	i. Solar module lay up process explained ii. Solar module sealing process explained. iii. Solar module

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	laying up and sealing vi. Hazardous materials and processes. vii. Method of laying-up & sealing. viii. Lay-up and sealing machine capacity					lay-up & sealing requirement listed iv. Solar module lay-up & sealing standards listed v. Solar module lay-up & sealing schedule explained vi. Hazardous materials and processes listed vii. Lay-up & sealing method described
		i. Identify solar module lay-up & sealing requirement ii. Identify solar module lay-up & sealing standards iii. Interpret solar module lay-up & sealing schedule iv. Identify hazardous materials and processes used v. Identify lay-up & sealing method.	*Attitude* i. Thorough and precise in interpreting solar module lay up & sealing process requirements. *Environment* i. Adopt 3R concept	19	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
2. Inspect workplace condition	i. Common work area hazard at production system and its risk. ii. Conducive work environment iii. Ergonomic procedure at work. iv. Introduction to safety and health environment • Workplace safety signage • Workplace layout • Personnel Protective Equipment (PPE) requirement			4	Lecture & Group Discussion	i. Hazards at Lay-up and sealing work area listed. ii. Work area checked and cleared of hazards. iii. Lighting and ergonomic work condition checked iv. Humidity and temperature climatic condition confirm. v. Work area ventilation system functionality checked vi. Unsafe working conditions reported to safety officer
		i. Check and clear work area from hazards. ii. Check lighting and ergonomic work condition iii. Confirm humidity and temperature climatic condition iv. Check work area ventilation system functionality		9	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		v. Report unsafe working conditions to safety officer	*Attitude* i. Resourceful and meticulous in identifying hazardous objects ii. Adhere to safe work area principles. *Environment* i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety environment ii. Ensure workplace is safe			
3.Prepare lay-up and sealing solar sub-module materials	i. Introduction to lay up and sealing materials. • double side tape • copper foil • buss bar • sealing edge • cover glass ii. Method and application procedure for lay up			16	Lecture & Group Discussion	i. Lay up- and sealing material requirement listed ii. Lay-up and sealing materials prepared iii. Copper foil for solar module production

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	and sealing process. iii. Method for sampling and segregation					cleaned and free from dust and contaminants iv. Defective materials identified and segregated according to sampling and inspection procedures.
		i. Prepare lay-up and sealing process materials ii. Clean copper foil iii. Identify defective materials iv. Segregate defective material according to sampling and inspection procedures	*Attitude* i. Resourceful and meticulous in identifying lay up & sealing materials requirement ii. Adhere to safe work area principles. *Environment* i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects	38	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Safety i. Adhere to safety environment requirement. ii. Ensure workplace is safe			
4. Prepare bussing machine.	i. Introduction to Bussing machine operation and process. • Functionality • Calibration • Grounding procedure ii. Application on bussing machine operation (SOP). iii. Method for loading module. iv. Common bussing process error. v. Safety procedure on bussing machine preparation			16	Lecture & Group Discussion	i. Bussing machine operation and process explained. ii. Bussing machine set up and tested prior calibration for functionality in accordance with the manufacturers' specification, iii. Calibration of the bussing machine carried out as manufacturers' specification. iv. Faults diagnosed, rectified or reported to superior for further action.
		i. Set up bussing machine as per requirement ii. Check bussing machine functionality.		38	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		iii. Test run bussing machine iv. Calibrate bussing machine according to specification v. Rectify bussing machine faults	*Attitude* i. Precise and focus in setting up and calibration of the machine. requirement ii. Handle machine with care iii. Adhere to safe work area principles. *Environment* i. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety procedure. ii. Ensure workplace is safe			

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
5. Carry out solar module lay-up and sealing activity	i. Solar module lay-up and sealing process ii. Loading of solar module procedure (SOP) iii. Type of material for lay up and sealing process • Double sided tape • Copper foil • Buss bar • Sealing edge • Cover glass iv. Temperature and pressure control interface v. Final quality inspection procedure for lay up and sealing process vi. Data sheet recording process procedure.			16	Lecture & Group Discussion	i. Solar module lay-up and sealing process explained. ii. Solar module condition checked against dirt, grease and other contaminants iii. Dirt and other contaminants cleaned iv. Bussing machine v. Personal and respiratory protective equipment used. vi. Double side tape, Copper foil tape, Buss bar, Sealing edge tape cover glass placed and aligned according to job requirement vii. Temperature and the
		i. Check solar module cosmetic defect against dirt, grease and other contaminants. ii. Clean dirt and		38	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		other contaminants iii. Operate bussing machine in accordance with standard operating procedures. iv. Place lay-up and sealing material v. Align lay-up and sealing material vi. Place and align cover glass to module as per requirement vii. Monitor temperature and the pressure of bussing machine condition viii. Adjust temperature and the pressure of bussing machine ix. Inspect sealed module as per specification. x. Record lay-up and sealing activity according	*Attitude* i. Precise and focus in operating the machine. requirement ii. Handle coater machine with care			pressure of bussing machine condition adjusted to specified requirement viii. Lay-up and sealing solar module inspected ix. Lay-up and sealing of solar module complied. x. Data sheet recording process carried out

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			iii. Adhere to safe work area principles. *Environment* i. Adhere to SOP on hazardous machineries and object ii. Adhere to safety procedure. iii. Ensure workplace is safe *Safety* i. Adhere to safety procedure. ii. Ensure workplace is safe			
6. Inspect solar module quality	i. Common defect of module at lay up and sealing process • Misalignment of double side tape, copper foil, buss bar, sealing edge, cover glass ii. Test results record and reporting procedure			12	Lecture & Group Discussion	i. Lay-up and sealing of solar module checked against misalignment • double side tape • copper foil tape • Buss bar • sealing edge tape • cover glass

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		i. Check lay-up and sealed solar ii. Segregated non conformance or defects for rework iii. Record and report test results		28	Demonstration & Observation	ii. Non conformance or defects segregated for rework iii. Test results recorded and reported
7. Shut down Lay-up and Sealing machine.	i. Bussing machine shut down procedure (SOP). • Panel clearance ii. Bussing machine's parts to be inspected and clean (SOP). iii. Defective parts and maintainance reporting procedures			5	Lecture & Group Discussion	i. Lay-up and Sealing machine shut down in sequence ii. Lay-up and Sealing machine parts inspected and cleaned iii Defective equipment's parts sent for maintenance or repair if applicable
		i. Shut down lay-up and sealing machine ii. Inspect and clean lay-up and sealing machine parts iii. Send defective parts for		9	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		maintenance or repair if applicable	*Attitude* i. Precise and focus in shutting down the machine. ii. Handle machine with care iii. Adhere to safe work area principles. *Environment* i. Adhere to SOP on hazardous machineries and object ii. Adhere to safety procedure. *Safety* i. Adhere to safety procedure.			
8. Carry out housekeeping activities.	i. Conformance an non-conformance lay-up and sealing process solar module criteria ii. Non-conformance solar module			4	Lecture & Group Discussion	i. Conformance and non-conformance criteria lay-up and sealed solar panel explained.

