Benazir Bhutto Shaheed
Youth Development Program

Occupational Skill Standards

REFRIGERATION AND AIR CONDITIONING

PROJECT MANAGEMENT UNIT
Directorate of Manpower & Training
Labour department, Government of Sindh

FOREWORD

The people government recognizing the plight of jobless, semi-literate, and educated youth of Pakistan has decided to launch a program to employ 5 lakh youth (age 18-35 years) throughout the country, province wise and impart them employable skills through short and medium term (6 to 12 months courses) under Benazir Bhutto Shaheed Youth Development Program (BBSYDP).

The task before SINDH Government is to impart the training to one lakh youth in the province using its existing Technical Training Centres / Departments and where inevitable to outsource the courses.

Keeping these objectives in view, Sindh Government has opened the venues for such opportunities for youth to be trained in the employable skills under this project with following objectives.

- Enhance employability of un-employed youth belonging to lower income group providing training in employable skills.
- Relevant skills for industrial and Economic Development.
- Improving Access, Equity and Employability.
- Assuring quality for Skill Development.
- Meet the emerging demand of growing industries and Development projects.
- Development of employable skilled workers primarily for wage employment in industries.
- Provision of basic skills for the rural poor primarily for self-employment.

The project has very clearly defined objectives which shall address the unemployment menace in the province. It envisages that no additional workshop, labs, and classroom shall be constructed for training of the youth, where as the existing 34 Training Centres of the Directorate of Manpower & Training mandated / established for skill development shall impart employable skill training to youth targeted in this project.

The occupations / trades are selected in sectors where employment is available. In this regard the Employers Federation / Associations and group of industries have been consulted.

The curriculum consisting of skills and operations for imparting the training for 06–12 months courses are available based on 80% practical and 20% theoretical knowledge. The training methodology and activities are predefined in the respective curriculum. Periodical progress of the trainees is made compulsory.

It has been a team effort of the Training Management Board and Trade Testing Board who have supervised the trade specialists in the development of the Curriculum according to the needs of the job market.

KARIM BAKHSH H. SIDDIQUI
Director,
Manpower & Training Sindh, Karachi

REFRIGERATION AND AIR CONDITIONING
(12 MONTHS COURSE)

OVERALL OBJECTIVE

After completion of the course, trainees should be able to find suitable employment to do basic level service and repair domestic refrigeration and air conditioning units under the supervision of skilled A.C mechanic.

SPECIFIC OBJECTIVES:

After completion of the course, trainees should be able to:

- Observe safety precautions, both personal and when using equipment & tools as well as when handling Freon refrigerant.
- Identify and competently use the hand tools and equipment.
- Understand the measuring and making of different dimensions, metric/English system.
- Diagnose and repair faults in the electric circuits.
- Carry out charging for refrigeration in refrigerators.
- Diagnose & repair faults in domestic refrigeration & air conditioning units.
- Serve and repair the domestic refrigerators, water coolers, deep freezers & Air conditioners.

TRAINING PARAMETERS

Course Code	B-01
Entry level	Matriculation
Age group	20 – 38 years
Medium of Instructions	English / *Urdu / Sindhi*
Duration of the course	12 Months
Contact Hours	1201
Daily Contact Hours	Four Hours per day
Per Class Trainees	Maximum 25
Timing of Training	Morning Shift (09:00 A.M. to 01:00 P.M.) Evening Shift (02:00 P.M. to 06:00 P.M.)

KNOWLEDGE REQUIREMENT:

After completion of the course, the trainee should be able to:

- Observe safety precautions, both personal and when using equipment and tools.
- Demonstrate the use of different types of tools and equipment used in the R.A.C workshop.
- Convert different metric/English system for measurements.
- Explain the various electrical components, their location, operation, and function.
- Explain the purpose of refrigeration and air conditioning.
- Explain the principle of the refrigeration cycle.
- Diagnose and repair faults in domestic refrigeration and air conditioning units.
- Install and service the refrigerator, water cooler, deep freezer, window air conditioner, and split air conditioners.

