SYLLABUS FOR

MECHANIC REFRIGERATION AND AIR-CONDITIONING

UNDER

CRAFTSMEN TRAINING SCHEME

As approved by
GOVERNMENT OF INDIA

In consultation with
THE NATIONAL COUNCIL FOR
VOCATIONAL TRAINING

Issued by
GOVERNMENT OF INDIA
MINISTRY OF LABOUR
DIRECTORATE GENERAL OF
EMPLOYMENT & TRAINING
NEW DELHI

2007

GENERAL INFORMATION

1. Name of the Trade : REFRIGERATION AND AIR-CONDITIONING MECHANIC
2. N.C.O. Code No. : 845.70
3. Entry Qualification : Passed in 10th. Class Examination under 10 +2 system with Science and Maths or its equivalent
4. Duration of Craftsman Training : Two Years

UNIT WISE DISTRIBUTION OF PRACTICAL SKILLS

General Engineering Training	Unit A
Refrigeration services basics and components of various refrigeration systems	Unit B
Refrigerants used in Appliances & RAC equipment	Unit C
Servicing of Domestic & Commercial Appliances	Unit D
Servicing Cold Storages and Commercial Refrigeration Plants	Unit E
Servicing Small Air-conditioning Plants	Unit F

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LIST OF PERSONS PARTICIPATING IN HIDECOR EXPERT GROUP MEETING TO REVIEW THE SYLLABUS

(In alphabetical order)

	Organisation	Remarks
S. Agarwal	Dy. Director Faculty, IIT Delhi	
nder Batra	Principal Consultant, Centre for Interactive Management India, New Delhi	Resoponsible for Overall coordination of the task
mar Devotta	Head, Process Engineering, NCL Pune	
fred Egger	Head, PFU HIDECOR Project	Overall incharge of HIDECOR Project
yer	Ex-GM (R & D), Voltas Ltd	Prepared the draft syllabus and incorporated the review comments
uvekar	Dy. G.M. Godrej Appliances Ltd.	Also a member of the earlier Trade Committee
y Kant	Dy. Director, CSTARI, Kolkata	Representative of CSTARI

Marston	Training Manager, IT Power India, Ponmdicherry	
nade	Director, IT Power India, Pune	
havan	Manager, Advanced Technology Support, Kirloskar Copeland Ltd., Pune	
ardesai	Sr. Executive, Advanced Technology Support, Kirloskar Copeland Ltd., Pune	
Vichare	IT Power India, Pondicherry	

Weekwise distribution of Practical Skills

Training Skill Area	No. of Week	Week No.	
		From	To
Induction, Orientation Safety,	1	1	
Basic Fitting	5	2	6
Basic Sheet Metal	1	7	
Basic Welding, Brazing	3	8	10
Basic Electrical	6	11	16
Basic Electronics	4	17	20
Basic Electro-Mechanical Devices	1	21	
REVISION & TEST	2	22	23

Training Skill Area	No. of Week	Week No.	
		From	To
Refrigeration System & Servicing Basics and Practices including use of Tools	5	24	28
Servicing Components like Compressors, Evaporators Condensers	4	29	32
Servicing of Accessories & Controls of Refrigeration System	4	33	36

Unit C

Unit	Training Skill Area	No. of Week	Week No.	
			From	To
C-1	Refrigerants, Handling, Safety, Leak Testing, Evacuating and Charging	3	37	39
C-2	Recovery / Recycling, Retrofitting of CFC, Systems with Replacement Refrigerants	2	40	41

Unit D

Unit	Training Skill Area	No. of Week	Week No.	
			From	To
D-1	Servicing Refrigerators	3	42	44
D-2	Servicing Air-Conditioners	3	45	47
D-3	Servicing Auto AC	2	48	49
D-4	Servicing Components / Ind. Training	2	50	51
D-5	Servicing Commercial Appliances	4	52	55
	REVISION & TEST	1	56	

E

nit	Training Skill Area	No. of Week	Week No.	
			From	To
-1	Overhaul & Service of Compressors used in Low Temperature Application	6	57	62
-2	Overhaul & Service of Condensers, Colling Water system including Cooling Tower, Water Treatment Plant & Pumps.	6	63	68
3	Servicing of Chillers, Fin & Tube Evaporators and Controls	4	69	72
4	Operations & Maintenance of Cold Storages	8	73	80
	REVISION & TEST	2	81	82

F

it	Training Skill Area	No. of Week	Week No.	
			From	To
1	Relative Humidity & Air Flow Measurements	2	83	84
2	Ducting	2	85	86
3	Servicing AC Plants (small)	3	87	89
	Installation & Operation of Small AC Plants	3	90	92

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Jnit	Training Skill Area	No. of Week	Week No.	
			From	To
G-1	Auto AC Repair, Maintenance	1	93	
G-2	Retrofit Auto AC systems with HFC	1	94	
G-3	Repair Maintenance of Domestic / Commercial Appliances	2	95	96
G-4	Retrofit Domestic / Commercial Applicances with HCs/HFCs	2	97	98
G-5	Retrofitting Cold Storage with non CICs	2	99	100
G-6	Industrial Training	2	101	102
	REVISION & TEST	2	103	104

SYLLABUS FOR THE TRADE OF REFRIGERATION AND AIR-CONDITIONING MECHANIC

Training – 2 Years

Practical	Theory	W/shop Cal.	W/Shop Science	Engg.Drg.
2	3	4	5	6
tion training Familarisation he Institute. Type of practi- ining to be followed Work- Safety.	Importance of the trade in the industrial and commercial field. Theoretical subjects to be taught. Terminal Performance Objectives.	—	—	—
Bench vises and simple ıg and measuring tools. g/Layout practice as per 'rint. Chipping with flat ınd hammer. Rough and g operations. Grinding of o correct wedge angle. ving to a line.	Method of marking, Marking media, Simple marking measuring tools & their use. Chisel hacksaw frame, blade type specification & their use.	Fraction addition, subtraction, multiplication and division.	Unit & Measurements, fundamentals & derived units.	Free hand sketching of straight line, Rectangle, circle, polygon etc.
at, square & curved sur- ıts, grooves, angular pro-	Files and drills Types specifications, Uses, care and safety	–do–	–do–	–do–

(11)