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	disposal procedure iii. Waste designated area. • 5S Program iv. Disposal of scrap module panel					ii. Non-conformance solar module determined for disposal or rework. iii. Non-conformance lay-up and sealed solar module for rework sent to designated areas as per job requirement iv. Non-conformance lay-up and sealed solar module solar module for scraping sent to designated areas as per job requirements v. Work area restored as per job area requirement.
		i. Determine non-conformance solar module for disposal or rework. ii. Sent non-conformance module for disposal to designated areas iii. Sent non-conformance module for rework to designated areas according to standard operating procedures iv. Restore work area as per job area requirement.		9	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude ii. Resourceful and meticulous in segregating waste type iii. Adhere to safe work area principles. *Environment* i. Adhere to SOP on hazardous disposal ii. Ensure workplace is safe *Safety* i. Adhere to safety requirement ii. Wear PPE			

Employability Skills

Core Abilities	Social Skills
01.01 Identify and gather information 02.01 Interpret and follow manuals, instructions and SOPs 02.03 Communicate clearly 02.04 Prepare brief reports and checklist using standard forms 03.03 Accept responsibility for own work and work area 06.03 Identify and highlights problems 01.04 Analyse information 02.08 Prepare pictorial and graphics information 04.01 Organize own work activities 02.10 Prepare reports and instructions 02.03 Convey information and ideas to people 03.11 Provide consultation and counselling 03.12 Provide coaching/on-the-job training	1. Communication skills 2. Conceptual skills 3. Interpersonal skills 4. Learning skills 5. Leadership skills 6. Multitasking and prioritising 7. Self-discipline 8. Teamwork

Tools, Equipment and Materials (TEM)

ITEMS	RATIO (TEM : Trainees)
1. Sample of Work Instruction on Lay-up and Sealing of solar module	1:5
2. Lay-up and Sealing of solar module operating manual	1:5
3. Lay-up and Sealing of solar module machine	1:10
4. Hand tools	1:5
5. Sample of defected solar module from Lay-up and Sealing of solar module	1:5 1:5
6. Sample of solar module rework guidelines	1:1
7. Lay-up and Sealing of solar module Inspection results reporting format	1:1 1:5
8. Personal Protective Equipment (PPE)	1:1

REFERENCES

REFERENCES

1. Markvart, T, Castaner, L. (2004), Solar Cells: Materials, Manufacture and Operation Elsevier, 2004, 556 pages ISBN, 9780080541419
2. I.M. Dharmadasa (2013), Advances in Thin Film Solar Cells, Pan Stanford Publishing ISBN 9789814316071
3. Arvin Shah (2010), Thin Film Silicon Solar Cells, Taylor and Francis Group ISBN 9782940222360
4. Daniel Abou-Ras, Thomas Kirchartz, Uwe Rau (2009) Advanced Characterization Technique for Thin Film Solar Cells, Wiley-VCH Verlag GmbH & Co ISBN 9783527410033

CURRICULUM of COMPETENCY UNIT (CoCU)

Sub Sector	RENEWABLE ENERGY						
Job Area	SOLAR PANEL MANUFACTURING (THIN-FILM MODULE FABRICATION)						
Competency Unit Title	SOLAR MODULE LAMINATION PROCESS						
Learning Outcome	Solar module lamination is the process of laminating solar module with specified laminating material using laminator machine. The outcome of this competency is to ensure the process of laminating off solar module is carried out according to the specified standard on solar module lamination. The person who is competent in solar module lamination process shall be able to: • Identify solar module lamination process requirement, • Prepare laminator machine, • Carry out solar module lamination procedures, • Check product quality from any defects and • Shut down the lamination machine						
Competency Unit ID	*EE-212-3: 2013-C03*	**Level**	3	**Training Duration**	270	**Credit Hours**	27

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
1. Identify solar module lamination process requirement	i. Content of Working instruction ii. Fundamental of Solar module lamination process iii. Solar module lamination process requirement iv. Solar module lamination operation standards			7	Lecture & Group Discussion	i. Content of Working instruction described ii. Solar module lamination process explained iii. Solar module lamination operation requirement accurately listed.

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	v. Module lamination schedule vi. Hazardous materials and processes used in solar modules production process					iv. Panel lamination operation standards identified from WI. v. Panel lamination operation schedule obtained from the production supervisor. vi. Hazardous materials and processes used in sub modules production process identified
		i. Interpret Solar module production requirement ii. Identify Solar module standards iii. Interpret solar module production schedule. iv. Identify hazardous materials and processes used in solar module production	*Attitude* i. Thorough and precise in interpreting production requirements. *Environment* i. Adopt 3R concept	20	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
2. Prepare laminator machine	i. Parts and function of laminator machine ii. Set up and test laminator machine procedures iii. Calibration for laminator machine functionality. iv. Laminator machine temperature requirement. v. Laminator pressing time per module requirement. vi. Inspection laminator surface technique			14	Lecture & Group Discussion	i. Parts and function of laminator machine explained ii. Laminator machine set up and test procedures described. iii. Calibration procedures listed. iv. Laminator machine set up and tested prior calibration for functionality. v. Laminator temperature checked and set up. vi. Laminator pressing time per module is checked and set up. vii. Laminator surface checked by visual inspection for dust and
		i. Set up laminator machine ii. Calibrate laminator machine iii. Check and set laminator temperature iv. Check laminator pressing time per module.		40	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		v. Check laminator surface visually. vi. Test run laminator machine as manufacturers' specification. vii. Rectified laminator machines faults viii. Record lamination machine condition	*Attitude* i. Resourceful and meticulous in preparing machine operation ii. Adhere to safe work area principles. *Environment* i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects *Safety* i. Aware of safety environment requirement. ii. Ensure workplace is safe			debris.. viii. Laminator machine checked and test run. ix. Laminator machines' faults diagnosed, rectified or reported to superior for further action. x. Safety procedures adhere