SKILL REQUIREMENT:

After completion of the course, the trainee should be able to:

- Observe safety precautions, achieve accident prevention and environmental protection.
- Use different types of tools and equipment used in R.A.C workshop.
- Read and understand electrical drawings.
- Make different joints of cable wires.
- Demonstrate the use of a multimeter, voltmeter, and clamp-on ammeter.
- Make the electrical connections of single-phase induction motors.
- Install components, switches, fuses, and relays, and wire up the electric circuits.
- Solder, braze, and bend copper tubing.

SCHEME OF STUDIES:

S. No.	Topic	Time (Hours)		
		Theory	Practical	Total
1	Safety precautions	04	12	16
2	Electricity	28	100	128

S. No.	Topic	Time (Hours)		
		Theory	Practical	Total
3	Refrigeration and air conditioning	28	82	110
4	Electrical components and controls	36	98	134
5	Installation, servicing & maintenance	38	138	176
6	Basic refrigeration system	30	112	142
7	Condensers	30	112	142
8	Motor Compressors	25	80	105
9	Trouble shooting	20	208	228
10	Basic *Arabic* Communication	20	--	20
	Total	259	942	**1201**

DETAIL OF TOPICS:

S. No.	Topic	Time (Hours)		
		Theory	Practical	Total
1	**SAFETY PRECAUTIONS** • Safety precautions, personal & equipment. • Use, care & maintenance of tools and equipment. • Safety precautions and first aid treatment of electric shock.	04	12	16
2	**ELECTRICITY** • What is electricity? • Conductors and insulators. • Wire and cables. • Wire joints. • Ohm's law. • Magnetic field. • A.C and D.C motors.	28	100	128

S. No.	Topic	Time (Hours)		
		Theory	Practical	Total
3	**REFRIGERATION AND AIR CONDITIONING** • Types and functions of hand air pumps, air compressors, Pedestal air pumps, try square and spirit levels. • Types, properties, and purposes of installation materials. • Types, properties, and purposes of general materials. • Refrigerants and refrigeration cycle.	28	82	110
4	**ELECTRICAL COMPONENTS AND CONTROLS** • The system of measurement, English & matric conversion. • Types and function of measurement tools. • Types, construction, and function of temperature measuring instruments. • Metric & English conversion of Temperature. • Type, construction and function of pressure gauges. • Type, construction and function of vacuum gauges. • Type, construction, function & operation of electric measuring tools & equipment.	36	98	134
5	**INSTALLATION, SERVICING & MAINTENANCE** • Types, construction, functions of swaging, flaring, bending, reaming, and pinch-off tools.	38	138	176

S. No.	Topic	Time (Hours)		
		Theory	Practical	Total
	• Types of spanners/wrenches and function of hand tools, • Types and functions of hammers, pliers, screw drivers, and vices. • Types and functions of drilling machines & bits, grinders and grinding wheels. • Types and functions of cent Punches, scribers, drivers, files, oil cans & grease guns.			
6	**BASIC REFRIGERATION SYSTEM** • Types, construction, functions and applications of: ✓ Basic refrigeration cycle ✓ Ice & evaporative refrigeration ✓ Fahrenheit and centigrade scales ✓ BTU, specific, sensible and latent heat ✓ Compression and defrost system ✓ Pressure measurement system ✓ Behavior of bases and fluids ✓ Refrigeration types, requirements, characteristic and colour codes ✓ Refrigerant handling and transfer procedure, safety requirements, distilling system and procedure ✓ Types, purpose and operation of gauge manifold valves and service valves ✓ Types and purpose of refrigeration compressors, refrigerant flow controls, and motor controls (thermostats)	30	112	142

S. No.	Topic	Time (Hours)		
		Theory	Practical	Total
	✓ Fundamental refrigeration compression cycle ✓ Basic refrigeration vapour compression system and components analysis ✓ Basic refrigeration systems, malfunction analysis, troubleshooting procedures and isolation. ✓ Types, construction & function of evaporators. ✓ Troubleshooting procedure for all types of evaporators.			
7	**CONDENSERS** • Types, construction, functions of condensers. • Troubleshooting procedure for all types of condensers. • Repairing techniques and procedures for all types of condensers. • Cleaning and servicing methods and procedures of condensers.	30	112	142
8	**MOTOR COMPRESSOR** • Types, construction, functions of compressors. • Procedure and methods of testing. • Installing and troubleshooting procedure. • Repairing techniques. • Purpose & function of compressor oil used in compressors, charging procedure of oil in compressors.	25	80	105