2	3	4	5	6
ing clear and blind hole, sinking, counter boring, rinding and reaming. Use ınd Power drills.	aspects, Drilling speed, feed & Coolants.			
clear and blind hole. g by die. Fitting stud & ıg broken stud. Hand & fitting dowel pin	Specification, use and safety of Tapf & dies Reamers type. Elements of Screw threads, Thread forms.	–do–	Study of Matter, mass. volume, density & specific gravity.	Free hand sketching of simple solid cube, rectangular block, cylinder etc.
n and checking of lon- l, angular parallelism, ess, flatness and icity. 1. Dimensional ıents using Vernier meas- ıtruments like Calipers, ters, Depth and Height Feeler Gauges, Dial Indınd Dial Bore gauges. measuring tools-Square ıl Protractors. 3. Use of dges for checking Flat- Straightness. Dial gauges ing concentricity.	Important precision measuring, marking and checking tools type and their specification, use, care and safety.	Decimal addition, subtraction, multiplication and division.	–do–	–do–

2	3	4	5	6
ing flat surface sharpening aper. Lapping and polishing rface.	Limit, fit and tolerance I.S.I. specificatioin. Scraper-type, specification and use-lap material and plate type, Specification & use.	–do–	Motion, displacement, speed, velocity, acceleration.	–do–
sheet metal tools and equip- care and safety. Sheet metal ig basics comprising shear- itting, bending at the edges flanges and hemmed locks. sing, forming. Use of sheet screws for joining; using or joining. Introduction to ular duct fabrication.	Sheet metal tools and equipment type specification, care and safety. Types of sheet metal joints and their use. Rivet & riveting–their types and use. Calculation of Blank sizes from component drawing.	Decimal addition substraction, multiplication and division.	Study of Motion displacement speed velocity, accleration.	Free hand sketching of simple solid cube, Rectangular block, cylinder etc.
rization with the practice c Welding; 2) Oxy Acety- is welding on thin sheet id Oxy cutting. 3) Safety in g of Oxy Acetylene Cylin- gulators etc.	Introduction to basic principles of commonly used welding processes arc welding, oxyfuel gas welding/ cutting, brazing & soldering.	–do–	–do–	Use of different type of line and symbol for drawing.

2	3	4	5	6
ls and equipment care Setting oxy-acetylene ng and adjustment of e joint on M.S. Pre- fitting lap joints for ng / brazing, impor- ting and capillary ac- appropriate torches, uxes. Practice on Oxy PG adn Air LPG.	Welding tools and equipment type specification and use. Safety method in welding. Method of gas welding, gas used and flames adjustment. Differences between Soldering and Brazing in terms of temperatures, filler materials, joint strengths and applications. Use of Oxy Acetylene, Oxy LPG and Air LPG for brazing / soldering.	Conversion of decimals to common fraction	Study of laws of motion. Force and Momentum and their measurement.	–do–
lding current setting, maintaining arc. Sim- weld joint on M.S.	Method of electric welding electrode-type and application object of flux coating. Welding symbols and I.S.I. code for gas and arc welding.	Conversion of decimals to common fraction.	–do–	Free hand sketching of nut, bolt, rivets, washers etc.
ctrician hand tools. aution and first aid. ıgle and standard con- soldering.	Electrician hand tools type, specification, use, care and safety. Common terms used in the trade. Conductors and insu-	Reduction of common fraction to decimal.	–do–	–do–

2	3	4	5	6
	lators. Selected letters symbols and sign as per I.S.I. rules for medium voltage.			
ng of current voltage, nd energy by voltmeter. r, wattmeter & energy easurement of resistance hm meters. Use of ers.	Electrical work, power and energy –their calculation in simple electrical circuit. Type use & construction of common electrical measuring instruments.	Percentage & its application.	Study of weight, graviation and center of gravity.	Free hand sketching of screw and screw threads.
n of simple electrical cir- s circuit and parallel cir- suring insulation resist- rth resistance.	Simple electrical circuit, essential requirement of electrical circuit, series and parallel circuit. Different types of resistances. Earthing and fuses.	Percentage & its application.	Magnetic Induction, Self & Mutual Inductance. EMF generation.	Free hand sketching of screw and screw threads.
d connecting electrical olders fuses, plug sock- /. board and testing.	Types, grades and sizes of insulated wire and cables – their selection and use. List of material for wiring.	–do–	–do–	–do–

2	3	4	5	6
itenance and running of e and poly phase motor, dn transformer. Single tor starting mehtods like C, CSIR & CSCR and f Current and Potential	A.C. Motor, starters and transformer. Their working principles, specification & use. Care & safety. Run/start capacitors and PTCs. Motor protection devices. Temperature rise of windings.	–do–	Work, Power, Energy, Sources of Energy. Kinetic and Potential Energy.	Simple orthographic projection using 1st angle and 3rd angle projection.
aintenance and running ingle and ply phase mo- s and transformers. Meth- arting 3ph motors, over- short circuit protection.	A.C. motor starters and transformer. Their working principles, specification and use. Care and Safety.	Percentage & its application.	–do–	
ation of transistors, resis- acitors, diodes, S.C.R.S., .Cs.	Introduction to Electronics. Princples and Applications Basic Principles of Diodes, Semiconductors, Amplifiers, Transistors, SCR's.	Mensuration area of square, triangle, circle and ellipse.	–do–	Drawing different types of clutches, coupling, bearing and lubrication system.

2	3	4	5	6
nd bridge rectifier, cir- : regulators. Construc- / voltage Power Sup- ruction of transistor rcuit.	Rectification – zener diode as voltage regulator – transistors parameters – CB, CE, CC, configuration, amplification.	–do– –do–	Heat and Temperature, Measurement of Temperature	–do–
tor circuits and C.R. wave shaping. Wiring Γ for motor control.	Photo diodes – photo transistors, multi-vibrator, CR & LR circuit. SCRs, UJTs, ICs.	–do–	–do–	–do–
id State Thermostats, note Controls.	Thermistors, RTDs, Electronic Thermostats. Principles of Remote Controls and Controllers.	Mensuration area of square, triangle, circle and ellipse.	Different Thermometer Scales. Mutual Conversion. Absolute Temperature.	Drawing different types of clutches, coupling, bearing and lubrication system.
ıd testing contactors, ys, pressure controls, oids, heaters, Pressure	Use and function of Contractors / Starters, Crankcase Heaters, Pressure Controls, Solenoids, Timers both Electromechanical and Solid State.	–do–	Quantity of Heat and its different units and their mutual relations.	–do–