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
3. Carry out solar module lamination process	i. Operating laminator machine procedures ii. Monitoring technique of critical process parameter in laminating of solar module operation iii. Importance of temperature and the pressure of lamination machine condition monitoring iv. Trim solar sealing edge tape remnant. v. Positive and negative cable assembly procedures. vi. Carry out record data sheet process of lamination format.			38	Lecture & Group Discussion	i. Operating procedures of laminating machines listed. ii. Critical process in laminating solar module monitored. iii. Laminator machine operated in solar module laminated as per job requirement. iv. Lamination of solar module operation is monitored according to Technical Data Sheet specification. v. Temperature and the pressure of lamination machine condition monitored according to Technical Data Sheet
		i. Operated Laminator machine ii. Laminated solar module as per job requirement iii. Monitor solar module lamination		70	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		operation iv. Monitor lamination machine temperature and pressure condition v. Adjust lamination machine temperature and pressure. vi. Trim solar sealing edge tape remnant vii. Assembly positive and negative cable according to International Electro-technical Commission (IEC) standard and specification viii. Recorded lamination operation activity	*Attitude* i. Precise and focus in setting up the machine. requirement ii. Handle machine with care iii. Adhere to safe work area principles.			specification. vi. Lamination machine operation vii. Solar sealing edge tape remnant trimmed as per job requirement. viii. Positive and negative cable assembled according to International Electro-technical Commission (IEC) standard ix. Data sheet recording process of lamination operation carried out.

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Environment i. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety procedure. ii. Ensure workplace is safe			
4.Check laminated solar module quality	i. Type of defects on solar module after lamination process such as • Air bubbles • Delaminate ii. Methods of defects inspection iii. Segregate non conformance or defects for rework guidelines. iv. Recording and reporting inspection procedures			17	Lecture & Group Discussion	i. Type of defects on solar module after lamination explained. ii. Defects on solar module inspected visually and listed iii. Segregation guidelines of non-conformance or defects listed. iv. Non conformance or defects segregated for rework as per work instruction. v. Inspection
		i. Inspect solar module defects		35	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		according to product specification ii. Segregate non conformance or defects for rework as per work instruction. iii. Recorded product quality results and reported to superior	*Attitude* i. Precise and focus in setting up the machine. requirement ii. Handle machine with care iii. Adhere to safe work area principles. *Environment* i. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety procedure. ii. Ensure workplace is safe			results recorded and reported

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
5. Shut down lamination machine	i. Shut down lamination machine procedures ii. Post operation lamination machine's parts inspection iii. Post operation lamination machine's parts inspection cleaning process iv. Post operation maintenance or repair defective equipment's parts			7	Lecture & Group Discussion	i. Shut down procedures of lamination machine explained. ii. Post operation lamination machine parts to be inspected listed. iii. Post operation lamination machine parts to be cleaned listed iv. Lamination machine shut down in sequence v. Lamination machine's parts inspected vi. Lamination machine's parts cleaned vii. Defective equipment's parts identified and sent for maintenance.
		i. Shut down lamination machine in sequence ii. Inspect and clean lamination machine's parts iii. Send defective equipment's parts for maintenance or repair.		20	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Precise and focus in setting up the machine. requirement ii. Handle machine with care iii. Adhere to safe work area principles. *Environment* i. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety procedure. ii. Ensure workplace is safe			

Employability Skills

Core Abilities	Social Skills
Identify and gather information 02.01 Interpret and follow manuals, instructions and SOPs 02.03 Communicate clearly 02.04 Prepare brief reports and checklist using standard forms 03.03 Accept responsibility for own work and work area 06.03 Identify and highlights problems 01.04 Analyse information 02.08 Prepare pictorial and graphics information 04.01 Organize own work activities 02.10 Prepare reports and instructions 02. 03 Convey information and ideas to people 03. 11 Provide consultation and counselling 03.12 Provide coaching/on-the-job training	1. Communication skills 2. Conceptual skills 3. Interpersonal skills 4. Learning skills 5. Leadership skills 6. Multitasking and prioritising 7. Self-discipline 8. Teamwork

Tools, Equipment and Materials (TEM)

ITEMS	RATIO (TEM : Trainees)
1. Sample of Work Instruction on Laminating of Solar Module	1:5
2. Laminator machine operating manual	1:5
3. Laminating machine of Solar Module	1:10
4. Hand tools	1:5
5. Sample of defected solar module from laminator machine	1:5
6. Sample of specification conforming solar module from laminator machine	1:10
7. Sample of solar module rework guidelines	1:1
8. Laminated solar module Inspection results reporting format	1:5
9. Personal Protective Equipment (PPE)	1:1

References

REFERENCES

1. Markvart, T, Castaner, L. (2004), Solar Cells: Materials, Manufacture and Operation Elsevier, 2004, 556 pages ISBN, 9780080541419
2. I.M. Dharmadasa (2013), Advances in Thin Film Solar Cells, Pan Stanford Publishing ISBN 9789814316071
3. Arvin Shah (2010), Thin Film Silicon Solar Cells, Taylor and Francis Group ISBN 9782940222360
4. Daniel Abou-Ras, Thomas Kirchartz, Uwe Rau (2009) Advanced Characterization Technique for Thin Film Solar Cells, Wiley-VCH Verlag GmbH & Co ISBN 9783527410033

CURRICULUM of COMPETENCY UNIT (CoCU)

