DOCUMENT RESUME

ED 251 645 CE 040 232

AUTHOR	Henderson, William Edward, Jr., Ed.
TITLE	Articulated, Performance-Based Instruction Objectives Guide for Air Conditioning, Refrigeration, and Heating. Volume II (Second Year).
INSTITUTION	Greenville County School District, Greenville, S.C.; Greenville Technical Coll., S.C.
PUB DATE	Oct 84
NOTE	374p.; Prepared by the Articulation Program Task Force Committee for Air Conditioning, Refrigeration, and Heating.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC15 Plus Postage.
DESCRIPTORS	*Air Conditioning; Behavioral Objectives; Competency Based Education; Curriculum Guides; *Equipment Maintenance; Fuels; Grade 12; *Heating; High Schools; Job Skills; Learning Activities; *Refrigeration; Secondary Education; Solar Energy; Trade and Industrial Education; Units of Study; *Ventilation

ABSTRACT

This articulation guide contains 17 units of instruction for the second year of a two-year vocational program designed to prepare the high school graduate to install, maintain, and repair various types of residential and commercial heating, air conditioning, and refrigeration equipment. The units are designed to help the student to expand and apply the basic knowledge already mastered and to learn new principles and techniques and to prepare him/her for entry-level work as an apprentice. The seventeen units cover aid conditioning calculations (psychrometrics, residential heat loss and heat gain, duct design and sizing and air treatment); troubleshooting and servicing residential air conditioners; commercial refrigeration; commercial air conditioning; heating systems (electrical resistance heating, heat pumps, gas heating, oil heating, hydronics, solar heating systems); automotive air conditioner maintenance/repair; estimating and planning heating, ventilation, and air conditioning jobs; customer relations; and shop projects. Each unit contains some or all of these components: unit overview, minimum suggested terminology, task listings, and tasks. A task sheet for each task details the performance objective, performance actions, performance standards, and related technical information. An addendum provides additional materials needed to complete the task. A proficiency report and competency checklist are appended. (YLB)

ARTICULATED, PERFORMANCED-BASED INSTRUCTION OBJECTIVES GUIDE
FOR
AIR CONDITIONING, REFRIGERATION, AND HEATING

VOLUME II
(Second Year)

DEVELOPMENT PERIOD
FEBRUARY, 1984 - OCTOBER, 1984

PREPARED BY
ARTICULATION PROGRAM
TASK FORCE COMMITTEE
FOR
AIR CONDITIONING, REFRIGERATION, AND HEATING
REPRESENTING
THE SCHOOL DISTRICT OF GREENVILLE COUNTY
AND GREENVILLE TECHNICAL COLLEGE
GREENVILLE, SOUTH CAROLINA

PUBLICATION OF
ARTICULATION PROGRAM
OF THE SCHOOL DISTRICT OF GREENVILLE COUNTY
AND GREENVILLE TECHNICAL COLLEGE

OCTOBE , 1984
EDITION I

ARTICULATED, PERFORMANCE-BASED CURRICULUM GUIDE

THE SCHOOL DISTRICT OF GREENVILLE COUNTY

DR. J. FLOYD HALL
SUPERINTENDENT

DR. NORMAN MULLINS
ASSOCIATE SUPERINTENDENT FOR EDUCATIONAL DEVELOPMENT

MRS. DORIS CLANTON
DIRECTOR, INSTRUCTIONAL SERVICES

MR. O. RICHARD COTHRAN, JR.
CONSULTANT, VOCATIONAL EDUCATION

ARTICULATION GUIDE

THE SCHOOL DISTRICT OF GREENVILLE COUNTY AND GREENVILLE TECHNICAL COLLEGE

THE SCHOOL DISTRICT OF GREENVILLE COUNTY
GREENVILLE, SOUTH CAROLINA

1984

Henderson, Wm. Edward Jr., ed. Articulated, Performanced-based Instruction Objectives Guide for Air Conditioning, Refrigeration, and Heating - Vol. II. Greenville, SC: Articulation Program of The School District of Greenville County and Greenville Technical College, 1984.

ACKNOWLEDGEMENT

The Articulated, Performanced-based Instruction Objectives Guide for Air Conditioning, Refrigeration, and Heating is the product of the work of the following instructor Task Force Committee participants representing the secondary programs of The School District of Greenville County and the post-secondary similar program at Greenville Technical College.

Donaldson Career Center	William H. Moon
Enoree Career Center	Alvin P. Granger
Foothills Career Center	Broadus R. Abbott Jr.
Golden Strip Career Center	Tom M. McKinney
Greenville Technical College	Ralph Johnston

The cooperation of the instructor participants and others representing The School District of Greenville County, Greenville Technical College, the South Carolina State Department of Education, and the South Carolina State Board for Technical and Comprehensive Education is appreciated.

Typist. . . . . Teresa Everett, Program Secretary

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BIAS STATEMENT

Articulated, performance-based instruction guides are developed based upon tasks (objectives) important to the success of entry level workers. The objectives are derived from task analysis and available tasks lists such as V-TEC Catalogs. Standards of performance are those expected by local businesses and industries for job success. Test samples are included to represent valid and reliable measures of vocational competency.

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Wm. Edward Henderson Jr., Coordinator
Occupational Education Articulation Program
The School District of Greenville County
and Greenville Technical College
1983

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AIR CONDITIONING, REFRIGERATION, AND HEATING

SECOND YEAR

(Secondary Level)

The units and task of this section of the Articulated, Performanced-based Instruction Guide for Air Conditioning, Refrigeration, and Heating are designed for the second year of a two-year secondary level, vocational education program. There, however, is mutual agreement among instructor participants of the Task Force Commiittee for Air Conditioning, Refrigeration, and Heating that there typcially will be some overlap between the first year and the second yaar of training.

The secondary instructors may elect to introduce tasks described in this second year section during the initial year of training or may delay skill development training described in the first year section until the student's second year in the vocational program.

First year training includes basic theory, fundamentals, and skills. During the second year, new topics, such as heating, are introduced. The second year program, however, builds on the basic theory and fundamentals already mastered and is designed to develop employable skills in installation, servicing, and troubleshooting HVAC systems.

There is a limit to what may be taught during the time allocated for the Air Conditioning, Refrigeration, and Heating program. Students serious about a career in HVAC work should consider continuing their career development at Greenville Technical College.

UNITS 18.0, 19.0, 20.0, and 21.0

AIR CONDITIONING CALCULATIONS

The following units may be considered and studied as a module of related fundamentals and skills:

Unit 18.0 - Psychrometrics
Unit 19.0 - Residential Heat Loss and Heat Gain
Unit 20.0 - Duct Design and Sizing
Unit 21.0 - Air Treatment

These related units of training are designed for introductory level training since the secondary level graduate is being prepared for entry-level employment primarily as an installer, service mechanic, or maintenance mechanic trainee.