S. No.	Topic	Time (Hours)		
		Theory	Practical	Total
9	**TROUBLESHOOTING** • Refrigerant and gas charging. • Repairing techniques and procedures for all types of evaporators. • Cleaning and servicing methods and procedures of evaporators. • Servicing of window air conditioners and split units. • Servicing of all types of refrigerators and chillers.	20	208	228
10	**Basic Arabic communication** • Introduction of Arabic language • Basic Arabic grammar • Formation of sentences • Speech practice	20	--	20
	Total	**295**	**942**	**1201**

TOOLS AND EQUIPMENT:

Following tools and equipment are prescribed for 20 trainees.

S. No.	Tool / Equipment	Quantity
1	Flat baster file	22
2	Flat smooth file 10"	22
3	Round file 10"	22
4	Half round file 10"	22
5	Triangular file 10"	22
6	Square file 10"	12
7	Tube cutter with reamer	12

S. No.	Tool / Equipment	Quantity
8	Flaring tools set	05
9	Swaging tool set	05
10	Spring bender set	05
11	Pully bender set	04
12	Portable electric blower	03
13	Pinch off tool	12
14	Gauge manifold	04
15	Low-pressure gauge	04
16	Vacuum Pump, rotary type	02
17	Oxygen acetylene gas welding set	02
18	Multimeter	12
19	Clamp on ammeter	12
20	Feeler gauge	12
21	Socket spanner set	12
22	Ring spanner set	12
23	Open-ended spanner set	12
24	Screw wrench 8”	12
25	Screw wrench 10”	12
26	Screw wrench 12”	12
27	Flat screw driver 4”	12
28	Flat screw driver 6”	12
29	Flat screw driver 8”	12
30	Flat screw driver 810’	12
31	Phillip’s type screwdriver 4”	12
32	Phillip’s type screwdriver 6”	12
33	Phillip’s type screwdriver 8”	12

S. No.	Tool / Equipment	Quantity
34	Interchangeable screwdriver set	12
35	Thermometer, C^0 & F^0	12
36	Dial-type Thermometer	12
37	Capacitor tester	02
38	Allen key set	12
39	Pipe wrench 12”	06
40	Pipe wrench 18”	06
41	Combination pliers 8”	22
42	Side cutter 6”	22
43	Long Nose pliers 6”	22
44	Phase tester	22
45	Heat gun	12
46	Thimble punch pliers	12
47	Hollow punch set	06
48	Pulley puller	06
49	Mallet (Plastic)	06
50	Vernier caliper 100mm	12
51	Measuring tape 5 meter	22
52	Portable hand drill machine	12
53	Needle file set	12
54	Steel foot ruler	22
55	Cross peen hammers	12
56	Ball pen hammer	12
57	Straight peen hammer	12
58	Electronics leak detector	06
59	Halide torch leak detector	06

S. No.	Tool / Equipment	Quantity
60	Soldering iron	12
61	Bench vice	12
62	Pipe vice	12
63	Threading die up to 1" size	12
64	Hacksaw	22
65	Fins straightening comb	22
66	Sprit level	22
67	Diamond drill 5/8"–3/16"	12
68	Oil Cain	06
69	Tin cutter	08
70	Scriber	12
71	Steel wire brush	22
72	Oil charging pump	02
73	Riveting plier2	06
74	Drill 1/8", 3/16", 3/8", 5/8" steel	12
75	Drill	08
76	Worktable	08
77	Wooden stool	22
78	Office table	02
79	Office chair	04
80	Refrigerator (direct cool)	03
81	Refrigerator (non-frost)	03
82	Water cooler (electric)	03
83	Deep freezer	02
84	Window air conditioner (1.5 tons)	01
85	Split air conditioner (1.5 tons)	03

S. No.	Tool / Equipment	Quantity
86	Sealed compressor (1.5 HP)	02
87	Sealed compressor (2 HP)	02
88	Semi-sealed compressor (1 HP)	03
89	Open type compressor (1 HP)	04
90	Rotary type compressor (1 HP)	04
91	2-speed fan motor (window air conditioner)	03
92	3-speed fan motor (window air conditioner)	03
93	Insulation remover for PVC cable	12