Sub Sector	RENEWABLE ENERGY
Job Area	SOLAR PANEL MANUFACTURING (THIN-FILM MODULE FABRICATION)
Competency Unit Title	SOLAR MODULE PERFORMANCE TESTING
Learning Outcome	Solar module performance testing is the process of testing the solar module produced meets the quality standard of the specified performance using specified testing procedures. The outcome of this competency is to ensure the solar module produced meet the performance standard as per company requirement. The person who is competent in solar module performance testing shall be able to: • Identify solar module performance testing requirement, • Inspect workplace condition, • Prepare material for performance testing, • Prepare solar module simulator test machine • Carry out solar module simulator test, • Carry out solar module leakage test, • Carry out solar module washing process, • Inspect solar module quality • Carry out housekeeping activities

Competency Unit ID	*EE-212-3: 2013-C04*	**Level**	3	**Training Duration**	320	**Credit Hours**	12

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
1. Identify solar module performance testing requirement	i. Definition on solar module performance testing process. ii. Requirement for solar module performance testing.			10	Lecture & Group Discussion	i. Solar module performance testing process explained. ii. Solar module performance testing requirement

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	iii. Solar module performance testing standard and specification. iv. Solar module performance testing process system. v. Definition on hazardous materials used in production. vi. Safety requirement for solar module performance testing process					listed. iii. Performance testing standards explained from WI. iv. Solar module performance testing schedule described. v. Hazardous materials and processes used in performance testing of solar module process listed. vi. Safety requirement for solar module performance testing identified
		i. Interpret Solar module performance testing requirement ii. Identify performance testing standards. iii. Interpret solar module performance testing schedule. iv. Identify hazardous materials and processes used in performance testing of solar module process		25	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		v. Identify safety requirement for solar module performance testing	*Attitude* i. Thorough and precise in interpreting production requirements. *Environment* i. Adopt 3R concept			
2. Check workplace condition	i. Common work area hazard at production system and its risk ii. Conducive work environment. • Lighting • Humidity • Temperature • Ventilation iii. Ergonomic procedure at work. iv. Introduction to safety and health environment • Workplace safety signage • Workplace layout			10	Lecture & Group Discussion	i. Work area checked and cleared of hazards according to site and legislative requirements. ii. Work condition such as lighting and ergonomic is checked according to site and legislative requirements. iii. Climatic condition such

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	v. Personnel Protective Equipment requirement					as humidity and temperature confirmed according to solar module performance testing standard requirement iv. Work area ventilation system functionality confirmed to a specified level as required by the standard operating procedures. v. Unsafe working conditions determined and reported to safety office.
		i. Check and clear work area from hazards. ii. Check lighting and ergonomic work condition iii. Confirm humidity and temperature climatic condition iv. Check work area ventilation system functionality v. Report unsafe working conditions to safety officer	*Attitude* i. Resourceful and meticulous in identifying hazardous objects ii. Adhere to safe work area principles. *Environment* i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects	25	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Safety i. Adhere to safety environment ii. Ensure workplace is safe			
3. Prepare material for performance testing	i. Testing material content ii. Procedure for module performance testing • Method, • Instrument iii. Chemical solutions preparation procedure for leakage current test of solar module			10	Lecture & Group Discussion	i. Content in Technical Sheet listed. ii. Performance testing procedure explained. iii. Solar module performance testing materials listed as per job requirement. iv. Solar module for performance testing prepared as per requirements specified in Technical Data Sheet. v. Chemical solutions for leakage current test of
		i. Identify solar module performance testing materials. ii. Prepare solar module for performance testing iii. Prepared chemical solutions for leakage test		25	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Resourceful and meticulous in preparing module for testing *Environment* i. Adopt 3R concept. *Safety* i. Adhere to safe work area principles.			solar module performance testing prepared as specified in Technical Data Sheet
4. Prepare solar module simulator test machine.	i. Introduction to simulator machine operation and process. • Functionality • Calibration Grounding procedure • Flash count ii. Simulator machine calibration operating procedure • Common error in simulation such as'Simulator not ready'			10	Lecture & Group Discussion	i. Solar module testing simulator machine operation and process explained. ii. Calibration of Simulator machine procedure explained. iii. Common error in simulation operation described. iv. Simulator machine set up and tested

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		i. Set up simulator machine ii. Check simulator machine flash count. iii. Calibrate solar panel simulator machine iv. Test solar panel simulator machine against standard solar panel on voltage as per requirement. v. Test solar panel simulator machine against standard solar panel on current generated vi. Test solar panel simulator machine against standard solar panel on efficiency. vii. Test solar panel simulator machine against standard solar panel on lamp intensity viii. Evaluate and report testing result		25	Demonstration & Observation	prior calibration for functionality in as per manufacturer specification. v. Flash count of the simulator machine counted vi. Solar module simulator calibrated machine as per manufacturer specification. vii. Faults diagnosed, rectified and reported to superior viii. Safety procedures explained

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Resourceful and meticulous in preparing the test *Environment* i. Adopt 3R concept. *Safety* i. Adhere to safe work area principles			
5. Carry out solar module simulator test	i. SOP on operating Simulator machine operation. ii. Importance of pressure in simulating process. iii. Pressure control interface. iv. Handling and Loading of module for performance testing • Module polarity • Cable connection			10	Lecture & Group Discussion	i. SOP on simulator machine described ii. Simulator machine operated according to manufacturers' specification. iii. Solar module to be tested placed according to performance testing requirement iv. Solar module positive and negative cable fixed to the

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	v. Solar module performance. • Voltage, • Current • Efficiency • Lamp intensity vi. Solar module simulator calibration operating procedure vii. PPE requirement during testing process.					respective polarity according to performance testing requirement. v. Solar module test result on voltage/current/ efficiency data analysed as per specification and performance testing requirement. vi. Solar module that failed one or more of the tests segregated for rework as job requirement vii. Select solar module that passed the tests for leakage test viii. PPE requirement during testing process listed ix. Test results reported according to
		i. Operate simulator machine. ii. Place solar module for test iii. Fix solar module positive and negative cable to the respective polarity. iv. Analyse solar module test result v. Segregate failed solar module for rework vi. Sent solar module qualified for leakage test. vii. Report test results to superior		25	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Focus in operating the machine *Environment* i. Adopt 3R concept. *Safety* i. Adhere to safe work area principles			standard operating procedures
. 6. Carry out solar module leakage test.	i. SOP application on leakage test process. ii. Handling and loading of module for leakage test. • Solution level, conductivity and temperature • Cable connection iii. Leakage test evaluation. • Type of instrument used • Degree current leakage detected			10	Lecture & Group Discussion	i. Solar module to be tested placed and submerged according to performance testing requirement and manufacturer operation manual. ii. Solar module leakage current data analyzed and compared to the standard solar module given according to performance testing requirement