2	3	4	5	6
on of components in a on System - like com- vaporator, Condenser, Devices, Refrigeration lter Driers etc. for vari- :rating and Air-condi- achines.	Fundamentals of Refrigeration and understanding and typical Refrigeration System, its components, working etc.	Square root of perfect square. Square of whole number and decimal.	Pressure Atomospheric, absolute barometric and gauge pressures; Bourdon gauges, compound and vacuum gauges.	Sketching of different views of simple solid and hollow bodies.
ıtion & use of genaral ools used in Refrigera- :e.	Temperature Pressure Relationships, The refrigeration cycle. Sensible and Latent Heats. Superheating and sub-cooling.	–do–	–do–	–do–
on Refrigeration & cutting, Bending, aging, making headers tion of Flared joints on joints and sweat ints.	Understanding Cu tubes used in Refrigeration; soft Annealed, Hard drawn etc. & cleanliness of Cu tubes used in Refrigeration. Flared, compressed & brazed joints, standard flared &	–do–	Evaporation Boiling condensation Freezing Effect of pressure on these. Study of Tables & Charts.	–do–

2	3	4	5	6
	other fittings available – brass and copper			
g of tube joints (Cu to Cu, Steel, Cu to Brass) using (*i*) G (*ii*) 02-LPG (*iii*) 02-C_2H_2; & use of the above gases he right torches, Brazing Rods. Distinguishing good from bad joints. Flared compression joints.	Theory of Brazing. Safe handling of cylinders. Care to be taken whilst preparing joints for Brazing. Flame Chemistry & temperature. Use of right torches, tips & flame. Use of appropriate Brazing filler rods and fluxes.	–do–	–do–	–do–
	–do–	–do–	Specific heat, Sensible Heat, Latent Heat, Super Heat, Total Heat, Enthalpy.	–do–
rization with the Internal uction and identification of nents in : metic Reciprocal compres-	Working principles of Hermetic, Semi-Hermetic & open type compressors of the Reciprocal, Rotary, Scroll & Rotary	Square root of perfect square. Square of whole number and decimal.	–do–	Isometric views of simple objects such as cubes, rectangular block, prism etc.

2	3	4	5	6
d in Regrigerators and Cs etic Rotary Compressors Cs. ble Plate Compressors uto AC compressors. etic scroll compressors. i-Hermetic Reciprocal sors. type Reciprocal Com-	Wobble plate compressos used in Auto AC Understanding the working of the Lubrication system, shaft seals in open compressors and capacity control of multicylinder compressors.			
	–do–	–do–	–do–	–do–
of Evaporators in : Cooled Refrigerators ree Refrigerators Coolers Coolers ACs s e and Parallel flow	Basic Evaporation proces on the PH chart. Types of Evaporators like — Dry Expansion type — Shell & tube, DX type — Flooded type — Role of Accumulator — Importance of Superheat — Distribution of circuits.	–do–	Vapours and gases. Saturated and Superheated vapours. Critical Pressures and temperatures.	–do–

2	3	4	5	6
·ization with Condensers gerators : Vater coolers; Room ACs; , using Ram Air & Pusher ndensing units servicing nsers & condensing units. nce of keeping condens- ı.	Role and operation of condensers. Condenser capacity, types of condensers like static condensers, Forced Draught, Coil type, Shell & Tube type, Desuperheating condensing & Subcooling in condensers.	Metric system of weight and measurement unit and conversion factors, problems.	Vapours & Gases, saturated and Superheated vapours. Critical pressures and temperatures.	Use of drawing instruments, T square, drawing boards.
ies used in Refrigerators. ' ACs & Split ACs - Cut- cleaning of Capillaries. of Capillaries. Use of Ther- c Expansion Valves .ting superheat sensing ' of internal and external ıtion Valves urement & adjustment of ıt.	Metering Devices. 1) Role 2) Types of metering devices, fixed and modulating orifice controls. 3) Capillaries 4) Fixed orifices. 5) Float valves - Low Side, High side. 6) Constant pressure Exp-Valves 7) Thermostatic Expansion Valves. 8) Electronic expansion valves.	–do–	–do–	

2	3	4	5	6
ıtion of circuits in a DX ator, TXV problem at low Common problems and shooting. Sutdy of all ac- es & their location in the stem. Pencil type & Re- le core filter drier. Accu- r Receivers, crank case	Liquid Distributors & their role, Refrigeration cycle accessories & their role— * Filter drivers * Sight glass Suction Line Accumulator Crankcase heaters Hot gas mufflers Oil separators Receivers Heat Exchangers.	–do–	–do–	–do–
·ation & Testing of bimetal- rmostats. Fluid Pressure ; type Thermostat, Elec- Thermostats. ing & Testing of Bellows essure stats - High & low ·e. ration of Humidistats, sens- ments, Range & differential nent.	System Controls : Basic Controls, Operated by Temperature (Thermostats) Humidity (Humidistats) Pressure (Pressure stats) Time (Time Switch)	Algebraic symbol, addition, substraction, multiplication and division.	–do–	Use of different types of scales, inch & mm lettering, number of alphabets.

2	3	4	5	6
n and testing of solenoid ıd 4-way reverse valves ıs. Thermal Bi-Metallic Relays & internal over- ector, Oil pressure safety peration of Pump down	Operating Controls Refrigerant solenoid valves. Four way Reversing Valves. Back pressure valves. Check valves. Safety Controls. Electric overload protectors. Pressure safety switch.	–do–	Chemistry of Common elements, like carbon, oxygen, Hydrogen & Halogens.	–do–
nt Cylinders Identifica- efrigerants safety in the of refrigerants. Safe han- efrigerant Cylinders and	Refrigerants. Historical Developments till today. Physical & chemical properties adn Environmental habards of CFCs & HCFCs. Montreal protocol & India's CFC/HCFC phase out schedules. Ozone Rules 2000. Substitute refrigerants in lieu of CFC's their properties & comparison with CFCs, HFCs and HCs. wrt component changes flammability etc.	–do–	–do–	–do–

2	3	4	5	6
Sealed system using ier / valve; Use Recov- ine to recover CFC/ Cs; Basic tests for qual- covered refrigerant. o remove component ange. Clean/flush with emicals Trichloro-eth- ty in handling N_2 cyl- 2 stage regulator. Re- of Component and d sealing system; Leak h dry N_2. Evacuation tage Rotary Vacuum se of Micron level auge to ensure proper vel. Charging refriger- harging stations / mani- charging cylinders / scales.	Need for elimination of refrigerant emissions through; Recovery/ Recycling; Good Brazed joints; Proper leak testing before charging refrigerant. Importance of cleanliness and Hygiene in a refrigeration system. Importance of evacuation of Moisture and Non condensable. Gases from a refrigeration system and the need for Rotary 2 stage Vacuum pumps to reach the needed vacuum levels. Understanding of units used to define vacuum levels.	Simple equations & transposition problems.	–do–	–do–

