Skill India
कौशल भारत - कुशल भारत

Directorate General of Training

सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
DIRECTORATE GENERAL OF TRAINING

COMPETENCY BASED CURRICULUM

CERTIFICATE COURSE ON

OPERATION AND MAINTENANCE OF PSA OXYGEN PLANT

NSQF LEVEL- 4

SECTOR : CAPITAL GOODS & MANUFACTURING

OPERATION AND MAINTENANCE OF PSA OXYGEN PLANT

Duration: 180 Hours

NSQF LEVEL - 4

(Version: 1.0)

Designed in 2021

Developed By

Ministry of Skill Development and Entrepreneurship
Directorate General of Training
Sectoral Trade Course Committee of Capital Goods & Manufacturing Sector
&
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1. COURSE INFORMATION

1.1 GENERAL

The Directorate General of Training (DGT) under Ministry of Skill Development & Entrepreneurship offers a range of vocational training courses catering to the need of different sectors of the economy/ labour market. The vocational training programs of short-term duration are intended for up skilling of NTC/ NAC pass out candidates. After passing out of the course, the trainee is awarded a competency-based certificate approved by DGT.

1.2 PROGRESSION PATHWAYS

- Can join industries as PSA Oxygen plant Operator and will be progress further as Senior Technician, Supervisor and can rise to the higher level.
- Can become Entrepreneur in the related field.

1.3 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements:-

S No.	Course Element	Notional Training Hours
1.	Professional Skill (Trade Practical)	48
2.	Professional Knowledge (Trade Theory)	32
3.	Onsite Training	100
	Total	**180**

1.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of course through formative assessment and at the end of the training programme through summative assessment as notified by the DGT from time to time.

a) The Continuous Assessment (Internal) during the period of training will be done by Formative Assessment Method by testing for assessment criteria listed against learning

outcomes. The training institute has to maintain an individual trainee portfolio as detailed in assessment guideline.

b) The pattern and marking structure is being notified by DGT from time to time. The learning outcome and assessment criteria will be the basis for setting question papers for final assessment.

c) Assessment will be evidence based comprising the following:

- Job carried out in labs/workshop
- Record book/ daily diary
- Answer sheet of assessment
- Viva-voce
- Progress chart
- Attendance
- Assignment
- Project work
- Participation and punctuality

Evidences of internal assessments are to be preserved until forthcoming examination for audit and verification by examining body.

d) The minimum pass percentage for skill test is 60%.

2. JOB ROLE

Brief description of Job roles:

Engineers and Related Technologists, other Architects; Engineers and Related Technologists, Other include all other engineers and technologists, such as those engaged in proper utilization of machine and manpower, safety devices and other industrial problems, research work in laboratories and application of results thereof to manufacture and solve practical problems, not elsewhere classified.

Operation and Maintenance of PSA Oxygen Plant:

- Proficiency to work as Plant operator of PSA Oxygen plant in the course of Plant and Personal Safety.
- Competent to do all the Maintenance aspects viz. preventive/ breakdown/ predictive/corrective/ effective maintenance of Compressor, Refrigerant air drier, filters and drains , bacteria filter ,silencers (Mufflers) , flow meter, different types of valves , pressure and temperature gauges, booster compressor, etc. the PSA Oxygen Plant and troubleshooting of PSA Oxygen Plant.
- Do the functional checks as when and where required viz. the concentration of Oxygen from Oxygen gas analyzer
- Start and Shut down of PSA Oxygen Plant by SOP/ instructional manuals.
- Refill medical grade Oxygen in cylinders from Manifold station.