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	iv. PPE requirement during simulating process					and manufacturer operation manual.
		i. Place and submerge solar module to be tested in the tank ii. Analyse solar module leakage current data and compare to the standard solar module given iii. Record and report test results are	*Attitude* i. Focus in operating the machine *Environment* i. Adopt 3R concept. *Safety* i. Adhere to safe work area principles	25	Demonstration & Observation	iii. Test results are recorded and reported according to standard operating procedures
7. Carry out solar module washing process	i. Washing operation and its process. ii. Removal of solution. iii. Drying of module			10	Lecture & Group Discussion	i. Washing operation and its process described. ii. Purpose of

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	iv. Solar module labelling and tapping procedure					washing process explained iii. Solar module washing requirement prepared. iv. Solar module washed in as per job requirement v. Solar module dried in as per job requirement vi. Solar module labelled vii. Solar module cable taping of cable carried out as per job requirement
		i. Prepare solar module washing requirement as job requirement ii. Wash solar module iii. Dry solar module iv. Label solar module. v. Tape cable on solar module	*Attitude* i. Focus in operating the machine *Environment* i. Adopt 3R concept. *Safety* i. Adhere to safe work area principles	25	Demonstration & Observation	
8. Inspect Solar module quality	i. Common defects of solar module at performance testing. • Leakage current			10	Lecture & Group Discussion	i. Non-conformance or defects such as current leakage and

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	• Low voltage, efficiency drop ii. Rework procedure for non-conformance module					low voltage identified and segregated for rework or scraping ii. Test conformance solar module selected for packaging iii. Data sheet recording process carried out according to work instruction
		i. Segregate non-conformance or defects such as current leakage and low voltage for rework or scraping as per work instruction. ii. Select test conformance solar module for packaging iii. Carry out data sheet recording process according to work instruction	*Attitude* i. Focus in operating the machine *Environment* i. Adopt 3R concept. *Safety* i. Adhere to safe work area principles	25	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
9. Carry out housekeeping activities	i. Conformance an non-conformance solar module criteria ii. Non-conformance solar module disposal procedure iii. Waste designated area. • 5S Program iv. Disposal of scrap module			10	Lecture & Group Discussion	i. Conformance an non-conformance solar module criteria explained ii. Waste disposal of non conformance solar module procedure described iii. Non-conformance solar module for disposal or rework determine iv. Non-conformance solar module for rework sent to designated areas as per job requirement v. Non conformance solar module for scraping sent to designated areas for disposal according to
		i. Determine non-conformance solar module for disposal or rework. ii. Send non-conformance solar module for rework sent to designated areas iii. Send non-conformance solar module for scraping to designated areas iv. Restore work area as per job area requirement.		25	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Focus in operating the machine *Environment* i. Adopt 3R concept. *Safety* i. Adhere to safe work area principles			standard operation procedures vi. Work area restored according to standard operation procedures

Employability Skills

Core Abilities	Social Skills
01.01 Identify and gather information 02.01 Interpret and follow manuals, instructions and SOPs 02.03 Communicate clearly 02.04 Prepare brief reports and checklist using standard forms 03.03 Accept responsibility for own work and work area 06.03 Identify and highlights problems 01.04 Analyse information 02.08 Prepare pictorial and graphics information 04.01 Organize own work activities 02.10 Prepare reports and instructions 02.03 Convey information and ideas to people 03.11 Provide consultation and counselling 03.12 Provide coaching/on-the-job training	1. Communication skills 2. Conceptual skills 3. Interpersonal skills 4. Learning skills 5. Leadership skills 6. Multitasking and prioritising 7. Self-discipline 8. Teamwork

Tools, Equipment and Materials (TEM)

ITEMS	RATIO (TEM : Trainees)
1. Sample on Work Instruction on Solar Module Performance Testing	1:5
2. Sample on Solar Module Performance Test procedures	1:5
3. Sample on Guideline of Calibration of Simulator Test Machine	1:5
4. Simulation Test Machine	1:10
5. Leakage Test Tank and its peripheral	1:10
6. Special Test Hand Tools (Pliers, Screwdriver, tape, cutter, etc)	1: 5
7. Multimeter	1:5
8. Sample on Data sheet recording format	1:5
9. Personal Protective Equipment (PPE)	1:1

References

REFERENCES

1. Markvart, T, Castaner, L. (2004), Solar Cells: Materials, Manufacture and Operation Elsevier, 2004, 556 pages ISBN, 9780080541419
2. I.M. Dharmadasa (2013), Advances in Thin Film Solar Cells, Pan Stanford Publishing ISBN 9789814316071
3. Arvin Shah (2010), Thin Film Silicon Solar Cells, Taylor and Francis Group ISBN 9782940222360
4. Daniel Abou-Ras, Thomas Kirchartz, Uwe Rau (2009) Advanced Characterization Technique for Thin Film Solar Cells, Wiley-VCH Verlag GmbH & Co ISBN 9783527410033

CURRICULUM of COMPETENCY UNIT (CoCU)

Sub Sector	RENEWABLE ENERGY						
Job Area	SOLAR PANEL MANUFACTURING (THIN-FILM MODULE FABRICATION)						
Competency Unit Title	SOLAR MODULE PACKAGING OPERATION						
Learning Outcome	Solar module packaging operation is the process of packaging the solar module/panel produced using specified packaging material for shipment and export. The outcome of this competency is to ensure the packaging of solar module/panel produced meet the packaging standard according to the company requirement. The person who is competent in solar module packaging operation shall be able to:- • Identify solar module packaging operation requirement, • Inspect work area condition, • Prepare packaging materials • Carry out solar module packaging process, • Carry out housekeeping activities						
Competency Unit ID	*EE-212-3: 2013-C05*	**Level**	3	**Training Duration**	180	**Credit Hours**	18

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
1. Identify solar module packaging operation requirement	i. Importance of solar module packaging ii. Solar module packaging process. iii. Requirement for solar module packaging operation iv. Solar module packaging standard and specification. v. Critical activities in handling module packaging operation			5	Lecture & Group Discussion	i. Importance of solar module packaging explained ii. Solar module packaging process described iii. Solar module packaging operation requirement listed.