2	3	4	5	6
for previous week	Same as for previous week	Same as for previous week	Same as for previous week	Same as for previous week
fitting of a CFC filled Do-c Refrigerator with Hy-rbons using sealed com-nts in the Refrigerator & pressor. ·/ Service of HC Refrige-system using correct ques & ensuring safety g brazing, evacuating, ing.	Changes in components & practices whilst retrofitting CFC appliances with HC and HFC refrigerants. a) HCs - Flammability issues to be addressed using sealed components. b) HFCs - Changes in compressors, luboil, need for filter driers of XH7/XH9, & greater risk of moisture absorption & system failures.	–do–	Chemistry of Ammonia, Carbon Dioxide, CFCs, HCFCs, and HCs. –do– Heat transfer Conduction, Convection, Radiation. Thermal Conductivity and Insulations.	Drawing of simple figure and solid with dimensions & titles.
tting with HFCs / Service with HFCs.	–do–	Standard formulas. Simple simultaneous equations with two unknown quantities.		–do–

2	3	4	5	6
led Domestic Refrigera-ing Direct cooled Re-& cleaning / inspection of components in the door & door seal tight-cing the electrical and l refrigerant system & nts. Testing Thermostats tomatic defrost system, or relay & overload, fety wrt Earth, continu-ng. Reassembly & Test-formance.	Study construction of the Refrigerator & components like door, gaskets, PUF Insulation, chiller tray, crisper etc. Electrical components & wiring drawings, Ref sealed system, Roll bond evaporators, Suction Heat exchanger, open and concealed clean back condensers.	–do–	–do–	Projection of square, circle, polygon etc.
Refrigerators : of the components. lectric cricuit, thermo-ost Heaters, Air purifi-ucting & distribution & through evaporator. / inspection / testing of	Study construction of Frost Free (2 or 3 door) Refrigerator parts particularly, the forced draft cooling. Air Duct circuit, the temperature control in Freezer & Refrigerator the Evaporator, the automatic defrost system the hot gas lines to prevent con-	–do–		–do–

2	3	4	5	6
onents. Reassemply and test-	densation on cabinet. The Electrical system.			
le Shooting Common Prob- n Refrigerators like : cooling ır cooling h current ctrical leaks er leakage ess frost etc. proper tools & instruments anifold with guages, Am- Voltmeter, Electrical test- ard, Multi Meters, Ther- ers for diagnostics.	Theory behind the causes of the problem & the analytical approach to trouble shooting need for right instruments & tools to trouble shoot.	–do–	Heat transfer Conduction, Convection, Radiatioin. Thermal Conductivity and Insulations.	
ng a WRAC & cleaning/ ion / testing of the compo- ike outer wrapper, Grills, , Motor, condenser fan, rtition, evaporator & con-	Study of construction & functioning of WRAC. Role of each component. Principles of working. Evaporative cooling of condenser.	–do–	–do–	–do–

2	3	4	5	6
venturis, Sweep mecha- synchronous motor, Vent nism, Rotary switch & ther- , Electrical components apacitors (Start & Run), Electrical wiring, checks for ng & continuity. Reassem- est.				
ng of a Room & condens- t, identifying & cleaning / ion testing of components ssembly. Operation of tan- blowers, sweep & swing nism with stepper motor. al & Electronic compo- esting including special ns like Autocool, Sleep, . wiring & piping between & Condensing unit.	Study of Split Acs/Room unit & Condensing unit. Principles of pipe sizing & study of service valves for charging at site. Principles of working of Infra red remote control & understanding Electrical / Electronic circuitry. Condensate removal from room units & need for traps.	Simple algebraic problems	–do–	–do–

2	3	4	5	6
e shooting of some com-encountered problems like cooling t-cycling n noise levels in Room/ iser Unit. er dripping in Room unit iting of room unit. em in the working of elec-controls	Importance of maintaining filter Cleanliness. The problems in installation with Evaporator at higher/lower levels & vice versa. Also use of right instruments & tools to trouble shoot.	–do– –do–	Gas laws perfect & real gases, Dalton's laws.	Projection of solid & hollow object.
to AC : Mounting Brack-ngine blocks & compres-Brackets & adjustment of sion. Types of 'O' Ring ssion pipe joints & flared after market systems, Hot ystems & mixing valves nperature control. Opera-Electromagnetic cultches compressors. Air flow &	Study of Refrigerant systems in Auto AC and Air flow & direction control in Evaporator. How performance varies with compressor / engine speed. Difference in R-12 & R-134 a system Temp. control in the cab Electrical / Electronic wiring diagram.	–do–	–do–	–do–

2	3	4	5	6
ion control. Protection h HP-LP switches, Receiv-ast Idle control devices, n valves.				
g of wiring based on dia-identification & function components like thermo-lectrically operated valves, connectors, H.P./L.P. es, compressor clutch, al-or/battery. Repairing/ ation & charging of systems. le shooting of common ms like : cooling r cooling uced air supply gine overheating h compressor noise	Theory behind the problems listed under Trouble shooting and analytical approach to trouble shooting.	–do–	–do–	–do–

2	3	4	5	6
icing of blowers, Motors, in Air conditioners & com-ial appliances for Evapora-and Condensers.	Description, construction, function of different types of blower and fans, motors etc. used for Evaporators and Condensers.	–do–	–do–	–do–
ng of Capacitors, Relays .	Role of Start & Run capacitors, relays and PTCs.	–do–	–do–	–do–
' of water cooler construc-Instantaneous and Storage), circuit, Refrigeration Cir-Electrical Circuit, Working ıtrol. Soldering of Cu tubes ıinless Steel, Trouble shoot-commonly faced problems ondenser fan failures, cor-etc.	Explanation of a) Water storage, distribution & drainage. b) Refrigeration system using R-22 & components in lieu of R-12. c) Electrical & control system d) Insulation e) Retrofitting with HFC 134a or HCs.	Logarithmic reading from table, determination of characteristic & antilogarithm	Horse power Indicated and Brake HP.	Views of various solid and hollow object & cut by section plane.
ing & servicing Visicooler, itive maintenance & trou-ooting Retrofitting with	Chest type bottle coolers, Deep Freezers and Visi coolers, Description, Construction & func-	–do–	–do–	–do–

2	3	4	5	6
ocarbons or HFC 134a.	tion. Substituting R-12 with R-134a or Hydrocarbon.			
king Ice Candy Plant & Ice n ge Troble shooting, servic-& testing. Retrofitting with 134a.	Ice Candy plant & Ice Cream storage. Their types function & applications. Retrofitting CFC12 plants with HFC 134a.	Application of logarithmic	–do–	–do–
ıantling of commercial type rocating compressor, check-omponent parts.	Performance of reciprocating compressor metric efficiency, factor influencing volumetric efficiency.	Geometric properties, line, angle, triangle and circle.	Simple Machines & Mech. Advantages.	Isometric views to orthographic views
king & servicing valve plate piston assembly, lapping e plate etc. Fitting and test-	Commercial type reciprocating compressor - their type construction and application.	–do–	Simple Machines & Mech. Advantages.	–do–