BASIC AIR CONDITIONING FORMULAS

TO DETERMINE	EXPRESSED AS	COOLING	HEATING and/or HUMIDIFYING
Total Airflow	CFM_T	1. $CFM_T = \frac{N_T V}{60 \text{ min/hr}}$	1. $CFM_T = \frac{N_T V}{60 \text{ min/hr}}$
Infiltration or Ventilation	CFM_o	2. $CFM_o = \frac{N_o V}{60 \text{ min/hr}}$	2. $CFM_o = \frac{N_o V}{60 \text{ min/hr}}$
Number of Air Changes Per Hr. – Total	N_T	3. $N_T = \frac{CFM_T (60 \text{ min/hr})}{V}$	3. $N_T = \frac{CFM_T (60 \text{ min/hr})}{V}$
Number of Air Changes Per Hr. – Outdoor Air	N_o	4. $N_o = \frac{CFM_o (60 \text{ min/hr})}{V}$	4. $N_o = \frac{CFM_o (60 \text{ min/hr})}{V}$
Total Heat (H_T)	Btuh	5. $H_T = CFM_T \times 4.5 \times (h_1 - h_2) = \text{Btuh}$	6. $H_T = CFM_T \times 4.5 \times (h_2 - h_1) = \text{Btuh}$
Sensible Heat (H_S)	Btuh	7. $H_S = CFM_T \times 1.08 \times (T_1 - T_2) = \text{Btuh}$	8. $H_S = CFM_T \times 1.08 \times (T_2 - T_1) = \text{Btuh}$
Latent Heat (H_L)	Btuh	9. $H_L = CFM_T \times .68 \times (W_1 - W_2) = \text{Btuh}$	10. $H_L = CFM_T \times .68 \times (W_2 - W_1) = \text{Btuh}$
Entering Air Temperature (T_1) (Mixed Air)	°F.D.B.	11. $T_1 = t_1 + \frac{CFM_o}{CFM_T} \times (t_2 - t_1) = °F.\ D.B.$ ① ① If duct heat gain is a factor, add to T_1: $\frac{\text{Duct Heat Gain (Btuh)}}{CFM_T \times 1.08}$	12. $T_1 = t_1 - \frac{CFM_o}{CFM_T} \times (t_1 - t_2) = °F.\ D.B.$ ① ① If duct heat loss is a factor, subtract from T_1: $\frac{\text{Duct Heat Loss (Btuh)}}{CFM_T \times 1.08}$
Leaving Air D.B. Temperature (T_2)	°F.D.B.	13. $T_2 = T_1 - \frac{H_S}{CFM_T \times 1.08} = °F.\ D.B.$	14. $T_2 = T_1 + \frac{H_S}{CFM_T \times 1.08} = °F.\ D.B.$
Required Airflow	CFM_T	15. $CFM_T = \frac{H_S \text{ (total)}}{1.08 \times (T_1 - T_2)} = \text{CFM}$ OR $CFM_T = \frac{H_S \text{ (internal)}①}{1.08 \times (t_1 - T_2)} = \text{CFM}$ ① Sensible load of outside air not included	16. $CFM_T = \frac{H_S}{1.08 \times (T_2 - T_1)} = \text{CFM}$
Enthalpy – Leaving Air (h_2)	Btu/lb dry air	17. $h_2 = h_1 - \frac{H_T}{CFM_T \times 4.5} = \text{Btu/lb. dry air}$	18. $h_2 = h_1 + \frac{H_T}{CFM_T \times 4.5} = \text{Btu/lb. dry air}$
Leaving Air W.B. Temperature	°F.W.B.	19. Refer to Enthalpy Table and read W.B. temperature corresponding to enthalpy of leaving air (h_2) (see # 17).	20. Refer to Enthalpy Table and read W.B. temperature corresponding to enthalpy of leaving air (h_2) (see # 18).
Heat Required to evaporate water vapor added to ventilation air	Btuh	21. $H_L = CFM_o \times .68 (W_3 - W_o) = \text{Btuh}$	22. $H_L = CFM_o \times .68 (W_3 - W_o) = \text{Btuh}$
Humidification Requirement	Lbs. water/hr	23. $\left(\begin{array}{c}\text{Make up}\\ \text{Moisture}\end{array}\right) = \frac{\text{Excess Latent Capacity of System} \times \text{\% Run Time}}{1060 \text{ Btu/lb.}} = \text{Lbs./hr.}$ (Industrial Process Work)	24. $\left(\begin{array}{c}\text{Make up}\\ \text{Moisture}\end{array}\right) = \frac{H_L \text{ loss Btuh (see \# 22)}}{1060 \text{ Btu/lb.}} = \text{Lbs./hr.}$

LEGEND

CFM_T	=	Total airflow cubic feet/min	
CFM_o	=	Outdoor air cubic feet/min	
N_T	=	Total air changes per hour	
N_o	=	Outdoor air air changes per hour	
V	=	Volume of space cubic feet	
H_T	=	Total heat Btuh	
H_S	=	Sensible heat Btuh	
H_L	=	Latent heat Btuh	
* h_1	=	Enthalpy or total heat of entering air Btu/lb	
* h_2	=	Enthalpy or total heat of leaving air	Btu/lb
T_1	=	Temperature of entering air	
T_2	=	Temperature of leaving air	
T_{adp}	=	Apparatus dewpoint	°F D.B.
t_1	=	Indoor design temperature	°F D.B.
t_2	=	Outdoor design temperature	°F D.B.
W_1	=	Grains of water/lb of dry air @ entering condition	Grains/lb
W_2	=	Grains of water/lb of dry air @ leaving condition	Grains/lb
W_3	=	Grains of water/lb of dry air @ indoor design conditions	Grains/lb
W_o	=	Grains of water/lb of dry air at outdoor design conditions	Grains/lb

DERIVATION OF AIR CONSTANTS

The air constants below apply specifically to standard air which is defined as dry air at 70°F. and 14.7 P.S.I.A. (29.92 in. mercury column.) They can, however, be used in most cooling calculations unless extremely precise results are desired.

4.5 (To convert CFM to Lbs./hour)

$$4.5 = \frac{60 \text{ Min/hr}}{13.33} \text{ or } 60 \times .075$$

Where 13.33 is the specific volume of standard air (cu.ft./lb.) and .075 is the density (lbs./cu.ft.).

$$1.08 = \frac{.24 \times 60}{13.33} \text{ or } .24 \times 4.5$$

.24 BTU = specific heat of standard air (BTU/LB.°F)

$$.68 = \frac{60}{13.33} \times \frac{1060}{7000} \text{ or } 4.5 \times \frac{1060}{7000}$$

Where: 1060 = Average Latent Heat of water vapor. (BTU/LB)

7000 = Grains per lb.

* See Enthalpy of air (Total Heat Content of Air) Table for exact values.

MINIMUM SUGGESTED TERMINOLOGY

Psychrometrics	Science of measuring and changing the properties of air. *The study of the physical and thermodymanic properties of the atmosphere.
Dry-bulb Temperature	Air temperature as measured by an ordinary thermometer.
Wet-bulb Temperature	Air temperature measured by a thermometer whose bulb is covered by a wet cloth or wet wick and is moved (slung) in air that has a velocity of 1000 Ft./min.
Relative Humidity	Percentage of moisture in the air compared to the total amount of moisture the air could hold at the same temperature and barometric pressure.
Dew Point	Temperature at which moisture condenses as liquid on a surface.
Latent Heat	Addition of heat in a situation where moisture content increases but air temperature does not change.
Latent Cooling	Removal of heat in a situation where moisture content decreases but air temperature does not change.
Sensible Heat	Addition of heat in an environment where air temperature increased but moisture content does not change.
Sensible Cooling	Removal of heat in a situation where air tempeature decreases but moisture content does not change.
Sensible Heat Factor	Relationship of sensible heat to total heat.
Enthalpy	Heat in air as measured in BTU's/Pound of dry air.

* Second definition for Psychrometrics

HVAC
AIR CONDITIONING CALCULATIONS
SUGGESTED INSTRUCTION TIMES

HVAC UNIT/TASK		SUGGESTED HOURS
Unit 18.0	PSYCHROMETICS	
18.01	Determine Dew-Point Temperature of Air	*
18.02	Determine Relative Humidity of a Conditioned Space	*
18.03	Determine Relative Humidity from Dry-Bulb and Wet-Bulb Temperatures	*
18.04	Determine Dew-Point from Dry-Bulb and Wet-Bulb Temperatures	*
18.05	Determine How Outside Air Should be Conditioned: Heating	*
18.06	Determine How Outside Air Should be Conditioned: Cooling	*
Unit 19.0	RESIDENTIAL HEAT LOSS AND HEAT GAIN	
19.01	Compute Heat Loss and Heat Gain of a Residence	*
19.02	Calculate Comfort Cooling Heat Load for Assigned Space	*
19.03	Select Heating and Cooling Equipment for a Residence	*
Unit 20.0	DUCT DESIGN AND SIZING	
20.01	Design Duct Systems for a Structure	*
20.02	Select Registers and Grilles for Heating and Cooling Systems	*
20.03	Measure Air Flow Through Duct System	*
20.04	Measure Air Velocity in Duct Using Anemometer	*

*-Unit times not broken down at this time

	20.05	Measure Air Velocity and Air Flow Pattern in Open Room Using Smoke Draft Indicator	*
	20.06	Duct Design and Sizing Balance System	*
Unit 21.0		AIR TREATMENT	
	21.01	Indentify Common Residential Air Treatment Techniques	*
	21.02	Install Humidifier with Low Voltage Controls	*
	21.03	Install Power Humidifier in Duct System	*
	21.04	Install an Electronic Filter	*
	21.05	Charge a Dehumidifier	*
	21.06	Wire Compressor and Fan Motor	*
		TOTAL HOURS	105

* Unit times not broken down at this time

UNIT 18.0

PSYCHROMETRICS

This unit on psychrometrics is concerned with introducing the secondary student to the basic information on the psychrometric chart, dry-bulb temperature readings, dew point temperature readings, relative humidity readings, basic psychrometric processes, air conditioning processes shown on the psychrometric chart, determining relative humidity, determining dew point, determining how outside air should be conditioned in winter heating, and determining how outside air should be conditioned in summer cooling. The secondary graduate should be prepared to determine the relative humidity of a conditioned space, determine the relative humidity of an outdoor space, and determine the wet-bulb temperature of air outside a duct.

HVAC
PSYCHROMETRICS
SUGGESTED INSTRUCTION TIME

HVAC Unit/Task		SUGGESTED HOURS
18.0	PSYCHROMETRICS	
18.01	Determine Dew-Point Temperature of Air	*
18.02	Determine Relative Humidity of a Conditioned Space	*
18.03	Determine Relative Humidity from Dry-Bulb and Wet-Bulb Temperatures	*
18.04	Determine Dew-Point from Dry-Bulb and Wet-Bulb Temperatures	*
18.05	Determine How Outside Air Should be Conditioned: Heating	*
18.06	Determine How Outside Air Should be Conditioned: Cooling	*

* Times not broken down into individual units.