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	vi. Safety requirement for solar module packaging process					iv. Solar module packaging operation standards and specification listed v. Solar module packaging schedule obtained from the production supervisor. vi. Safety requirement for solar module packaging process listed
		i. Interpret accurately solar module packaging operation requirement ii. Identify solar module packaging operation standards and specification as per job requirement iii. Interpret solar module packaging schedule iv. Identify safety requirement for solar module packaging process	*Attitude* i. Thorough and precise in interpreting production requirements. *Environment* i. Adopt 3R concept	13	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
2. Inspect work area condition	i. Common work area hazard at production system and its risk. ii. Work place hazard signage iii. Conducive work environment. iv. Ergonomic procedure at work. v. Introduction to safety and health environment • Workplace safety signage • Workplace layout plan • PPE			5	Lecture & Group Discussion	i. Work area hazards and its risk described. ii. Work area hazards signage listed iii. Hazard at work area hazards listed. iv. Work condition such as lighting and ergonomic is checked. v. Climatic condition such as humidity and temperature confirmed as required vi. Work area ventilation system functionality confirmed to a specified level required. vii. Critical activities in handling module packaging
		i. Check and clear work area hazards. ii. Check lighting and ergonomic condition iii. Identify humidity and temperature condition iv. Confirm work area ventilation system		13	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		functionality v. Identify unsafe working conditions	*Attitude* i. Resourceful and meticulous in identifying hazardous objects ii. Adhere to safe work area principles. *Environment* i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety environment ii. Ensure workplace is safe			listed viii. Unsafe working conditions listed and reported to safety officer.
3. Prepare packaging materials	i. Type of solar module packaging materials ii. Technique of preparation solar module packaging box iii. Preparation of solar module			14	Lecture & Group Discussion	i. Type of solar module packaging materials listed. ii. Solar module packaging box prepared as per job requirement.

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	packaging separator paper iv. Preparation solar module packaging wrapper v. Preparation solar module packaging sticker labelling					iii. Solar module packaging separator paper prepared in as per the job requirement. iv. Solar module packaging wrapper prepared as per job requirement. v. Solar module packaging sticker labelling prepared as per job requirement
		i. Identify solar module packaging materials ii. Prepare solar module packaging box. iii. Prepare solar module packaging separator paper iv. Prepare Solar module packaging wrapper v. Prepare solar module packaging sticker labelling	*Attitude* i. Resourceful and meticulous in identifying hazardous objects ii. Adhere to safe work area principles.	32	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Environment i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety environment ii. Ensure workplace is safe			
4. Carry out solar module packaging process;	i. Fundamental of solar module packaging process ii. Solar module packaging procedure • Data sheet • Sticker label • Label position • Manual leg • Storage area iii. Solar module packaging defects. iv. Packaging data sheet procedures			16	Lecture & Group Discussion	i. Packaging process explained ii. Packaging procedures explained iii. Packaging box manually placed at robot dock iv. Solar module placed into boxes with respective wattages as per job requirement. v. Packaging box manually removed from robot dock
		i. Place packaging box at robot dock. ii. Place solar module into boxes with respective		38	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		wattages shown. iii. Remove packaging box from robot dock iv. Inspect solar module v. Label solar module packaging sticker. vi. Check solar module packaging quality vii. Segregate non conformance or defects for rework. viii. Record packaging data sheet recording. ix. Store solar module packaging before shipment	*Attitude* i. Precise and focus in setting up the machine. requirement ii. Handle machine with care iii. Adhere to safe work area principles. *Environment* i. Adhere to SOP on hazardous			vi. Solar module inspected based on the packaging datasheet vii. Solar module packaging sticker labelled as job requirement. viii. Solar module packaging quality visually checked against defects. ix. Non conformance or defects segregated for rework x. Packaging data sheet recording according to work instruction. xi. Solar module packaging stored before shipment

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			machineries and objects <u>*Safety*</u> i. Adhere to safety procedure. ii. Ensure workplace is safe			
5. Carry out housekeeping activities	i. Type of waste and unwanted materials from packaging activity ii. Areas designated for waste disposal iii. Work area reinstatement			3	Lecture & Group Discussion	i. Type of waste and unwanted materials from packaging activity listed. ii. Area designated for waste disposal identified iii. Unwanted material from packaging material disposed at designated areas iv. Work area condition restored in accordance with standard housekeeping practices.
		i. Segregate waste material for rework and disposal ii. Dispose unwanted materials at designated areas iii. Restore work area condition as work area requirement		6	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
			Attitude i. Resourceful and meticulous in identifying hazardous objects ii. Adhere to safe work area principles. *Environment* i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety environment ii. Ensure workplace is safe			

Employability Skills

Core Abilities	Social Skills
01.01 Identify and gather information 02.01 Interpret and follow manuals, instructions and SOPs 02.03 Communicate clearly 02.04 Prepare brief reports and checklist using standard forms 03.03 Accept responsibility for own work and work area 06.03 Identify and highlights problems 01.04 Analyse information 02.08 Prepare pictorial and graphics information 04.01 Organize own work activities 02.10 Prepare reports and instructions 02.03 Convey information and ideas to people 03.11 Provide consultation and counselling 03.12 Provide coaching/on-the-job training	1. Communication skills 2. Conceptual skills 3. Interpersonal skills 4. Learning skills 5. Leadership skills 6. Multitasking and prioritising 7. Self-discipline 8. Teamwork

Tools, Equipment and Materials (TEM)

ITEMS	RATIO (TEM : Trainees)
1. Sample of Working Instruction Packaging of Solar Module	1:5
2. Work area lay out plan (packaging of solar module)	1:5
3. Sample of hazard signage	1:5
4. Sample of solar module packaging standard and specification	1:5
5. Packaging box	1:5
6. Sample of label stickers	1:1
7. Sample of common solar module packaging defects.	1:5
8. Personal Protective Equipment (PPE)	1:1