2	3	4	5	6
king lubricating system. :ing oil pump etc. Fitting :sting.	Compressor lubrication. Types of lubrication Splash and forced feed. Compressor oil function and characteristic.	–do–	Transmission of Motion & Power	–do–
:ing and servicing capacity ıl of the compressor fitting sting.	Compressor capacity control. Different method and application.	–do–	–do–	–do–
ing and servicing bearing, eal etc. Fitting & testing.	Multistage compressor - their function, construction and application.	Graph-object & use of graph. Rules of plotting, graph interpolation.	–do–	Orthographic views to isometric views
; gasket and assembly of :ssor. Testing efficiency.	Centrifugal compressor, Construction and Application Refrigerants used. Alternatives to R-11, like R-123 to R-12 like R-134. Screw compressor chillers, types construction.	–do–	–do–	–do–

2	3	4	5	6
ing of water cooled con- r & receiver. Checking, :e, Repairing and testing, ıling of condenser.	Condenser-its type and capacity water cooled condenser their type, construction and application.	–do–	Stress strain, Modulus of Elasticity, Ult Strength.	–do–
ing evaporative condenser, ıng repairing & testing.	Evaporative condenser - their function, construction and application.	–do–	–do–	–do–
ing of cooling tower - its ınd maintenance installa-	Cooling tower - its principle, type, capacity, construction & disadvantage of different types of cooling towers. Selection of site, efficiency. Wet bulb temp and C. T. approach.	The plotting of coordinates. Representation of simple equation.	–do–	Development of surface of simple object
:ing of water softening and noving plants - its care and :nance.	Water conditioning scale and deposit control, corrosion and its control. Slime and Algae - water conditioning systems.	–do–	Properties and use of cast iron, Wrought iron, Plain carbon steel, Alloy steel.	–do–

2	3	4	5	6
ing of water circulating s. Dismantling & nbly.	Principles of working of a pump. Causes of commonly faced problems like poor pumping air leaks, high power consumption.	–do–	–do–	–do–
piping using Black or Gal-d steel pipes, Hard copper	Introduction to standard fittings, valves etc. used inchilled water, condenser water & drain lines.	–do–	–do–	–do–
ing of extended surface air evaporators. Study & ıg of De Frost System.	Plates & Tube forced air DX evaporators. Types of Defrost systems & condensate disposal.	Trigonometry, Trigonometric functions - standard formulae	–do–	Curve of interpenetration
ng of water / Brine Chill-	Water / Brine chillers. Types of Brines used as secondary refrigerants.	–do–	Effect of Alloying elements and properties of metals	–do–
ıg of suc-liquid Heat Ex-s.	Suc-liquid Heat Exchangers, Their function, construction, application & advantages.	–do–	–do–	–do–

2	3	4	5	6
of Electrical controls in ge & Commercial refrig-	Study of controls & electrical wiring disgrams used in cold storage / commercial refrigeration.	–do–	–do–	–do–
cold store cooling sys-ol and instrument.	Food preservation spoilage agents - control of spoilage agents, preservation by refrigeration.	Use of trigonometric table, applied problems.	Properties and uses of copper, zinc, lead, tin, aluminum etc.	Drawing of rivet & riveted joints
cold store cooling sys-ol and instrument.	Cold storage-type construction capacity and specification.	–do–	–do–	–do–
commercial type com-se of vibration elimina-ıck absorber.	Method of installing compressor vibration eliminator and shock absorber their type and application.	–do–	–do–	–do–
wiring of the compres-ıecking the wiring sys-plant.	Study of layout and electric wiring of the storage plant.	–do–	Properties and use of Brass, Bronze as bearing material.	Drawing of different types of threads, nuts, bolts, locking devices, keys & cutters.
:sting leak detection and ; the system.	Method of pressure testing leak detection and evacuating the system.	Calculation of area of triangle, polygon etc.	–do–	–do–
;as to the system & test-iciency.	Method of charging gas to the system and testing efficiency.	–do–	–do–	–do–

2	3	4	5	6
rage plant, operation, its l safety.	Cold storage plant operation. Its common trouble and remedies.	–do–	Meaning of tenacity, elasticity, malleability, brittleness, hardness, ductility.	–do–
n	–do– Revision Test	–do– — —	–do– — —	–do– — —
ry & wet bulb thermomng Psychorometers. Us-hrometric chart to plot s. Rough checking of the nce of AC Eqpt.	Fundamentals of Central Air conditioning - Comfort Air conditioning - Comfort Air conditioning conditions. Psychometrics. Dry & Wet Bulb, Dew point temperatures. Introduction to psychometric charts.	Volume & weight of simple soild bodies.	Hygrometry properties of Air relative and absolute humidity.	–do–
nemometers for measurow. Use of Inclined tube er for measuring air pres-ot tube for air flow meas-	Various types of Central AC like. All air, All water, Air water and Unitary AC assessing air flow requirements and distribution. Blowers, fans, working	–do–	–do–	–do–

2	3	4	5	6
	principles, static and velocity pressures.			
material and standards Read-understanding Duct layout ings sheet metal duct work. gitudinal and transverse s.	Duct systems - Principles of locating outlets, ducts and equipment. Basics of Duct sizing.	–do–	–do–	Drawing of pulley and pulley drive, gear and gearing
t material and standards. ling & understanding Duct ut drawings sheet metal duct t. Longitudinal and trans-e joints. Service & maintee of various types of filters.	Basics of indoor air quality-particles, vapours and gases. Types of filters-prefilters, flat & vee type, pleated type, Electrostatic, HEPA & Electronic filters.	–do–	General laws of Thermodynamics 1st & 2nd laws. Mechanical equivalent of heat.	–do–
icing & trouble shooting of 's & commercial splits. Alter-vely, this can be dome on a ll central AC Plant.	Construction & study of commercial split systems and packaged ACs, Air and water cooled.	Volume & weight of regular cone sphere	–do–	–do–
led water piping and insula-Servicing of FCUs & water rol valves. Mixing dampers, & bypass dampers.	Understanding Central station AHUs and FCUs using chilled water, understanding chilled water layout & modulating valves for temperature control. Expansion tanks.	–do–	–do–	–do–