Reference NCO-2015:

2149.0100: Engineers and Related Technologists, other Architects

3. GENERAL INFORMATION

Name of the Trade	**Operation and Maintenance of PSA Oxygen Plant**
Course Code	DGT/8017
Reference NCO - 2015	2149.0100
NSQF Level	Level – 4
Duration of Craftsmen Training	**180 Hours** (80 hrs of institutional + 100 hrs on site) **For ITI Pass outs with 2 months experience:** 80 Hrs. (Onsite training is exempted)
Entry Qualification	NTC (ITI)/ NAC Passed in Fitter/Welder/ MMTM/RAC / Electrician /Instrument Mechanic, AOCP/MMCP/ IMCP trade.
Eligibility for PwD	LD, LC, DW, AA, LV, DEAF, AUTISM, SLD
Unit Strength (No. of Student)	25
Space Norms	80 sq. m
Power Norms	5 KW
Instructors Qualification for:	
(i) Operation and maintenance of PSA Oxygen Plant	Degree in Mechanical / Production/ Electrical/ Instrumentation/ Chemical Engineering from AICTE recognized University with one year experience in relevant field. OR Diploma in Mechanical /Production/Electrical/ Instrumentation/ Chemical Engineering from AICTE recognized Board with two years' experience in relevant field. OR NTC (ITI)/ NAC Passed in Fitter/Welder/ MMTM/RAC/ Electrician /Instrument Mechanic, AOCP/MMCP/ IMCP trade with three years experience in the relevant field.
List of Tools and Equip.	As per Annexure – I

4. LEARNING OUTCOME

Learning outcomes are a reflection of total competencies of a trainee and assessment will be carried out as per the assessment criteria.

4.1 LEARNING OUTCOMES

1. Demonstrate the fundamentals of generating Oxygen gas from atmospheric air following all prescribed safety norms.

2. Identify different blocks/ components from the generic layout of the PSA Oxygen generation plant and demonstrate the working principle.

3. Identify, troubleshoot, replace and test the components of the PSA Oxygen generation plant.

4. Plan and execute routine maintenance, maintain the log book for the operation of the plant and record the operational / maintenance data.

5. TRADE SYLLABUS

SYLLABUS – Operation and maintenance of PSA (Pressure Swing Adsorption) Oxygen Plant			
Duration: 180 Hours			
Duration	**Reference Learning outcome**	**Professional Skills (Trade Practical)**	**Professional Knowledge (Trade Theory)**
Professional Skill-9 Professional Knowledge-6	Demonstrate the fundamentals of generating Oxygen gas from atmospheric air following all prescribed safety norms.	• Orientation training: Lab Visit. • Demonstration and practice on cryogenic safety guidelines by OSHA. • Demonstration of Fire safety in oxygen enriched atmosphere. • PPE and safety equipment used in oxygen plants. • Follow the hygiene practices as per the standards applicable for oxygen plants. • Welding section visit. • Hands on practice on oxygen cylinder, identification with color code, cracking of cylinder, fixing the regulators and flow meters, checking and recording the cylinder pressure in Kg/cm^2 and in PSI. • Performing cylinder leak proof test. • Maintenance section visit. • Hands on practice on reading the pressure gauge. • Operating the valves, draining out the water, filter cleaning etc. • Audio and Video presentation show on oxygen plants and types of plants.	• Importance of the course in the context of Covid-19 pandemic. • Need of oxygen gas for the society, Healthcare, available sources, and separation methods. • Plant safety and personnel safety and hygiene. Law and regulations of OSHA. Cryogenic safety hazards. Use of Protective clothing. • Explain terms such as hazard, risk, lower explosive limit, permissible explosive limit, time weighted average, short term explosive limit, etc. • Types of fires, prevention and control methods, fire triangle, fire safety in Oxygen enriched atmosphere. • Units (SI & English) and measurements. • Pressure, Temperature, Volume, Density, Energy and Power: Definitions and measurement techniques, Instrumentation. • Pressure- Volume (PV) Diagram. Pressure-temperature Diagram. • Material Safety Data Sheet (MSDS) of Oxygen. • Properties of air, water and oxygen. Volumetric composition