References

REFERENCES

1. Markvart, T, Castaner, L. (2004), Solar Cells: Materials, Manufacture and Operation Elsevier, 2004, 556 pages ISBN, 9780080541419
2. I.M. Dharmadasa (2013), Advances in Thin Film Solar Cells, Pan Stanford Publishing ISBN 9789814316071
3. Arvin Shah (2010), Thin Film Silicon Solar Cells, Taylor and Francis Group ISBN 9782940222360
4. Daniel Abou-Ras, Thomas Kirchartz, Uwe Rau (2009) Advanced Characterization Technique for Thin Film Solar Cells, Wiley-VCH Verlag GmbH & Co ISBN 9783527410033

CURRICULUM of COMPETENCY UNIT (CoCU)

Sub Sector	RENEWABLE ENERGY						
Job Area	SOLAR PANEL MANUFACTURING (THIN-FILM MODULE FABRICATION)						
Competency Unit Title	SOLAR MODULE PRODUCTION WASTE HANDLING						
Learning Outcome	Solar module production waste handling is the process of segregating type of waste produced and disposing it according the legislative and company requirement. The outcome of this competency is to ensure the industrial wastes in solar module manufacturing are disposed according to the legislative and company requirement. The person who is competent in module/panel production waste handling shall be able to:- • Identify module production waste handling requirement, • Prepare personnel protective equipment (PPE) for handling waste • Prepare waste handling work area, • Handle solar module production waste • Carry out waste result analysis • Document waste result analysis						
Competency Unit ID	*EE-212-3: 2013-E01*	**Level**	3	**Training Duration**	120	**Credit Hours**	12

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
1. Identify module production waste handling requirement	i. Solar module production waste handling procedures ii. Solar module production waste handling standards • ISO 14001 • Department of Environmental Standard			8	Lecture & Group Discussion	i. Solar module production waste handling requirement listed ii. Solar module production waste handling standards explained to ensure

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	iii. Solar module production waste handling schedule iv. Type of hazardous materials waste produced in solar module production.					compliance with solar module job requirement. iii. Solar module production waste handling schedule described iv. Hazardous materials waste produced in solar module production listed.
		i. Interpret solar module production waste handling requirement ii. Identify solar module production waste handling standards iii. Interpret solar module production waste handling schedule iv. Identify hazardous materials waste produced in solar module production	*Attitude* i. Thorough and precise in interpreting production requirements. *Environment* i. Adopt 3R concept	19	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
2. Prepare Personnel Protective Equipment (PPE) for handling waste	i. Importance of PPE in handling solar module production waste ii. Types of PPE recommended in handling solar module production waste • Mask respirator • Face shield • Glove. • Safety boot			5	Lecture & Group Discussion	i. Solar module production waste handling PPE listed ii. Mask respirator prepared iii. Face shield prepared iv. Glove prepared. v. Safety boot prepared
		i. Identify solar module Production Waste Handling requirement ii. Prepare mask respirator iii. Prepare face shield iv. Prepare glove. v. Prepare safety boot	*Attitude* i. Thorough and precise in identify PPE *Environment* i. Adhere to safety rules requirement	13	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
3. Prepare waste handling work area	i. Importance of hazards free work area. ii. Hazards signage at work area iii. Hazards at waste handling area. iv. Waste handling area working condition such lighting and ergonomic v. Good climatic condition such as humidity and temperature vi. Work area ventilation system functionality vii. Unsafe working conditions reporting procedures			11	Lecture & Group Discussion	i. Importance of work area free from hazards listed. ii. Hazards signage's at work area identified iii. Hazards at waste handling area listed. iv. Work condition such as lighting and ergonomic described v. Climatic condition such as humidity and temperature explained vi. Work area ventilation system functionality explained vii. Unsafe working conditions listed and reported
		i. Check and clear work area hazards. ii. Check lighting and ergonomic condition iii. Identify humidity and temperature condition iv. Confirm work area ventilation system		25	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		functionality v. Identify unsafe working conditions	*Attitude* i. Resourceful and meticulous in identifying hazardous objects ii. Adhere to safe work area principles. *Environment* i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety environment ii. Ensure workplace is safe			
4. Handle solar module production waste	i. Importance of solar module solid waste segregation ii. Type of solar module • Solid waste scheduled • Non-schedule iii. Method of waste			14	Lecture & Group Discussion	i. Solar module solid waste segregated ii. Scheduled waste and non-schedule waste of solar module listed iii. Scheduled waste solar

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
	disposal • Scheduled waste solar module as per ISO14001 requirement • Unscheduled waste solar module sent to Waste Treatment Plant (WTP). iv. Importance of personal and respiratory protective equipment usage					module disposed as per ISO14000 requirement. iv. Unscheduled waste solar module sent to Waste Treatment Plant (WTP) v. Personal and respiratory protective equipment listed
		i. Identify scheduled waste and non-schedule waste ii. Segregate solar module solid waste iii. Dispose scheduled waste solar module as per ISO14000 requirement iv. Send unscheduled waste solar module sent to Waste Treatment Plant (WTP). v. Use personal and respiratory		32	Demonstration & Observation	

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		protective equipment.	*Attitude* i. Focus in carrying out production activities ii. Adhere to safe work principles. *Environment* i. Adopt 3R concept. ii. Adhere to SOP on hazardous machineries and objects *Safety* i. Adhere to safety environment ii. Ensure workplace is safe			
5. Carry out waste result analysis	i. Waste analysis results from laboratory from WTP, ii. DoE Standard and Regulation. iii. Report procedures on waste analysis			11	Lecture & Group Discussion	i. Content of laboratory waste analysis report explained ii. Content of DoE Standard and Regulation explained iii. Laboratory waste analysis results

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		i. Collect analysis results from laboratory. ii. Check waste analysis result from WTP, with DoE Standard and Regulation. iii. Report analysis result to the respective person for further action.	*Attitude* i. Meticulous in analysing data. *Environment* i. Adopt 3R concept. *Safety* i. Adhere to safety environment	25	Demonstration & Observation	analysed iv. Waste analysis result from WTP recorded, checked and compared with DoE Standard and Regulation. v. Result analysis informed to the respective person for further action.
6. Document waste result analysis	i. Submission of analysis result and documentation for management approval and consideration procedures. ii. Waste result analysis document filing system.			5	Lecture & Group Discussion	i. Result analysis and documentation for endorsement and approval by management submitted. ii. Waste result