2	3	4	5	6
y of controls in Packaged systems, their functioning of ole shooting. Alternatively, can be dome on a small cen- AC Plant.	Controls used in AC systems. Electromechanical, pneumatic & Electronic.	Volume & weight of simple, hollow bodies	–do–	Drawing of engine compressor and pump parts such as pistion, connecting rod, crankshaft valves etc.
lling compressor & other m components, electrical g, verifying airflow & dision. Operation of electrical nechanical components.	Introduction to load calculation in AC buildings. Sensible & latent heats.	–do–	–do–	–do–
& verify deep vacuum. Perleak checks & make repairs. system operation whilst ving all safety procedures.	Methods of leak detection, evacuation, charging gas, testing sytems.	Transmission & power-application problems	–do–	–do–
tion of AC Plant, Check for n leaks & check and clean xchangers. Check out samr acidity, check superheat cooling motor current.	System service & problem analysis a) Proper temp. & pressures at various location. b) Thermostat settings c) Noises d) Electrical measurements e) Methods of measuring superheat & subcooling f) Effects of overcharge & undercharge.	–do–	–do–	–do–

2	3	4	5	6
and maintenance of Auto/ Systems.	Performance testing of Auto AC Systems Bus and Rail AC	Transmission of Power. Application problems	Corrosion. Corrosive Action due to electrolytic and galvanic corrosion. Corrosion protection.	–do–
itting of CFC Car AC sysvith HFC 134a	Steps needed during retrofitting. Component changes. Performance variations after retrofit. Cost of retrofit.	–do–	–do–	–do–
and maintenance of retor and deep freezer	Review of commonly faced problems and analytical approach to problem solving using right instruments/tools	Estimating and Costing Applied problems.	–do–	–do–
itting Refrigerator/Freezer ICs	Review of safety measures and steps. Retrofitting of sealed components.	–do–	–do–	–do–
r & Maintenance of Ice Plant	Ice Candy Plant, ther maintenance, trouble diagnosis and remedies.	–do–		–do–

2	3	4	5	6
	Use of different control, agitators-FAM and secondary refrigerants.	–do–		–do–
Ice Candy Plant with alnon CFC refrigerant.	Choice of Economic alternative. If HFc 134s, all steps needes before changing components to be carefully followed	–do–		–do–
nd maintenance of Winom Air Conditioners	Review of commonly occurring problems and analytical approach to trouble shooting.	–do–		–do–
al Training : Cold Stor- and Ice Cream Plants al Training : Central Air oning Plants (DX and Water systems)				
maintenance, overhaul- ventive maintenance of C plants. Maintenance, and record keeping.	Planning for Preventive maintenance and scheduling of Maintenance activities in large AC and Refrigeration plants			
	Test	Test	Test	Test

SKILLS / COMPETENCIES EXPECTED TO BE ACHIEVED BY STUDENTS AFTER COMPLETION OF LEARNING AGAINST VARIOUS UNITS OF THE CTS

AFTER UNIT 'A'

1. Use and manipulate fitter's hand tools and equipment.
2. Using fitter's hand tools carry out simple fitting jobs.
3. Use and manipulate sheet metal tools and equipment.
4. Use and manipulate sheet metal tools and equipment to carry out simple sheet metal jobs.
5. Use and manipulate welder's tools and equipment. Carry out simple gas and arc welding jobs and gas cutting and brazing.
6. Use and manipulate electricians hand tools.
7. Use and manipulate electricians measuring instruments. Connect and operate AC motors and starters, single and three phase.
8. Use and manipulate electronic service tools.
9. Use and test electronic circuits.

AFTER UNIT 'B'

1. Use and manipulate refrigeration piping tools and equipment. Carry out tube cutting, flaring, swaging, bending etc.
2. Use and manipulate Brazing equipment and tools. Carry out tube joints using Oxy Acetylene and Air LPG brazing. Ability to discriminate between good and poor joints.
3. Identification, servicing, testing and checking performance of Components, accessories and controls of refrigeration systems of Domestic and Commercial stand alone appliances and Commercial Refrigeration and AC Plants.

AFTER UNITS 'C' & 'D'

1. Knowledge of Regulations in India for ODS phase out.
2. Use of Recovery/Recycling equipment.
3. Retrofitting of CFC based appliances with non CFCs i.e. HCs, HFCs and HCFCs.
4. Carrying out repairs/replacements of components in sealed systems for Appliances that work on HFCs, HCs.
5. Carrying out cleaning, leak testing, evacuation and charging of sealed refrigeration systems using any refrigerant in Domestic and Commercial Appliances.
6. Servicing and Trouble shooting of all Domestic and Commercial

AFTER UNIT 'E'

1. Servicing and overhauling Open type Compressors used in Commercial Cold Storage Plants.
2. Servicing Condensers, Cooling Towers and Water Treatment Plants used in Commercial Cold Storage Plants.
3. Servincing Evaporators used of Commercial Cold Storages.
4. Operate and Maintain small Commercial Cold Storage Plants.

AFTER UNITS 'F' & 'G'

1. Checking performance of small Central / Package AC installations in terms of Air Flow, Temperature and Relative Humidity.
2. Carry out Ducting work on small AC plants.
3. Servicing of Fan Coil Units and small AHU's.
4. Service and operate a small Package / Central AC plant.
5. Repair and maintain Auto/Car ACs, Refrigerators, Freezers and other stand alone commercial appliances, Ice Candy Plants and Room Air Conditioners.
6. Retrofit with non CFC refrigerants, Auto ACs, Refrigerators, Freezers and other stand alone commercial appliances and Ice Candy Plants.

LIST OF TOOLS & EQUIPMENT FOR THE TRADE OF "REFRIGERATION AND AIRCONDITIONING MECHANICS"

(For a batch of 16 trainees)