			of air. Humidity • Atoms, molecules and adsorption, desorption. Difference between adsorption and absorption. • Oxygen and its properties. Uses of oxygen. • Transportation methods of different type of oxygen cylinders/ containers. • Industrial oxygen and medical Oxygen differences. • Air separation methods: cryogenic and non-cryogen, adsorption methods advantages and disadvantages. • Introduction to oxygen generating plants and its application. • Types of oxygen generation plants.
Professional Skill-15 Professional Knowledge-10	Identify different blocks/ components from the generic layout of the PSA Oxygen generation plant and demonstrate the working principle.	• Audio and Video presentation show on oxygen plants layout and components. • Demonstration of PSA plant working principle. • Demonstration of Monitoring systems that can detect the onset of dangerous operating conditions and take appropriate actions to mitigate their consequences.	• PSA Plant layout & construction features. • Components of PSA plant : compressors, drier, filters, oxygen generators adsorption material, booster compressor, oxygen analyser, safety valves and PLC systems etc, • Working principle of PSA plant. • Monitoring systems for detection of fault and safety measures of PSA oxygen plant
Professional Skill-9 Professional Knowledge-6	Identify, troubleshoot, replace and test the components of the PSA Oxygen generation plant.	• Visit to Pneumatic section • Identification of type of compressor Installed, directional control, pressure control and flow control valves. • Hand on practice on working of compressor i.e. compressor switching ON & OFF, general maintenance of compressor,	• Compressors: types, advantages & disadvantages, construction and working principles of screw compressors used in PSA system. Maintenance features and trouble shooting. • Filters: types and features used in PSA systems, maintenance

		filters & types refrigeration and related equipment and different types of pipe fitting joints. • Hand on practice on control valve, solenoid valves, rotameter, pressure and temperature sensors /transmitters and gauges. • Visit to Electrical section: • Demonstration on switches, starters, and motors. • Cleaning of the PSA plant considering the electrical safety precautions. • Hands on - cleaning of different types of filter which are used in PSA oxygen plant.	features and troubleshooting. • Refrigeration, dehumidifiers: construction features and maintenance. • Control Valves: construction and operating principles of directional control, pressure control and flow control valves: • Solenoid valves: construction and operation. • Rotameter: working principle and ooperation. • Gauges, Sensors and Reading of control panel. • PSA plant operating process. • Regenerative principles. • Functions of molecular sieves. • Zeolite types and filtering process. • Principles of vacuum pressure swing adsorption system. • Maintenance features of components.
Professional Skill-15 Professional Knowledge-10	Plan and execute routine maintenance, maintain the log book for the operation of the plant and record the operational / maintenance data.	• Preparation of maintenance strategy plan followed in PSA oxygen plant. • Demonstration of safety involved in storage of cryogenic liquid and high pressure gas storage. • Hand on experience on Refill of medical grade Oxygen in various types of cylinders along with proper hose and adapters from Manifold station. • Creating and implementation of log book and maintenance with safety features. • Demonstration on working of smoke detectors & fire alarms used in the oxygen plant. • Testing of alarms for leakage, over/ under pressure and	• Maintenance - PSA oxygen plants and its components. • Log Books maintenance and its importance. • Safety precautions before and after operating the plant and its necessities. • Awareness of Do's and Don'ts. • Safety precautions on management of oxygen. • Need and procedure of NABL/ NABH Calibration gauges, valves etc. • Safety measures for storage of cryogenic liquid and high pressure gas storage.

		operational, other malfunction & faults. • Monitor, control and Test operating pressures. • Testing of oxygen concentration.	

Onsite Training Activities (100 Hrs):

1. Recognize & comply safe working practices to be followed in Oxygen processing plants, environment regulation, personal hygiene and housekeeping.
2. Observing the Fire safety norms in oxygen enriched atmosphere and use of protective clothing.
3. Identify the Components of PSA Oxygen plant, understand flow chart of plant and line tracing, familiarize individual functions and overall functions.
4. Awareness of the Do's and Don'ts before start of the plant.
5. Visit the panel boards, alarming systems and witness the operation of different switches.
6. Identify the compressor air flow system and filter assembly.
7. Participate in dismantling, assembly and cleaning of air filter used in various stages by removing condensates like water, oil, dirt, scale etc.
8. Identify and understand the operating procedure of various pressure relief and flow control valves used in the plant.
9. Identify various pressure gauges and sensors used in the plant and note the reading.
10. Open the drainage plugs for removal of condensates and ensuring the proper disposal of the same.
11. Check the purity of oxygen at the output side.
12. Observation of HMI control panel for alarms.
13. Perform testing of alarms for leakage, over/ under pressure and operational malfunction / faults.
14. Refer the maintenance log book and records for the required data of the system at the stipulate intervals as per SOP.
15. Participate in the basic regular and preventive maintenance of the plant by following the procedure described in the plant operating manual and as per OEM.
16. Perform the basic troubleshooting work in the eventuality of abnormal functions of the system components and entire plant.
17. Perform Refilling of medical grade Oxygen in various types of cylinders along with proper hose and adapters from Manifold station.