HVAC
TASK LISTINGS

UNIT/TASK	DESCRIPTION
Unit 18.0	PSYCHROMETRICS
18.01	(DETERMINE DEW-POINT TEMPERATURE OF AIR) Given thermometers, bottle ether, air aspirator, metal container, and other equipment, tools, and materials needed; observe proper method of determining the dew-point temperature of air within +/-1 degree F.
18.02	(DETERMINE RELATIVE HUMIDITY OF A CONDITIONED SPACE) Given the sling psychrometer, psychrometric chart, a cotton wick or equivalent, distilled water or equivalent, and a conditioned space selected by the instructor; determine the relative humidity of the conditioned space.
18.03	(DETERMINE RELATIVE HUMIDITY FROM DRY-BULB AND WET-BULB TEMPERATURES) Given the dry-bulb temperature of 72 degrees F and the wet-bulb temperature of 54 degrees F and a psychrometric chart; determine the relative humidity.
18.04	(DETERMINE DEW-POINT FROM DRY-BULB AND WET-BULB TEMPERATURES) Given a dry-bulb temperature of 75 degrees F and a wet-bulb temperature of 60 degrees and the psychrometric chart; determine the dew-point.
18.05	(DETERMINE HOW OUTSIDE AIR SHOULD BE CONDITIONED: HEATING) Given a winter heating situation where the outdoor dry-bulb temperature is 35 degrees F and the outdoor relative humidity is 25 percent and the indooor comfort conditions are with in the range of 30-35 degrees relative humidity and a temperature range of 72-75 degrees F; determine how the outside air should be conditioned to provide comfortable humidity and temperature combinations for the winter heating situation.
18.06	(DETERMINE HOW OUTSIDE AIR SHOULD BE CONDITIONED: COOLING) Given a summer air conditioning (cooling) situation where the outdoor dry-bulb temperature is 90 degrees F and the outdoor relative humidity is 70 percent and the indoor comfort conditions are within the range of 45-50 percent relative humidity and a temperature range of 75-78 degrees F; determine how the outside air should be conditioned to provide a comfortable humidity and temperature combination in summer cooling.

UNIT 18.0 | PSYCHROMETRICS

TASK 18.01 (OPTIONAL) | DETERMINE DEW-POINT TEMPERATURE OF AIR

PERFORMANCE OBJECTIVE:

Given thermometers, bottle ether, air aspirator, metal container, and other equipment, tools, and materials needed; observe proper method of determining the dew-point temperature of air within +/- 1 degree F.

PERFORMANCE ACTIONS:

18.0101 Place ether in bright metal container.*

18.0102 Stir ether with air aspirator.

18.0103 Place thermometer in fluid.

18.0104 Note temperature at which a mist or fog appears on outside of metal container.

18.0105 Record this dew-point reading.

*NOTE: Use extreme caution since ether is extremely flammable.

PERFORMANCE STANDARDS:

- Observe how to determine the dew-point temperature of air to within +/-1 degrees F.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

EXPANDED OBJECTIVE (PERFORMANCE TASK): Determine Dew-Point when only dry-bulb and wet-bulb temperatures are known by plotting the correct lines to determine dew point on the psychrometric chart.

a. Draw vertical line up chart from where dry-bulb temperature reads 75 degrees F.
b. Draw diagonal line down chart from point where wet-bulb temperature reads 60 degrees F until it intersects line drawn in step a.
c. From point where two lines intersect, draw horizontal line to left of chart.
d. Where line drawn in step c. intersects dew point scale, note reading __________.

DETERMINE DEW-POINT

WORKSHEET

	INDOOR						OUTDOOR					
	1	2	3	4	5	AV	1	2	3	4	5	AV
dry bulb												
dew point												

DETERMINE HUMIDITY

WORKSHEET

INDOOR		1	2	3	4	5	FINAL	rh	dp	th	vp	Sp. Vol.	Grains/lb. dry air
Sling	db.												
Psychrom.	wb.												
Wall	db.												
Psychrom.	wb.												
OUTDOOR													
Sling	db.												
Psychrom.	wb.												
Wall	db.												
Psychrom.	wb.												

UNIT 18.0 PSYCHROMETRICS

TASK 18.02 (DEMONSTRATION) DETERMINE RELATIVE HUMIDITY OF A CONDITIONED SPACE

PERFORMANCE OBJECTIVE:

Given the sling psychrometer, psychrometric chart, a cotton wick or equivalent, distilled water or equivalent, and a conditioned space selected by the instructor; determine the relative humidity of the conditioned space.

PERFORMANCE ACTIONS:

18.0201 Assemble tools, materials, and references.

18.0202 Saturate the wick thoroughly with distilled water.

18.0203 Whirl the psychrometer rapidly in the air for about 30 seconds and take a reading.*

18.0204 Whirl the psychrometer rapidly in the air for about 15-30 seconds more and take a final reading.*

* Follow manufacturer's instructions if available.

18.0205 Enter dry-bulb and wet-bulb readings on a psychrometric chart.

18.0206 Record the relative humidity of the conditioned space.

18.0207 Check accuracy of reading.

18.0208 Return psychrometer to storage.

PERFORMANCE STANDARDS:

-Determine relative humidity of a conditioned space.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe proper use of psychrometer
-Explain how to read the psychrometric chart
-Describe the procedures to determine relative humidity using the psychrometer
-Describe the care and storage of the psychrometer

JOB: MEASURE RELATIVE HUMIDITY

Tools, Materials and Equipment:

1. Sling Psychrometer
2. Psychrometric chart
3. Pencil
4. Paper

Procedure:

1. Obtain tools and equipment.

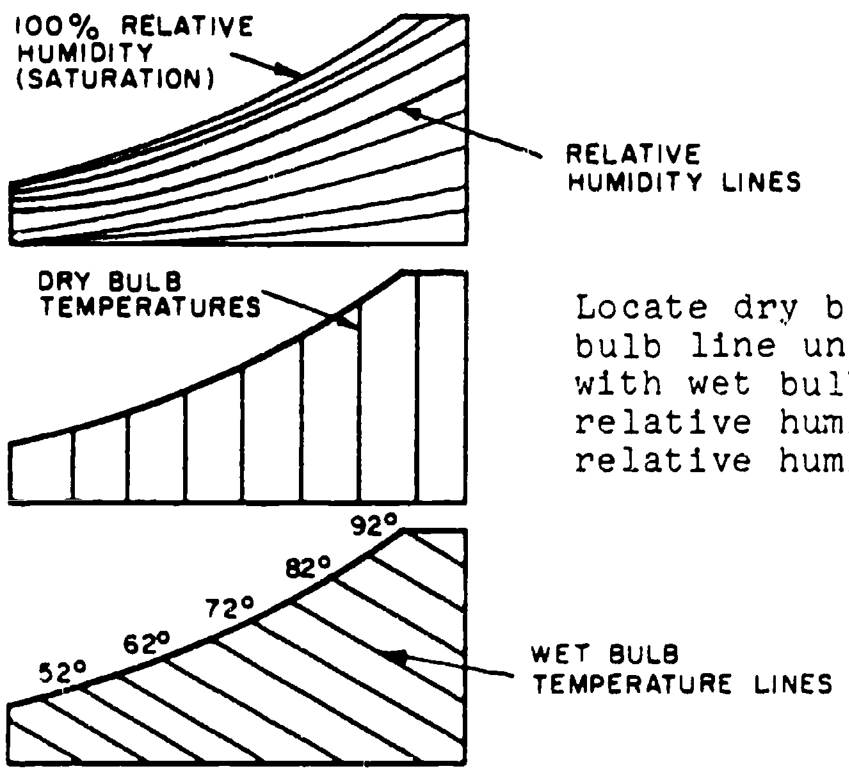
2. Wet the wick with water.