TRAINING MATERIAL:

S. No.	Item	Specification	Quantity
1	Soft copper tube	Ø 1/5"	100 feet
2	Soft copper tube	Ø 1/16"	100 feet
3	Soft copper tube	Ø 3/8"	120 feet
4	Soft copper tube	Ø 1/2"	120 feet
5	Silver soldering rod	18”	80 Nos.
6	Brazing rod		80 Nos.
7	Oxygen	standard cylinders	02
8	Acetylene gas	standard cylinders	02
9	Nitrogen gas	standard cylinders	02
10	Emery paper	No.01 sheet	40 Nos.
11	Soldering flax	200g jar	05 Nos.
12	PVC wire	3/029, 90-meter coil	02 Nos.
13	PVC wire	7/029	10
14	PVC tape	¾ "	10

S. No.	Item	Specification	Quantity
15	Flexible cable	01 core 23/76	10
16	Single pole switch	5-A	20 each
17	Two pin socket	5-A	24
18	Power plug	15 amps.	20 each
19	Wooden screw	½"	01
20	Wooden screw	¼"	10 each
21	Wooden screw	1"	05 each
22	Wooden screw	1- ¼ ”	20
23	Flare nut brass	¼"	10
24	Flare union	¼ "	10
25	Dead nut	¼ "	30
26	Dead plug	¼"	30
27	Flare nut	3/8"	80
28	Flare union	3/8"	50
29	Flare union	"T" 1/4"	20
30	Wooden board	8" x 10"	12
31	Starting capacitor	80–110 uf	10
32	Running capacitor	40–45 uf	10
33	Fan capacitor	5 uf	10
34	Current relay	1/4 hp	06
35	Current relay	1/5 hp	05
36	Current relay	1/6 hp	05
37	Current relay	1/8 hp	06
38	P.T.C. relay	1/4 hp	06
39	Potential relay	1/4 hp	06
40	Overload protector	1/4, 1/5, 1/6, 1/8 hp	10 each

S. No.	Item	Specification	Quantity
41	Compressor oil	POE	03 litter
42	Refrigerant cylinder	R-12	02 Nos.
43	Refrigerant cylinder	R-22	02 Nos.
44	Refrigerant cylinder	R-134a	02 Nos.
45	Refrigerant cylinder	R-11	01 No.
46	Thermal fuse		12 Nos.
47	Thermal disk		12 Nos.
48	Defrost timer		06 Nos.
49	Gasket (paper composition)	1/64" thick Sheet	24 Nos.
50	Polyurethane solution	(black and white)	01 kg each
51	Depoxy	100 g tube	12 Nos.
52	Epoxy	100 g tube	12 Nos.
53	Elfie	50 g tube	06 Nos.
54	Smad bod tube	100 g	10 Nos.
55	Capillary tube	0.031", 0.036"	80 feet each
56	Valve grinding paste	400 g jar	02 Nos.
57	Hank saw blade	12”	48 No.
58	Soap	Good quality bar	12 Nos.
59	Washing powder		04 kg
60	Duster cloth		48 Nos.
61	Cotton		02 kg
62	Grease		02 kg

QUALIFICATION OF INSTRUCTOR:

- BSc. Engineering in Air Conditioning and Refrigeration with two years of experience.
- Three years of Diploma of Associate Engineer in Refrigeration and air-conditioning technology with five years of working experience.

REFERENCE BOOKS:

- *Jaded* Electric wiring by Muhammad Ayub, Alfalah Book Center, Lahore;
- Refrigeration and air-conditioning by Billy C. Lengly, USA;
- Modern Refrigeration and Air Conditioning by Al Thous & Turn Quist, USA;
- RAC Mathematics by Muhammad Ayub.

Employability of graduate Trainees:

The graduate trainees of the course can be employed in the following sectors under the supervision of experienced A.C mechanics:

1. Hotels, Offices, Factories, Hospitals, Plazas.
2. Air Conditioning contractors/suppliers/service agents.
3. Self-employed

Examination and certification:

The testing and certification shall be carried out by the Trade Testing Board, Government of Sindh.