Examination

6. ASSESSMENT CRITERIA

LEARNING OUTCOMES	ASSESSMENT CRITERIA
1. Demonstrate the fundamentals of generating Oxygen gas from atmospheric air following all prescribed safety norms.	Prepare graphic representation for the process of oxygen generation.
	Maintain of all safety measures in cryogenic and high pressure working place.
	Use of protective clothing in handling cryogenic liquid.
	Identify the alarm systems and use of firefighting devices.
2. Identify different blocks/ components from the generic layout of the PSA Oxygen generation plant and demonstrate the working principle.	Prepare general layout design of PSA oxygen plant.
	Identify the mechanical and electrical components of the plant.
	Identify the sensors and its working principle used in PSA oxygen plant.
3. Identify, troubleshoot, replace and test the components of the PSA Oxygen generation plant.	List and do the functional checks of the plant before starting.
	Switch ON and OFF the plant and monitor the process of generation of oxygen.
	Identify any pipe leakages and do the pipe fitting.
	Identify the faulty components and troubleshooting and replace it as per Original Equipment Manufacturer (OEM) manuals/Instructions.
4. Plan and execute routine maintenance, maintain the log book for the operation of the plant and record the operational / maintenance data.	Record the daily routine functional checks before the start of the plant.
	Record the purity of oxygen generated using oxygen analyzer as per OEM Standards/Safe Operation Procedure(SOP)Manual.
	Maintain the safe storage procedure of cryogenic liquid and high pressure gas.

7. ANNEXURE-I

LIST OF TOOLS AND EQUIPMENT			
OPERATION AND MAINTENANCE OF PSA OXYGEN PLANT			
S No.	**Name of the Tools & Equipment**	**Specification**	**Quantity**
A: TRAINEES TOOL KIT (For batch of 25 Nos.)			
1.	Safety shoes	Regular size	25 Nos.
2.	Safety hand gloves Rubber	Regular size	25 Nos.
3.	Safety hand gloves PVC	Regular size	25 Nos.
4.	Ear plug	Good quality	25 Nos.
5.	Helmet	ISI Mark	25 Nos.
6.	Trainee tool Box	i) Double ended Open spanners set ii) Double ended Ring spanners set iii) Spanner – Adjustable set iv) Screw driver set v) Combination Pliers set vi) Allen Key Set vii) Socket Spanner with Ratchet Handle viii) Pipe Wrench set of 3 ix) Oil Can x) Torque Wrench set	25 Nos.
7.	Dust mask/Nose mask		25 Nos.
8.	Safety Goggles		25 Nos
B. GENERAL SHOP OUTFIT			
9.	First Aid Box		1 No.
10.	Filled Oxygen gas Cylinder		1 No.
11.	Oxygen Gas Pressure Regulator Double Stage		1 No.
12.	Bourdon tube Pressure Gauges	6 inch dial, 0-150 PSI 0- 10.2 kg/cm^2	1 No.