3. Sling the sling psychrometer chest high several times.

4. Record readings.

5. Plot readings on psychrometric chart.

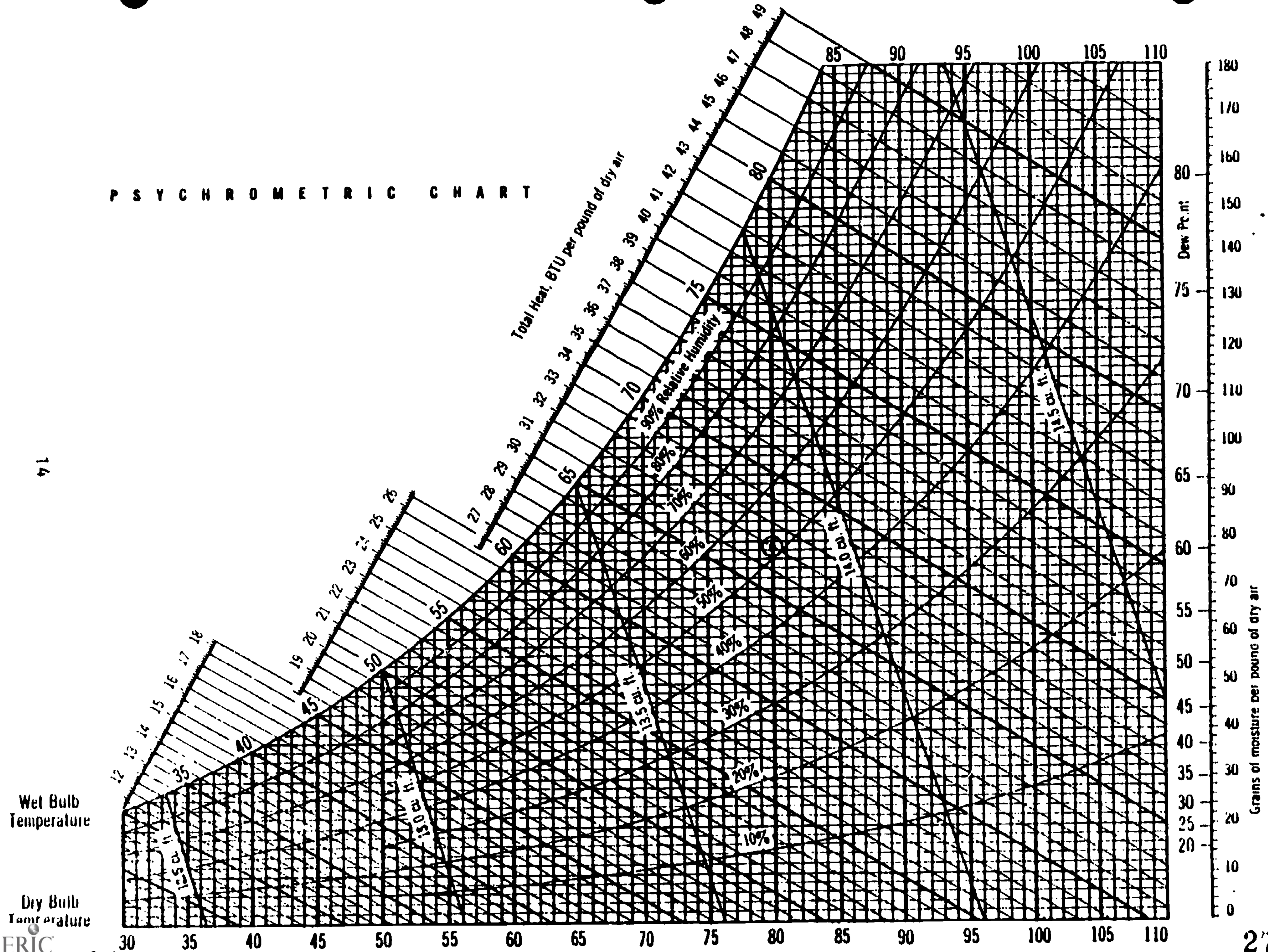
6. Determine relative humidity.



Locate dry bulb, go up dry bulb line until it intersects with wet bulb line. Read relative humidity from relative humidity curve.

PSYCHROMETRIC CHART

14



ADDENDUM TO TASK 18.02

UNIT 18.0 PSYCHROMETRICS

TASK 18.03 DETERMINE RELATIVE HUMIDITY FROM DRY-BULB AND WET-BULB TEMPERATURES

PERFORMANCE OBJECTIVE:

Given the dry-bulb temperature of 72 degrees F and the wet-bulb temperature of 54 degrees F and a psychrometric chart; determine the relative humidity.

PERFORMANCE ACTIONS:

18.0301 Assemble psychrometric chart.

18.0302 Draw verticle line up chart from point on dry-bulb temperature scale that reads 72 degrees F.

18.0303 Draw diagonal line down chart from point on wet-bulb temperature scale that reads 54 degrees F until it intersects the dry-bulb tempeature line.

18.0304 The point where the lines of dry-bulb and wet-bulb temperatures intersect, give a percent reading of relative humidity.

PERFORMANCE STANDARDS:

- Determine the relative humidity from the dry-bulb and wet-bulb temperature using the psychrometric chart. Performance must be to the instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 18.0 PSYCHROMETRICS

TASK 18.04 DETERMINE DEW-POINT FROM DRY-BULB AND WET-BULB TEMPERATURES

PERFORMANCE OBJECTIVE:

Given a dry-bulb temperature of 75 degrees F and a wet-bulb temperature of 60 degrees F and the psychrometric chart, determine the dew point.

PERFORMANCE ACTIONS:

18.0401 Assemble psychrometric chart.

18.0402 Draw vertical line up chart from where dry-bulb temperature reads 75 degrees F.

18.0403 Draw diagonal line down chart from where wet-bulb temperature reads 60 degrees F. until it intersects line drawn in above step.

18.0404 From point where the two lines intersect, draw a horizontal line to left of chart.

18.0405 The last line drawn will intersect the dew-point scale and provide a reading.

PERFORMANCE STANDARDS:

-Determine dew-point from dry-bulb and wet-bulb temperatures using the psychrometric chart. Performance must meet the instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 18.0 PSYCHROMETRICS

TASK 18.05 DETERMINE HOW OUTSIDE AIR SHOULD BE CONDITIONED: HEATING

PERFORMANCE OBJECTIVE:

Given a winter heating situation where the outdoor dry-bulb temperature is 35 degrees F and the outdoor relative humidity is 25 percent and the indoor comfort conditions are within the range of 30-35 degrees relative humidity and a temperature range of 72-75 degrees F, determine how the outside air should conditioned to provide comfortable humidity and temperature combinations for the winter heating situation.

PERFORMANCE ACTIONS:

18.0501 Assemble the psychrometric chart.

18.0502 Mark the chart where the 35 degree F dry-bulb temperature and relative humidity of 25 percent intersects.

18.0503 Place a mark where the 75 degree F dry-bulb temperature and relative humidity of 35 percent intersect.

18.0504 Draw a line between the marks made above.

18.0505 Calculate:
a. As RH increases/decreases moisture must be added or removed from the air.
b. As dry-bulb temperature increases/decreases heat must be added or removed from the air.

PERFORMANCE STANDARDS:

-Determine how outside air should be conditioned for a given heating situation.
-Performance must be to the instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Use of the psychrometic chart
-Determine "latent heat"
-Determine "sensible heat"

UNIT 18.0 PSYCHROMETRICS

TASK 18.06 DETERMINE HOW OUTSIDE AIR SHOULD BE CONDITIONED: COOLING

PERFORMANCE OBJECTIVE:

Given a summer air conditioning (cooling) situation where the outdoor dry-bulb temperature is 90 degrees F and the outside relative humidity is 70 percent and the indoor comfort conditions are within the range of 45-50 percent relative humidity and a temperature range of 75-78 degrees F, determine how the outside air should be conditioned to provide a comfortable humidity and temperature combination in summer cooling.

PERFORMANCE ACTIONS:

18.0601 Assemble psychrometric chart.

18.0602 Mark the chart where the 90 degrees F dry-bulb temperature and a relative humidity of 70 percent intersect.

18.0603 Place a mark where the 78 degrees F dry-bulb temperature and a relative humidity of 50 percent intersect.

18.0604 Draw a line between the marks.

18.0605 Calculate:
a. As relative humidity increases/ decreases, moisture must be added to or removed from the air.
b. As the dry-bulb temperature increases/ decreases, heat must be added to or removed from the air..

PERFORMANCE STANDARDS:

-Determine how outside air should be conditioned for a given cooling situation.
-Performance must be to the instructor's standards.

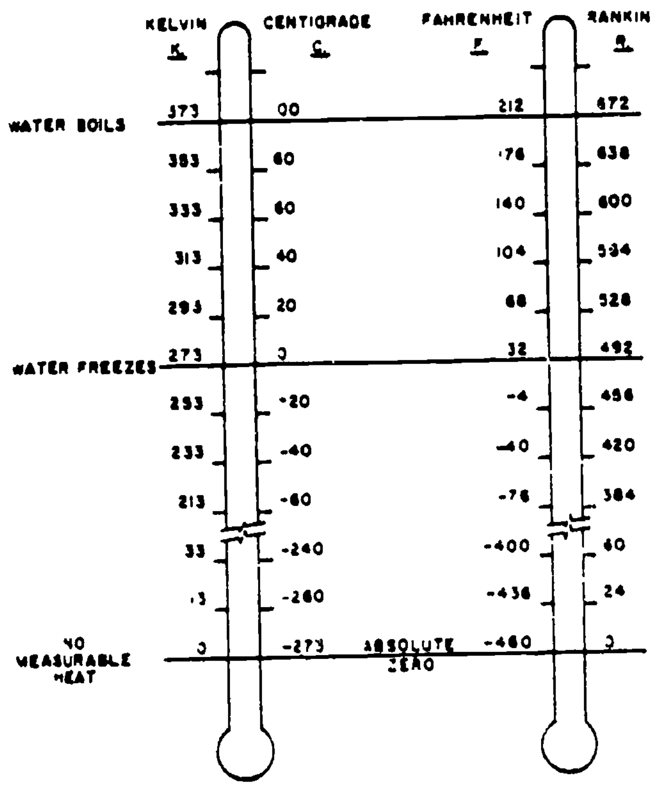
SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Use of the psychrometric chart.
-Determine "latent heat"
-Determine "sensible heat"