S.No.	Description	Quantity
1	Flaring tool set, single type for tube 4.7 to 16 mm OD.	4 Sets
2	Swaging tool, punch type, set of size, for tube 4.7 to 16 mm OD	4 Sets
3	Swaging tool, screw type, with adapter set of size for tube 4.7 to 16 mm OD	1 Set
4	Bending spring external type, for copper tube 3 to 6 mm. Dia	4 Sets
5	Pipe cutter miniature for copper tube 3 to 16 mm.Dia	4 Nos.
6	Pipe cutter with built-in reamer and space cutter, for copper tube 3 to 32 mm.	1 No.
7	Pinch off tool, for copper tube 6 to 18 mm. dia	4 Nos.
8	Ratchet spanner of 6.4 mm. sq. Reversible	4 Nos.
9	Capillary plug gauge	2 Nos.
10	Pinch off plier/crimping plier tool 6-18 mm. dia	2 Nos.
11	Piercing plier 6-18 mm. & Piercing valves both with access fittings	2 Nos. each
12	Spanner, double ended 4.7 mm to 16 mm.	5 Sets
13	Spanner, double ended 19 mm to 31.8 mm.	1 Set
14	Ring spanner, off set 4.7 mm to 16 mm.	5 Sets
15	Ring spanner, off set 19 mm 31.8 mm.	1 Set
16	Box spanner size 6.4 to 10 mm.	2 Sets
17	Wrench adjustable length 150 mm.	1 No.
18	Wrench adjustable length 200 mm.	2 Nos.
19	Wrench adjustable length 250 mm.	2 Nos.
20	Pipe wrench size 50 & 150 mm.	1 No. each
21	Torque wrench 300 mm. 12.7 mm. square drive right and left hand	1 Set
22	Valve key - T, Handle - 4.7 & 6.4 mm. sq.	4 Sets
23	Socket set, reversible ratchet, 12.7 mm. square drive with extension, 4.7 to 31.2 mm.	2 Sets
24	Socket set, reversible ratchet, 1/2" square drive with extension, 3/16" to 1 1/4" BSW & SR	1 Set
25	Pressure gauge, diameter 63 mm. with recalibration set screw, scale 0 to 35 kg/sq.cm.	4 Nos.
26	Compound gauge, diameter 63 mm. with Recalibration	4 Nos

30	Lapping plate 250 × 200 mm.	2 Nos.
31	Punch hole for cutting gasket, 4.7 to 16 mm. dia	4 Nos.
32	Scissor, gasket cutting stainless steel. length 25 mm.	4 Nos.
33	L-Allen key set, size 1.5 to 6.4 mm.	4 Sets
34	T-Allen key set, size 5/32" & 1/8"	4 Sets
35	Screw driver, plastic handle. 6 mm. tip length 100, 150 mm.	17 each
36	Screw driver, plastic handle, 10 mm. tip length 200, 250 mm.	5 each
37	Philips screw driver-complete set in leather case	2 Sets
38	Screw driver, plastic handle, 3 mm. tip length 100 and 150 mm. insulated	1 Set
39	Pliers combination insulated, length 200 mm.	2 Nos.
40	Pliers long nose, length 200 mm.	2 Nos.
41	Pliers flat nose, length 150 mm.	1 No.
42	Hammer ball pein 450 gms.	4 Nos.
43	Hammer ball pein 220 gms.	4 Nos.
44	Hammer Nylon 300 gms.	4 Nos.
45	Engineers rule 300 gms.	1 No.
46	Tape, measuring 10 m graduation in mm.	1 No.
47	Tape measuring 2 m graduation in mm.	2 Nos.
48	Chisel flat length 150 mm.	4 Nos.
49	Hack-saw tubular metal frame adjustable	4 Nos.
50	Scriber 150 mm. length	4 Nos.
51	Divider, spring joint length 150 mm.	4 Nos.
52	Caliper spring joint, outside length 150 mm.	4 Nos.
53	Caliper spring joint inside length 150 mm.	4 Nos.
54	Caliper, odd leg, spring joint, length 150 mm.	4 Nos.
55	Centre punch length 100 mm.	4 Nos.
56	Oil can pressure type - 1 litre	2 Nos.
57	File, flat medium double cut, length 200 mm.	4 Nos.
58	File, half round medium, double cut length 200 mm.	4 Nos.
59	Flie, half round, fine double cut, length 150 mm.	4 Nos.
60	File round, fine, double cut, length 150 mm.	4 Nos.
61	File flat, fine double cut, length 150 mm.	4 Nos.
62	File square, fine double cut, length 150 mm.	4 Nos.
63	Engineers square 200 mm. long	2 Nos.
64	Marking Block, universal spindle 200 mm.	2 Nos.
65	V-Block, with clamp 75 mm.	2 Nos.

70	Blow-lamp capacity 1/2 litre	2 Nos.
71	Blow-lamp capacity 1 litre	2 Nos.
72	Puller 3 legged, with flexible arm 120 mm	1 No.
73	Puller 2 legged, with flexible arm 300 mm.	1 No.
74	Hand blower portable complete 1/10 HP	1 No.
75	Spirit level precision metallic 200 mm.	1 No.
76	Plumb weight 200 g.	1 No.
77	Snipper sheet metal straight nose 200 mm.	1 No.
78	Tap set with matching drills 3 mm. to 16 mm. size	1 Set
79	Tap set with matching drills 1/4" to 5/8" SAE size	1 Set
80	Tap and die set 1/4" to 5/8" SAE size	1 Set
81	Tap and die set 3 mm. to 16 mm. size	1 Set
82	Vernier Caliper length 250 mm.	1 No.
83	Micrometer, outside measurement 0-25 mm.	2 Nos.
84	Vernier height gauge 250 mm.	1 No.
85	Bench vice 75 mm. jaw	2 Nos.
86	Bench vice 120 mm. jaw	2 Nos.
87	Electrical drill portable with chuck and key, capacity 6.4 mm.	2 Nos.
88	Pillar drilling machine 200 to 2500 rpm. capacity 20 mm.	1 No.
89	Pedestal grinder, double ended wheel dia 200 mm. 3000 rpm.	1 No.
90	Oxy-Acetylene welding set complete with cylinders regulators welding torches with difference nozzles	2 Nos.
91	Gas cylinder truck two wheel type	2 Nos.
92	Line tester 500 volt. Heavy duty	4 Nos.
93	Tong-tester 0-10-30 amps., 0-500 volts (Clamp on Multimeter)	4 Nos.
94	Knife folded stainless steel - 150 mm.	4 Nos.
95	Voltmeter AC/DC portable, precision grade teak wood case, leather belt, 0 to 5 amp.	7 Nos.
96	Ammeter AC/DC portable, precision grade teak wood case, leather belt, 0 to 5 amp.	5 Nos.
97	Ammeter AC/DC portable, precision grade teak wood case, leather belt, 0 to 30 amp.	5 Nos.
98	Megger - 1000 Volt.	1 No.
99	Varic input 230 Volt output 400 volt.amp. portable complete with meters and controls.	1 No.
100	Wattmeter, multi range upto 1 KW	1 No.