	(C type) with		
13.	Air Compressor	Reciprocating type /helical screw type/ centrifugal type with pressure switch (any one) Working pressure 150psig, hydraulic testing pressure 225 psig, 100 liters tank capacity or above, with pressure switch, pressure gauge, Safety valve	1 No.
14.	Gate Valve	50 mm diameter, non-rising steam type (Flanged / Thread End)	1 No.
15.	Globe Valve	50 mm diameter (Flanged / Thread End)	1 No.
16.	Ball Valve	50 mm diameter (Flanged / Thread End)	1 No.
17.	Needle Valve	15 mm diameter (Thread End)	1 No.
18.	Manually Pressure control valve	15 mm diameter (Thread End)	1 No.
19.	Pressure Regulator	With Moisture trap and Pressure gauge (0-30 PSI) (Thread End)	1 No.
20.	Safety Valve (Spring Type)	15 mm diameter (Thread End)	1 No.
21.	Check valve (NRV) check	50 mm diameter Lift check valve (Thread End)	1 No.
22.	Solenoid Valve (N/C Type)	15 mm diameter (Thread End) 230 V, Pressure 0- 5 kg/cm^2	1 No.
23.	Control Valve (Pneumatically Operated)	15 mm diameter – Globe type (Thread End) Normally Closed and Air to Open type	1 No.
24.	Pressure tranducer or Pressure sensor with transmitter and display unit		1 No.
25.	Temperature sensor with transmitter and display unit		1 No.
26.	Rotameter (flow meter) for Oxygen Gas	10 m^3/hr or 0-35 LPM (15 mm, Flanged / Thread End)	1 No.
27	PSA Oxygen Simulator with softwares		1 No.
28.	Vapour compression Refrigeration unit	Humidification and dehumidification	1 No.
29.	Carbon Filter with pressure Gauge	25 mm (Thread End)	1 No.

30.	Filter with pressure Gauge	25mm (Thread End), 10 Micron	1 No.
31.	Filter with pressure Gauge	25mm (Thread End) 5 Micron	1 No.
32.	Filter with pressure Gauge	25mm (Thread End) 0.1 Micron	1 No.
33.	Bacteria Filter/Hepa filter	25mm (Thread End)	1 No.
34.	Oxygen Analyser		1 No.
35.	Computer (PC) with latest configurations and Internet connection	CPU: 32/64 Bit, i7 or latest processor	2 Nos.
36.	Different types of pipe fittings and joints	Coupling, Union, Elbow, bend, Reducer(50x25), Expander (25x50) Tee Joint Cross Joint, Plug, Cap Flange, Nipple: 6"and 12" long, (Thread End- all 25mm diameter) clamp (clip, ladder, pinch)	1 Set
37.	PSA Oxygen generating plant	MoU with the industry	
38.	Double desk	class room furniture	15 Nos.
39.	Instructors chair		1 No.
40.	Instructors table		1 No.

8. ANNEXURE-II

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts and all others who contributed in designing/ revising the curriculum. Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

List of Expert Members contributed/ participated for finalizing the course curriculum of "OPERATION AND MAINTENANCE OF PSA OXYGEN PLANT"			
S No.	**Name & Designation (Mr./Ms.)**	**Organization**	**Remarks**
1.	Sandhya Salwan, Deputy Director General	DGT, New Delhi	Convener
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3.	Ravi Chilukoti, Joint Director	DGT, New Delhi	Coordinator
4.	L K. Mukherjee, Joint Director	RDSDE Utter Pradesh, Kanpur	Coordinator
5.	Prof Sameer Khandekar,	IIT kanpur	Expert
6.	Prof Malay,	IIT Kanpur	Expert
7.	Dr. Chandra Shekhar Goswami, Senior Technical Superintendent	IIT Kanpur	Expert
8.	Cap Kiran G	Naval Dockyard Vishakhapatnam	Expert
9.	G.N. Eswarappa, Joint Director	CSTARI,Kolkata	Member
10.	M. Kumaravel, Deputy Director	NSTI, Bengaluru	Expert
11.	M. Rajeswari, Deputy Director	NSTI, Bengaluru	Expert
12.	GC Saha, Deputy Director	NSTI, Kanpur	Expert
13.	Sunil Wakde , Assistant Director	RDSDE Gujarat, Gandhinagar	Expert
14.	Snehasish Bandyopadhyay, Assistant Director	CSTARI, Kolkata	Expert
15.	Bharat K Nigam, Training Officer	CSTARI, Kolkata	Expert