WIND CHILL FACTOR			AMBIENT TEMPERATURE												
		F	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25
		C	2	-1	-4	-7	-9	-12	-15	-18	-21	-23	-26	-29	-32
WIND SPEED	5 MPH	F	33	27	21	16	12	7	1	-6	-11	-15	-20	-26	-31
		C	1	-3	-6	-9	-11	-14	-17	-21	-24	-26	-29	-32	-35
	10 MPH	F	21	16	9	2	-2	-9	-15	-22	-27	-31	-38	-45	-52
		C	-6	-9	-13	-17	-19	-23	-26	-30	-33	-35	-39	-43	-47
	15 MPH	F	16	11	1	-6	-11	-18	-25	-33	-40	-45	-51	-60	-65
		C	-9	-12	-17	-21	-24	-28	-32	-36	-40	-43	-46	-51	-54
	20 MPH	F	12	3	-4	-9	-17	-24	-32	-40	-46	-52	-60	-68	-76
		C	-11	-16	-20	-23	-27	-31	-36	-40	-43	-47	-51	-56	-60
	25 MPH	F	7	0	-7	-15	-22	-29	-37	-45	-52	-58	-67	-75	-83
		C	-14	-18	-22	-26	-30	-34	-38	-43	-47	-50	-55	-59	-64
	30 MPH	F	5	-2	-11	-18	-26	-33	-41	-49	-56	-63	-70	-78	-87
		C	-15	-19	-24	-28	-32	-36	-41	-45	-49	-53	-57	-61	-66
	35 MPH	F	3	-4	-13	-20	-27	-35	-43	-52	-60	-67	-72	-83	-90
		C	-16	-20	-25	-29	-33	-37	-42	-47	-51	-55	-58	-64	-56
	40 MPH	F	1	-4	-15	-22	-29	-36	-45	-54	-62	-69	-76	-87	-94
		C	-17	-20	-26	-30	-34	-38	-43	-48	-52	-56	-60	-66	-70
	45 MPH	F	1	-6	-17	-24	-31	-38	-46	-54	-63	-70	-78	-87	-94
		C	-17	-21	-27	-31	-35	-39	-43	-48	-53	-57	-61	-66	-70
	50 MPH	F	0	-7	-17	-24	-31	-38	-47	-56	-63	-70	-79	-88	-96
		C	-18	-22	-27	-31	-35	-39	-44	-49	-53	-57	-62	-67	-71

F—FAHRENHEIT C—CENTIGRADE



CONVERSIONS

KELVIN	CENTIGRADE	FAHRENHEIT	RANKIN
K to C—K-273	C to F—C×1.8+32	F to R—F+460	R to K—R÷1.8
K to F—K×1.8-460	C to R—C×1.8+492	F to K—F+460÷1.8	R to C—R÷1.8-273
K to R—K×1.8	C to K—C+273	F to C—F-32÷1.8	R to F—R-460

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UNIT 19.0

RESIDENTIAL HEAT LOSS AND HEAT GAIN

Residential heat loss and heat gain is concerned with the standard procedures in the load calculations, the factors in determining heat loss and heat gain, calculating heat transfer multipliers, factors in sizing heating equipment, factors in sizing cooling equipment, ways structural modifications can effect equipment selections, estimating heat loss, calculating shaded and unshaded glass areas, estimating heat gain, and evaluating the effects of insulation.

MINIMUM SUGGESTED TERMINOLOGY

BTU (Btu)	A British thermal unit (Btu) is the amount of heat required to raise the temperature of one pound of water one degree F.
BTUH(Btuh)	British thermal units per hour (Btuh) express hourly heat flow.
Heat Transfer	Movement of heat from one standard of region to another.
HMT	The Heat Transfer Multiplier is an index of heat transfer through one square foot of a structural component at specific design conditions.
R-value	Rating given to material's ability to resist heat transfer.
U-value	One divided by the total R-value of a component.
Gross Exposed Walls	Total square footage, including doors and windows, of walls exposed to outside.
Net Exposed Walls	Total square footage, excluding doors and windows, of walls exposed to outside.
Exposed Partition	Wall separating a conditioned space from an unconditioned space.
Internal Heat Gain	Sensible heat gain produced by people and appliances.
Duct Loss and Duct Gain	Heating and Cooling that is lost or gained because of air leakage and heat transfer in ducts.
Ventilation	Controlled air brought into a structure.
Infiltration	Uncontrolled air that leaks into a structure.
CFM (Cfm)	Cubic feet per minute.
Ton of Refrigeration	Refrigeration equal to 12,000 Btuh.

HAVC
RESIDENTIAL HEAT LOSS AND HEAT GAIN
SUGGESTED INSTRUCTION TIME

HVAC Unit/Task		SUGGESTED Hours
19.0	RESIDENTIAL HEAT LOSS AND HEAT GAIN	
19.01	Compute Heat Loss and Heat Gain of a Residence	*
19.02	Calculate Comfort Cooling Heat Load for Assigned Space	*
19.03	Select Heating and Cooling Equipment for a Residence	*

*Times not broken down into individual units.

UNIT/TASK	DESCRIPTION
Unit 19.0	RESIDENTIAL HEAT LOSS AND HEAT GAIN
19.01	(COMPUTE HEAT LOSS AND HEAT GAIN OF A RESIDENCE) Given a blueprint of a residence and the necessary heat gain-loss factor charts; compute the heat gain and loss. The calculations must be acceptable to the instructor.
19.02	(CALCULATE COMFORT COOLING HEAT LOAD FOR ASSIGNED SPACE) Given an assigned space and handouts determine the correct heat load.
19.03	(SELECT HEATING AND COOLING EQUIPMENT FOR A FOR A RESIDENCE) Given a blueprint of a structure with the heating and cooling loads calculated; select the heating and cooling equipment for the building. The equipment will supply heating and cooling for the structure and will not vary more than 20 percent from calculated value. The equipment will conform to the space provided in the blueprint.

UNIT 19.0 — RESIDENTIAL HEAT LOSS AND HEAT GAIN

TASK 19.01 — COMPUTE HEAT LOSS AND HEAT GAIN OF A RESIDENCE

PERFORMANCE OBJECTIVE:

Given a blueprint of a residence and the necessary heat gain-loss factor charts; compute the heat gain and loss. The calculations must be acceptable to the instructor.

PERFORMANCE ACTIONS:

19.0101 Determine size of structure and insulating qualities of its components from given floor plans or other information.

19.0102 Determine outside temperature (For calculating heat loss).

19.0103 Determine daily temperature range for heat gain.

19.0104 Determine inside design temperature.

19.0105 Identify design temperature difference for heat loss.

19.0106 Determine HMT heating or HMT cooling.

PERFORMANCE STANDARDS:

-Compute heat loss and heat gain of a residence to within a predetermined value. Calculations must be acceptable to the instructor.