Work Activities	Related Knowledge	Applied Skills	Attitude / Safety / Environmental	Training Hours	Delivery Mode	Assessment Criteria
		i. Endorse all result analysis and documentation by management for approval and consideration. ii. File waste result analysis document.	*Attitude* i. Meticulous in documenting information & data data. *Environment* i. Adopt 3R concept. *Safety* i. Adhere to safety environment	13	Demonstration & Observation	analysis document filed

Employability Skills

Core Abilities	Social Skills
01.01 Identify and gather information 02.01 Interpret and follow manuals, instructions and SOPs 02.03 Communicate clearly 02.04 Prepare brief reports and checklist using standard forms 03.03 Accept responsibility for own work and work area 06.03 Identify and highlights problems 01.04 Analyse information 02.08 Prepare pictorial and graphics information 04.01 Organize own work activities 02.10 Prepare reports and instructions 02.03 Convey information and ideas to people 03.11 Provide consultation and counselling 03.12 Provide coaching/on-the-job training	1. Communication skills 2. Conceptual skills 3. Interpersonal skills 4. Learning skills 5. Leadership skills 6. Multitasking and prioritising 7. Self-discipline 8. Teamwork

Tools, Equipment and Materials (TEM)

ITEMS	RATIO (TEM : Trainees)
1. Sample of Solar module waste handling instruction module	1:5
2. Work area plan	1:5
3. Mask respirator	1:1
4. Face shield	1:1
5. Hand Glove.	1:1
6. Safety boot	1:1
7. List of Scheduled waste (Solar module as per ISO14000 requirement)	1:5
8. List of Unscheduled waste(Solar module production waste)	1:5
9. Sample of Waste result analysis document	1:5
10. Sample of DoE Standard and Regulation	1:5
11. Submission of analysis result and documentation for management approval and consideration procedures.	1:5
12. Sample of Waste result analysis document filing system	1:5

References

REFERENCES

1. Markvart, T, Castaner, L. (2004), Solar Cells: Materials, Manufacture and Operation Elsevier, 2004, 556 pages ISBN, 9780080541419
2. I.M. Dharmadasa (2013), Advances in Thin Film Solar Cells, Pan Stanford Publishing ISBN 9789814316071
3. Arvin Shah (2010), Thin Film Silicon Solar Cells, Taylor and Francis Group ISBN 9782940222360
4. Daniel Abou-Ras, Thomas Kirchartz, Uwe Rau (2009) Advanced Characterization Technique for Thin Film Solar Cells, Wiley-VCH Verlag GmbH & Co ISBN 9783527410033

SUMMARY OF TRAINING DURATION FOR SOLAR PANEL MANUFACTURING OPERATION (Thin Film Module)
LEVEL 3

CU ID	COPETENCY UNIT TITLE	WORK ACTIVITIES	RELATED KNOWLEDGE	RELATED SKILLS	HOURS	TOTAL
			(A)	(B)	(A+B)	(HOURS)
01	SOLAR SUB-MODULE PRODUCTION	1. Identify solar sub-module production requirements.	8	27	35	564
		2. Inspect solar sub-module workplace condition	8	27	35	
		3. Prepare solar sub-module production materials	24	57	81	
		4. Prepare Coater Machine	16	38	54	
		5. Inspect glass surface condition	16	38	54	
		6. Carry out first coating process	32	76	108	
		7. Carry out solar sub-module second coating process	24	57	81	
		8. Inspect solar sub-module quality	16	38	54	
		9. Shut down coating machine	8	19	27	
		10. Carry out housekeeping activities.	8	27	35	
02	SOLAR MODULE LAY-UP AND SEALING PROCESS	1. Identify Solar Module Lay Up & Sealing process requirement	8	19	27	242
		2. Inspect workplace condition	4	9	13	
		3.Prepare lay-up and sealing solar sub-module materials	16	38	54	
		4. Prepare bussing machine.	16	38	54	
		5. Carry out solar module lay-up and sealing activity	7	20	27	
		6. Inspect solar module quality	12	28	40	
		7. Shut down Lay-up and Sealing machine.	5	9	14	
		8. Carry out housekeeping activities.	4	9	13	
03	SOLAR MODULE LAMINATION PROCESS	1. Identify solar module lamination process requirement	7	20	27	268
		2. Prepare laminator machine.	14	40	54	
		3. Carry out solar module lamination procedures.	38	70	108	
		4. Check product quality from any defects and	17	35	52	
		5. Shut down the lamination machine	7	20	27	

04	SOLAR MODULE PERFORMANCE TESTING	1. Identify solar module performance testing equirement.	10	25	35	315
		2. Inspect workplace condition.	10	25	35	
		3. Prepare material for performance testing.	10	25	35	
		4. Prepare solar module simulator test machine.	10	25	35	
		5. Carry out solar module simulator test	10	25	35	
		6. Carry out solar module leakage test.	10	25	35	
		7. Carry out solar module washing process.	10	25	35	
		8. Inspect solar module quality.	10	25	35	
		9. Carry out housekeeping activities	10	25	35	
05	SOLAR MODULE PACKAGING OPERATION	1. Identify solar module packaging operation requirement	5	13	18	145
		2. Inspect work area condition	5	13	18	
		3. Prepare packaging materials	14	32	46	
		4. Carry out solar module packaging process	16	38	54	
		5. Carry out housekeeping activities	3	6	9	
TOTAL HOURS (Core Competencies)			448	1086	1534	1534
E01	SOLAR MODULE PRODUCTION WASTE HANDLING	1. Identify module production waste handling requirement	8	19	27	181
		2. Prepare personnel protective equipment (PPE) for handling waste	5	13	18	
		3. Prepare waste handling work area	11	25	36	
		4. Handle solar module production waste	14	32	46	
		5. Carry out waste result analysis	11	25	36	
		6. Document waste result analysist	5	13	18	
TOTAL HOURS (Elective Competencies)			54	127	181	181
TOTAL HOURS			502	1213	1715	1715