105	Transistor tester	1 No.
106	R.L.C. Bridge	1 No.
107	Stop watch	1 No.
108	Filler, gauge 0.05 mm. - 1 mm.	1 Set
109	Wire gauge metric and Whitworth	1 Set
110	Refrigerant cylinder capacity 2.5 Kg.	2 Nos.
111	Refrigerant cylinder capacity 30 Kg.	2 Nos.
112	I. Evacuating & Refrigerant charging station comprising a) Rotary two stage vacuum pump and motor (with gas ballast & anti suck back) Manifold with gauges & valves and capable of pulling vacuum upto 50 microns of Hg and with provision of connecting to a micron level vacuum gauge b) Graduated charging cylinder with provisions for temperature correction and all necessary isolating valves II. Evacuating & charging station as above but fitted with weighing scale (upto 2 kg. in lieu of (b) above and with accuracy of +/- 1 gram, for charging hydrocarbons.	1 No. 1 No.
113	Dial thermometer remote control, armoured capillary dial 75 mm. -.50 Deg. C to + 50 Deg. C.	2 Nos.
114	Two stage rotary vacuum pump of capacity approx 60-100 1pm, capable of evacuating to 50 microns of Hg and fitted with gas ballast, anti suck back valve and single phase motor.	1 No.
115	Anemometer (Vane type)	1 No.
116	Air compressor, two stage for oil-less dry air, with rust proof tank assembly, heater and control max. Pr. 10 kg/sq. cm cap. 45 litre, Motor 1 HP	1 No.
117	Scraper, triangular blade removable 60 mm.	2 Nos.
118	Descaling pump set with stainless steel impeller and housing complete with motor 1 HP and accessories.	1 No.
119	Spray outfit, 'V' twin, with motor 1/2 HP. Delivery upto 120 litre free air pressure upto 3 Kg/sq.cm. with spray gun and fitting.	1 No.
120	Pressure testing tank with lighting arrangement, pressure gauge (0 to 35 kg/sq.cm.) double stage	1 No.
121	Heating kit with infra red bulb (200 watt. capacity)	1 Set
122	Refrigerator, compression type 165 litre	1 No.
123	Refrigerator, compression type 300 litres double door, double compressor system.	1 No.
124	Deep freezer 165 litre - 18 Deg. C., 1/4 HP	1 No.

129	Ice candy unit complete with sainless steel tank, mould box, thermocole insulated sunmica body, agitator compressor, motor etc. Temperature, pressure refrigerant control gauges, motor, pipe fitting etc. 3000 k. Cal/hr. or working trainer model/simulator.	1 No.
130	Cold storage plant complete with all controls and accessories including cooling tower and water treatment plant capacity 15000 k. cal/hr. or working trainer model/ simulator.	1 No.
131	Air conditioning plant, direct and indirect water chiller, complete with all controls including humidity control etc. Capacity 15000 k. cal/hr. or working trainer model/ simulator. Alternatively, a Packaged Air-Conditioner of similar capacity.	1 No.
132	Condensing unit with open type compressor air cooled condenser controls etc. capacity 3000 k.cal./hr.	1 No.
133	Condensing unit with open type compressor evaporative condenser controls etc. capacity 3000 k.cal./hr.	1 No.
134	Reciprocating compressor with provision of capacity control etc. for demonstration, capacity 9000 kcal/hr. Semi Hermetic/Open type	1 No.
135	Welding table 900 × 900 × 700 mm. high	1 No.
136	Work bench 1000 × 600 × 800 mm. high	4 Nos.
137	Alimirahs, 195 × 90 × 49 cm.	2 Nos.
138	Lockers of eight compartments	2 Nos.
139	Chalkboard portable	1 No.
140	Instructor table and chair	1 No.
141	Micron vacuum gauge capable of reading upto 20 microns	2 Nos.
142	Sensor thermometer (digital)	2 Nos.
143	Fin straightener/Fin comb	4 Nos.
144	HC refrigerant in cylinders/disposable containers	2 Nos.
145	134 A refrigerant in cylinders	2 Nos.
146	Recovery unit one each for CFC & 134 A refrigerants with recovering of cylinders	2 Nos.
147	Reverse cycle AC/Heat pump 3000 kcal/hr. or 4500 kcal/hr.	1 No.
148	Split type AC 4500 kcal/hr. with Indoor unit & Outdoor units and Electronic Remote Control	1 No.
149	Refrigerator 170 litre using 134 A refrigerant	1 No.
150	No frost refrigerator 300 litre capacity using HC refrigerant	1 No.

	N2 in cylinder with drier unit and 2 stage regulator	
154	Trichloroethylene bottle	1 No.
155	Two way manifold with gauges	1 No.
156	Four way manifold with gauges	1 No.
157	Filter driers for CFC-12 & HFC-134a for repairs-retrofits	8 Nos.
158	Sealed ex-proof components for use in HC appliances : Thermostats, Sealed OLPS, Solid State PTCs, Door Switches, Lamp Holders	4 Nos.each
159	Components of Car AC systems a) Wobble plate compressor with mounting brackets b) Serpentine evaporator c) Parallel flow condenser d) Hoses, tubes, receiver, expansion valve e) Electrical components & wiring harness	1 No.each
160	Small capacity shell and tube condenser	1 No.
161	Fan coil unit with water valves (2 & 3 way)	1 No.
162	Shell and tube, DX chillers (small)	1 No.
163	Circulating water pump (small)	1 No.
164	Safety gloves, eye protection glasses	4 Nos.
165	Safety shoes (Optional)	
166	Pipe threading dies & pipe vice	1 No.
167	Schraeder valve core removal tool	1 No.
168	Acid test kit	1 No.
169	Refractometer (Optional)	1 No.
170	Hand formers & 20 g capacity lock former	1 No.
171	Pop rivet gun	1 No.
172	Brazing alloy rods for 1/4" to 7/8" tubes-Cu to Cu,Cu to Steel, Cu to Brass and appropriate fluxes	1 Set
173	Pitot tube & inclined tube manometer	1 No.
174	i) Hermetic compressors (1/8 hp to 1/2 hp for use in repair work of appliances for CFCs and HCs. ii) Hermetic compressor for 134a	2/3 Nos. 1/2 Nos.
175	Ball valves service valves, hand shut of valves of 1/4" to 7/8"	2 Nos. each
176	Quick couplers, process tube adaptors for 1/4", 3/8" tubes	2 pairs for each tube
177	Compressor tester for small hermetic compressors	1 No.
178	Hermetic compressor 1.5 (AC)	1 No.
179	Evaporator of direct cooled refrigerator with capillary, heat exchanger	1 No.
180	Evaporator of frost free refrigerator	1 No.
181	Accessories: thermostatic expansion valve, distributors driers (pencil, solid core type etc.), accumulators, receivers, bellows type thermostats, H.P. stat, L.P. stat, humidi stat, solenoid valves	1 No.each
182	Electrical accessories: current & potential relays, start & run capacitors, PTCs, overload protectors, relays, contactors	1 No.each
183	Visi cooler	1 No.
184	Recycling Unit (Optional)	1 No.