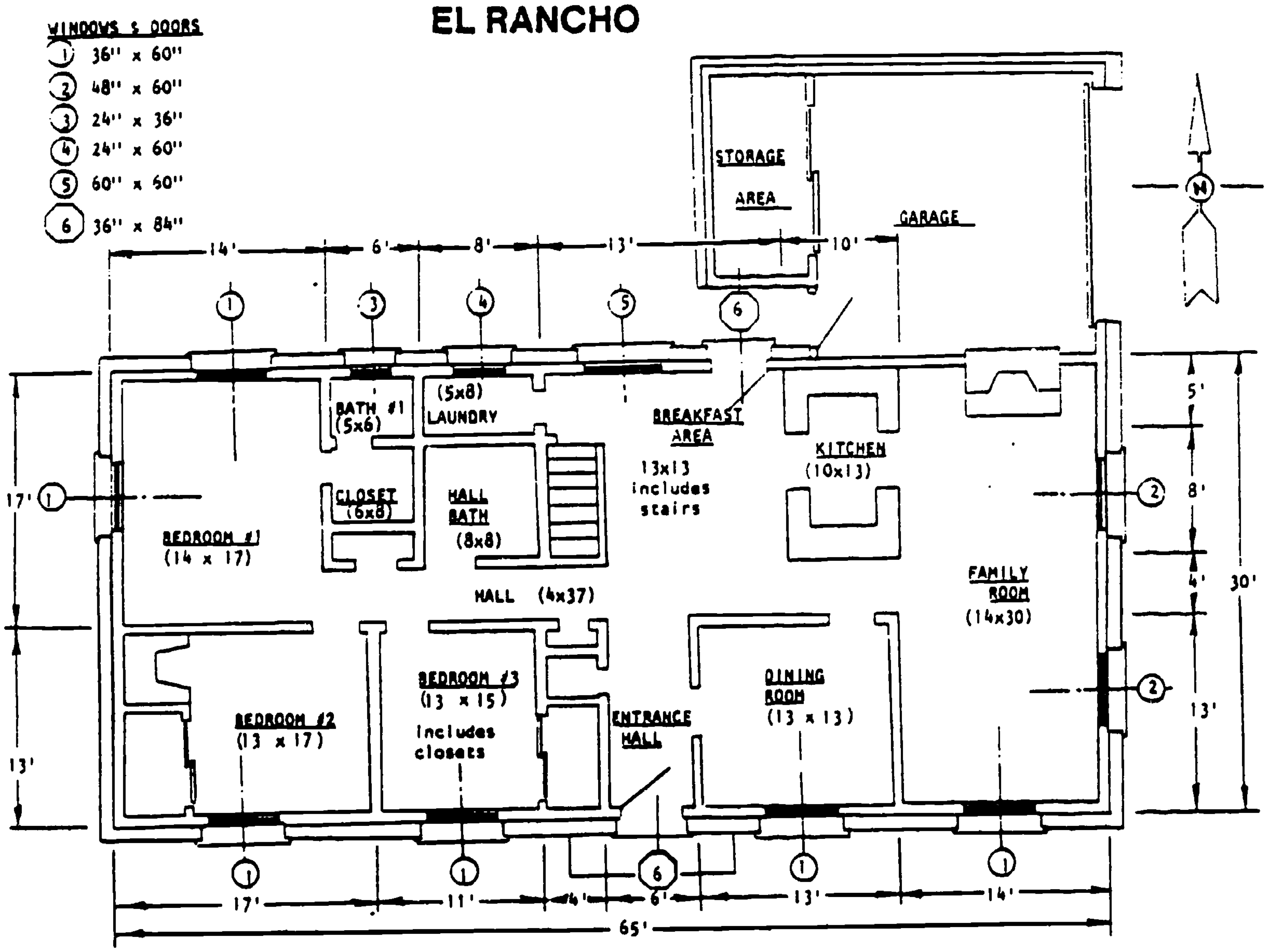
SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Define heat loss and heat gain
-Explain how to use heat gain-heat loss factor charts
-Demonstrate/describe how to calculate square footage of a floor, wall, and ceiling
-Identify various types of building materials
-Explain how to compute heat gain and loss
-Determine R-value of construction component
-Determine U-value of construction component
-Determine HMT for heating by multiplying U-value by design temperature difference (round off HMT)
-Determine HMT for cooling by multiplying U-value by equivalent temperature difference value (round off)

HOUSE PLAN AND SPECIFICATIONS

EL RANCHO



CUSTOMER:

LOCATION:

DESIGN CONDITIONS:

	WINTER	SUMMER
INDOOR	70°	75°
OUTDOOR	20°	95°

35° North Latitude
MEDIUM Daily Range

ORIENTATION: Front of house faces South.

WINDOWS: Double Hung, clear single pane glass with storm windows.
Shading by drapes.
Certification test rating: Infiltration less than .75 CFM per foot of crack.

DOORS: Solid Wood.
Weatherstripped.
Storm doors.

WALLS: Wood framing with R 13 batts.
Sheathing with 3/4" polystyrene (extruded).
Brick veneer.

CEILING: 10" mineral wool insulation (R 30).
Height — 8 feet.

ROOF: Dark asphalt shingles.

FLOOR: Basement only.

CONDITIONED SPACE: First floor plus basement.

GARAGE: Unconditioned.
Common wall with kitchen and family room is finished on both sides with R 13 batts and 3/4" extruded polystyrene sheathing; same as the other frame wall.

DUCTWORK: Basement installation; no duct insulation.

AIR CONDITIONING SURVEY AND CALCULATIONS

DEALER ______ ADDRESS ______ DATE ______

CUSTOMER ______ ADDRESS ______

INST. ADDRESS ______ BUSINESS OR USE ______ ESTIMATOR ______

ROOM VOLUME: Length ______ X Width ______ X Height ______ = Cu. Ft. ______

AIR CIRCULATIONS PER HOUR = CONDITIONER/CFM ( ) / ROOM VOLUME ( ) X 60 → DRY TONS

CONDITIONED AIR, CFM ______

OUTSIDE AIR, CFM ______

HEAT LEAKAGE		Net Sq. Ft. of Surface	COOLING DUTY Multiply Sq. Ft. by	COOLING DUTY B. T. U. Per Hour	HEATING DUTY Multiply Sq. Ft. by	HEATING DUTY B. T. U. Per Hour
WALLS OR PORTIONS OF WALLS EXPOSED TO OUTSIDE	(North		4.5		21.6	
	(South—Shaded		4.5		21.6	
	(South—Unshaded		9.0		21.6	
	(East		4.5		21.6	
	(West—Shaded		4.5		21.6	
	(West—Unshaded		12.0		21.6	
WALLS OR PORTIONS OF WALLS DIRECTLY IN CONTACT WITH GROUND			0		9.6	
GLASS IN OUTSIDE WALLS			Glass Brick Walls / Glass Windows			
	(North		7.5 / 16.8		84	
South	Shaded by Buildings		7.5 / 16.8		84	
	Shaded by Awnings or Koolshade Screens		12 / 30		84	
	Shaded by Venetian Blinds or Shades		20 / 45		84	
	(East		7.5 / 16.8		84	
West	Shaded by Buildings		7.5 / 16.8		84	
	Shaded by Awnings or Koolshade Screens		15 / 40		84	
	Shaded by Venetian Blinds or Shades		38		84	
DOUBLE PLASTER PARTITIONS NEXT TO UNCONDITIONED AREAS (See table on Reverse side for other construction.)			4.2			
CEILINGS	(Under Fin. Rooms		3.6		0	
For other Factors see Table on	(Under Attic				14.4	
Reverse Side.	(Under Flat Roof				21.6	
SKYLIGHTS			100		120	
FLOOR OR	(Over Fin. Rooms		3.6		0	
PORTIONS	(Over Basement		3.0		9.6	
OF FLOOR	(Over Ground		0		0	

INTERNAL HEAT	Unit	No. of Units	Multiply No. of Units by			
OUTSIDE AIR As Infiltration and/or Air Through Conditioner	C.F.M.		16		72	
PEOPLE (Normal No. of People)	Person		220			
LIGHTS (Watts on Sunny Day)	Watt		3.4			
OTHER SOURCES OF HEAT						
1. Coffee Urns	Urn		1800			
2. Steam Tables	Lineal Foot		340			
3. Motors	Horse Power		2546			
4. Motors,	Watts		3.4			
5. Electrical Apparatus	Watts		3.4			
6. Gas Apparatus	Per Burner		1500			
7.						

Total Dry Tons = ——— / 12000 =

Total Dry B. T. U. per hour =

Total Heating B.T.U. Per Hour =

MOISTURE TONS

INTERNAL HEAT	Unit	No. of Units	Multiply No. of Units by	B. T. U. per Hour
OUTSIDE AIR As Infiltration and/or Air Through Conditioner	c.f.m.		23.5 † 12	
PEOPLE	Person		*180	
OTHER SOURCES OF MOISTURE				
1. Coffee Urns	Urn		200	
2. Steam Tables	Lineal Foot		60	
3.				
4.				

COOLING LOAD SUMMATION

Dry Tons............=

Moisture Tons........=

Total Tons...........=

Summer Conditions:

Inside 80° F.—50% R.H.

Outside 95° F.—75° F.W.B.

Winter Conditions:

70° Inside 0° Outside.

Total Moisture Tons = ——— / 12000 =

Total Moisture B.T.U. per hour =

† For factors corresponding to other wet bulbs, see reverse side.

*For Increased Activity Rates such as Shop Work, Use 180 BTU per Hour.

SKETCH ROOM ON 2ND PAGE— Show adjacent rooms, doors, windows, outside walls, etc. Indicate North by arrow.

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ENGINEERING DATA

Sketch Areas To Be Conditioned Below

	ADDITIONAL PARTITION AND ROOF FACTORS	FACTORS: Without Insulation	FACTORS: With ½ Inch Insulation	FACTORS: Special
PARTITIONS	Single Plaster Partitions	7.5		
	Metal (or Wood) and Glass Partitions	10		
ROOFS No Attic Space	Corrugated Iron on Strips	50		
	Tar Paper on 1" Wood	26	17	
	Felt Roofing on 1" Wood	22	15	
	Composition Roofing on 3" Concrete	18	12	
	Composition Roofing on 6" Concrete	12	9	
WITH PLASTER (or Wood) CEILING under Attic Space	Tar Paper Or Composition Roof on 1" Wood	18	12	
	Composition Roof on 3" Concrete	12	9	
	Composition Roof on 6" Concrete	10	7.5	
	Sprayed Roof—all wetted surface			3.0
	2" Blanket Insulation (or heavier)			6.0

Factors for Outside Air Moisture Load With Various Outside Wet Bulbs.	Outside Wet Bulb	Factors
	73	3.7
	74	7.6
	75	12
	76	13.7
	77	18.5
	78	23.5
	79	27.3
	80	31.4

CONVERSION FACTORS — HEATING

$$\text{E.D.R. (STEAM)} = \frac{\text{HEATING B.T.U.}}{240}$$

$$\text{E.D.R. (HOT WATER)} = \frac{\text{HEATING B.T.U.}}{150}$$

DATA FOR DESIGN	
Maximum summer water temperature—degrees F	
Average water pressure Lbs. per sq. in.	
Maximum summer temperature Degrees F Compressor Room	
Electric Rate ¢ per K W H	
Water Rate $ per	
If cold well—give water temp. and flow in gal-min.	

TYPE OF PRESENT HEATING SYSTEM

☐ Hot Air Furnace Gravity	☐ Hot Air Furnace with Blower
☐ One Pipe Steam	☐ Two Pipe Steam
☐ Two Pipe Vapor	☐ Two Pipe Vacuum
☐ Hot Water	☐ Forced Hot Water
☐ Central Fan and Heating Coil	☐ Unit Heaters

Steam Operating Pressure Lbs. Sq. In.

Hot Water Operating Temperature, Deg. F.

Direction of Prevailing Wind

Current Characteristics (Power Co.) ------

------ Volts, ------ Cycle, ------ Phase

Water Supply and Drains by----------

Length: Supply --------Drain--------

Steam Lines Furnished by-----------

Length: Supply-------- Return--------

Wiring Furnished by--------------

Foundation Furnished by-------------

UNIT 19.0 RESIDENTIAL HEAT LOSS AND HEAT GAIN

TASK 19.02 CALCULATE COMFORT COOLING HEAT LOAD FOR ASSIGNED SPACE

PERFORMANCE OBJECTIVE:

Given an assigned space and handouts determine the correct heat load.

PERFORMANCE ACTIONS:

19.0201 Study assigned space: Obtain all dimensions, noting window, wall, ceiling, and floor construction: Make floor plan on graph paper.

19.0202 Complete calculations. Total sensible load. Latent heat load varies between 30% and 34% of sensible load except in unusual situations.

PERFORMANCE STANDARDS:

-Determine correct heat load of assigned space. Performance must be to instructor's standards. Measurements, use of forms, and calculations must be accurate.

SUGGESTED INSTRUCTION TIME: Hours

1 DESIGN CONDITIONS	Dry-Bulb Temp., °F	Wet-Bulb Temp., °F	Specific Humidity, Gr./lb.
Outside (Table 1)			
Inside			
Difference			

ITEMS							HEATING LOAD Btu/Hr.
2. TRANSMISSION LOSS (Table 3)	Sq. Ft.		Factor		Dry-Bulb Temperature Difference		
Windows		X		X		=	
		X		X		=	
Walls		X		X		=	
		X		X		=	
		X		X		=	
		X		X		=	
Roof		X		X		=	
Floor		X		X		=	
Other		X		X		=	
		X		X		=	
3. VENTILATION OR INFILTRATION (Tables 6 and 7; use the larger quantity only.)	Cubic Feet Per Minute				Dry-Bulb Temperature Difference		
Sensible Load		X				X 1.08 =	
	Cubic Feet Per Minute				Specific Humidity Difference		
Humidification Load		X				X 0.67 =	
4. TOTAL HEATING LOAD, Btu/Hr.							

A heating load estimate form
(Courtesy Air-Conditioning and Refrigeration Institute)

DATA:

Use, Residence _____ Commercial _____ Type _____

No. of Permanent Residents _____ No. of Transients _____ Average Hrs. _____ Total Hrs. _____

Building Construction and U. Coefficient:

Construction, Walls _____ Windows _____ Ceiling _____

Roof _____ Interior Partitions _____ Floor _____

U. Coefficient, Walls _____ Windows _____ Ceiling _____

Roof _____ Interior Partitions _____ Floor _____

Sun Exposure, Hrs./day, East _____ South _____ West _____

Awnings, East _____ South _____ West _____

Dimensions, Exterior, Length _____ Width _____ Height _____ Area _____ Sq. Ft.

Windows, Height _____ Width _____ x No. _____ Area _____ Sq.Ft.

Total Exterior Wall Area _____ Less the Window Area _____ = _____

Total Interior Wall Area _____

Heat Load Design Conditions, Outdoor db _____ wb _____ Indoor db _____ wb _____

Walls: Area _____ x td _____ x Coeff. _____ = _____

Windows: Area _____ x td _____ x Coeff. _____ = _____

Ceiling: Area _____ x td _____ x Coeff. _____ = _____

Floor: Area _____ x td _____ x Coeff. _____ = _____

Total _____

Sun Load East Wall, Area _____ x Coeff. _____ = _____

South Wall, Area _____ x Coeff. _____ = _____

West Wall, Area _____ x Coeff. _____ = _____

Total _____

Ventilation Load, Volume _____ x Coeff. _____ = _____ Total _____

Occupancy Load, No. of People _____ x Coeff. _____ = _____ Total _____

Miscellaneous Load, Electrical _____ Watts x Coeff. _____ = _____ Total _____

Total Load: Total Load _____ + Total Load x .35 _____ =TOTAL _____

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DESIGN DATA

OUTSIDE	SUMMER	INSIDE
F	DRY BULB	F
F	WET BULB	F
F	DEW POINT	F
%	PERCENTAGE HUMIDITY	%
	TOTAL HEAT BTU PER LB. OF AIR	
	GRAINS OF MOISTURE PER LB. OF DRY AIR	
F	WINTER	F

LATITUDE .... TIME ...... AM...... PM.

WALL COLOR		ROOF COLOR		WINDOWS	
LIGHT	☐	LIGHT	☐	AWNINGS	☐
MEDIUM	☐	MEDIUM	☐	SHADES	☐
DARK	☐	DARK	☐	BARE	☐

SUMMARY OF HEAT GAINS

ITEM NO.	ITEM	SENSIBLE	LATENT
9	CONDUCTION		
17	EXCESS SOLAR		
18	DUCTS		
22	BODY		
29	EQUIPMENT		
32	INFILTRATION		
33	TOTAL SENSIBLE		X X X X X X X
34	TOTAL LATENT		←
35	TOTAL HEAT GAINS		

SENSIBLE HEAT PERCENTAGE

36 ITEM 33 / ITEM 35 X 100 = ... X 100 = %

37 DRY BULB TEMP. AIR SUPPLY = F

38 WET BULB TEMP. AIR SUPPLY = F

39 RISE IN DRY BULB TEMP. OF AIR SUPPLY ROOM D. B. – ITEM 37 = – = F.

40 TOT. AIR SUPPLY = ITEM 33 / ITEM 39 = CFM

1.1 X .... = CFM

HEAT LOAD OF VENTILATION AIR

41 NO. PEOPLE X CFM/PERSON = CFM

42 CFM O. A. X BTU/HR/CFM = BTU/HR

TOT. COOLING LOAD ON COILS & REFR. APPAR.

ITEM 35 ....

PLUS ITEM 42 ....

43 TOT. COOLING LOAD BTU/HR ....

TONNAGE EQUIVALENT OF COOLING LOAD

44 ITEM 43 / 12000 = ... / 12000 = TONS

COOLING AND HEATING LOAD ESTIMATE SHEET

DATE .... JOB NO. .... EST. BY ....

NAME ....

ADDRESS ....

CITY & STATE ....

BRANCH OFFICE ....

ROOM .... FLOOR .... SH. NO. ....

L'GTH ..... W'DTH ..... HT. ..... VOL. .... CU. FT.

CONDUCTION SENSIBLE HEAT GAINS AND LOSSES

ITEM NO.	ITEM	DIMENSIONS	AREA SQ. FT.	SUMMER U	SUMMER TD	SUMMER SEN. HT. BTU/HR.	WINTER U	WINTER TD	WINTER SEN. HT. BTU/HR
1	EXTERIOR WALL GROSS			X	X	X X X X X X	X	X	X X X X X
2	EXTERIOR GLASS								
3	EXTERIOR WALL NET								
4	PARTITIONS NET								
5	GLASS IN PARTITIONS								
6	FLOOR								
7	CEILING OR ROOF								
8	MISC.								
9	TOTAL CONDUCTION GAINS & LOSSES								

EXCESS SOLAR HEAT GAINS

ITEM NO.	ITEM					
10	WALLS FACING					
11	WALLS FACING					
12	GLASS FACING					
13	GLASS FACING					
14	ROOF					
15	SKYLIGHTS					
16	MISC.					
17	TOTAL EXCESS SOLAR HEAT GAINS					
18	DUCT GAINS					

BODY HEAT GAINS

ITEM NO.	ITEM	SENSIBLE	LATENT
19	SENSIBLE NO. PEOPLE X		
20	LATENT (QUIET) NO. PEOPLE X		
21	LATENT (ACTIVE) NO. PEOPLE X		
22	TOTAL BODY HEAT GAINS		

EQUIPMENT HEAT GAINS

ITEM NO.	ITEM	SENSIBLE	LATENT
23	ELECTRIC LIGHTS WATTS X 3.4		
24	SMALL ELECTRIC MOTORS (2 H.P. & SMALLER) H.P. X 2900		
25	LARGE ELECTRIC MOTORS (3 H.P. & LARGER) H.P. X 2080		
26	ELECTRIC EQUIPMENT WATTS X 3.4		
27	GAS EQUIPMENT NO. X		
28	MISC. NO. X		
29	TOTAL EQUIPMENT GAINS		

INFILTRATION GAINS

ITEM NO.	ITEM	SENSIBLE	LATENT
30	ROOM VOLUME CU. FT. X SEN. FACTOR		X X X X X X X X X
31	ROOM VOLUME CU. FT. X LAT. FACTOR		
32	TOTAL INFILTRATION HEAT GAINS		

ADDENDUM TO TASK 19.02

UNIT 19.0 RESIDENTIAL HEAT LOSS AND HEAT GAIN

TASK 19.03 SELECT HEATING AND COOLING EQUIPMENT FOR A RESIDENCE

PERFORMANCE OBJECTIVE:

Given a blueprint of a structure with the heating and cooling loads calculated; select the heating and cooling equipment for the building. The equipment will supply heating and cooling for the structure and will not vary more than 20 percent from calculated value. The equipment will conform to the space provided in the blueprint.

PERFORMANCE ACTIONS:

19.0301 Size heating equipment based on the following factors:
a. Structure
b. Heat loss determined from design conditions
c. Temperature rise
d. Static pressure
e. Output capacity not less than the estimated heating load or less than specified by local codes
f. Output capacity not more than 15 percent above estimated heating load or more specified by local codes
g. System design compatable with cooling load projected cooling equipment

19.0302 Size cooling equipment based on the following factors:
a. Structure
b. System design compatible with heating load and projected heating equipment
c. Heat gain determined from design conditions
d. CFM correctly related to humidity control
e. Output capacity not less than 50 percent below estimated cooling load or less than specified by local codes
f. Output capacity not more than 12 percent above the estimated cooling load or more than specified by local codes

19.0303 Consider following factors in equipment selection:
a. Insulation in walls, over ceilings, thermopane or storm windows, weatherstripping on doors and windows
b. Shading of windows by drapes, shades, awnings, etc.
c. Outside colors such as light colors and light colored roofs.
d. Structural modifications that affect heating and cooling

UNIT 19.0 RESIDENTIAL HEAT LOSS AND HEAT GAIN

TASK 19.03 SELECT HEATING AND COOLING EQUIPMENT FOR A RESIDENCE

PERFORMANCE ACTIONS (CONT'D):

19.0304 Select heating and cooling equipment:
- a. Calculate total system load
- b. Calculate heating and cooling CFM
- c. Determine appropriate type of equipment to be used
- d. Select proper sized unit for heating
- e. Select condensing unit and evaporator coil for cooling
- f. Determine location of condensing unit, heating equipment, and thermostat

PERFORMANCE STANDARDS:

-Select heating and cooling equipment for a given structure. The equipment will supply heating and cooling for the structure and will not vary more than 20 percent from calculated value. The equipment will conform to the space provided in the blueprint supplied.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Identify options in selecting equipment
-Describe/define vertical and horizontal systems
-Explain up flow and down flow designs
-Identify advantages and disadvantages of gas heating, electrical heating, heat pumps, vertical systems, horizontal systems, up flow and down flow systems

UNIT 20.0

DUCT DESIGN AND SIZING

This unit, Duct Design and Sizing, introduces secondary students to the types of supply duct systems, the factors affecting system design, major steps of air system design, factors affecting return air duct design, locating registers and grilles, the advantages and disadvantages of registers and grille location, climatic zone conditions, factors in the distribution of conditioned air, room air patterns and outlet placement and velocity, the friction loss per 100 ft. chart, and the friction chart. The secondary graduate will be prepared to help design an air distribution system from a drawing, determine pressure drop across an evaporator coil, and determine CFM delivered by a forced air system.

MINIMUM SUGGESTED TERMINOLOGY

Proprietary System	Heating or cooling equipment incorporating its own air distribution system a part of the design.
Static Pressure	Measure of resistance of ducts, grilles, filters, and other surfaces to air flow.
Plenum	Fitting into which an aid handler discharges air or from which the air handler receives return air in a duct system.
Duct	Tube or channel through which air is moved.
Boot	Duct fitting which adapts the duct to a wall stack or to a register or grille.
Take-off	Departure point from a duct to which a duct fitting is attached to branch the system.
Equivalent Length	Resistance to air flow created by structural design of a fitting and represented by the length of straight duct which would offer the same resistance.
Effective Length	Sum of measured length of straight duct plus equivalent lengths of fittings in duct.
Actual Measured Length	Physical measurement of a duct.
Damper	Device used to control volume of air passing through or out of a duct or register.
Vane	Fixed or adjustable device used to direct air flow.
Grille	Louvered opening typically used in a return air opening.
Register	Grille that has a regulating damper device for controlling amount of air flow and vanes to control air direction.
Diffuser	Register which delivers fan shaped patters of air into a room.

System Pressure	Sum of negative and postive static pressure exerted by a blower.
Convection Currents	Air currents set in motion by cooling or warming of air brought in contact with hot or cold surfaces.
Stratification of Air	Where there is little or no movement of air in a room and air lies in temperature layers.
Temperature Gradient	Temperature change from one level or starum to the next.
Cascade Effect	Transfer of large masses of air due to convection currents in a structure often cause by air rising and cooler air falling through building accesses such as stairs.
Wall Stack	Thin, retangular duct which runs vertically inside a wall.
FPM (fpm)	Measurement of velocity in Feet per minute.
Terminal Velocity	Arbitrary maximum velocity of air stream which spreads or drops into a living area. Usually considered comfortable at 35-50 fpm.
Drop	Distance air falls vertically below a high sidewall supply outlet before slowing to terminal velocity.
Primary Air	Mixture of supply air from an outlet and room air at velocities above 150 fpm.

HVAC
DUCT DESIGN AND SIZING
SUGGESTED INSTRUCTION TIME

HVAC Unit/Task		SUGGESTED HOURS
Unit 20.0	DUCT DESIGN AND SIZING	
20.01	Duct Design Systems for a Structure	*
20.02	Select Registers and Grilles for Heating and Cooling Systems	*
20.03	Measure Air Flow Through Duct System	*
20.04	Measure Air Velocity in Duct Using Anemometer	*
20.05	Measure Air Velocity and Air Flow Pattern in Open Room Using Smoke Draft Indicator	*
20.06	Balance System	*

* Times not broken down into individual units

HVAC
TASK LISTINGS

UNIT/TASK	DESCRIPTION
Unit 20.0	DUCT DESIGN AND SIZING
20.01	(DESIGN DUCT SYSTEMS FOR A STRUCTURE) Given a blueprint of a residence, duct calculation chart, and the necessary measuring tools; design a duct system for a structure that will deliver air at designed temperatures, CFM and velocity requrired for the structure described in the blueprint.
20.02	(SELECT REGISTERS AND GRILLES FOR HEATING AND COOLING SYSTEMS) Given a blueprint of a residence, select registers and grilles for heating and cooling. The system must cause air to sweep the outside walls of the structure, not restrict air flow,will be the same size as duct outlets, and are adjustable for dampering air flow.
20.03	(MEASURE AIR FLOW THROUGH DUCT SYSTEM) Given a duct system stop watch, anemometer, and other needed supplies; measure the air flow at each duct outlet. The measurement result will be within 10 percent of a predetermined actual value or the value measured by the instructor.
20.04	(MEASURE AIR VELOCITY IN DUCT USING ANEMOMETER) Given anemometer, mechanic's tools, psychrometer, stop watch, cleaning cloth, and other materials; measure the air velocity in a duct system with a fan and one inlet and one outlet.
20.05	(MEASURE AIR VELOCITY AND AIR FLOW PATTERN IN OPEN ROOM USING SMOKE DRAFT INDICATOR) Given an air conditioning duct and fan system and open room, method of generating "smoke", stop watch, steel or other measuring tape (25-50') and other supplies as needed (such as aqua ammonia, dilute hydrochloric acid, etc., as recommended by instructor); measure the air flow pattern in the given space using a smoke draft indicator.
20.06	(BALANCE SYSTEM) Adjust the size of ducts and adjust the dampers of a given system so that each room receives the correct amount of air. Rooms must maintain desired temperatures. Ducts should not be noisy. Humidity should be correct for system. No stale air should be developed.

UNIT 20.0 DUCT DESIGN AND SIZING

TASK 20.01 DESIGN DUCT SYSTEMS FOR A STRUCTURE

PERFORMANCE OBJECTIVE:

Given a blueprint of a residence, duct calculation chart, and the necessary measuring tools; design a duct system for a structure that will deliver air at designed temperatures, CFM and velocity required for the structure described in the blueprint.

PERFORMANCE ACTIONS:

20.0101 Determine appropriate location of duct work.

20.0102 Calculate number of utlet and inlet openings.

20.0103 Calculate CFM required for each outlet.

20.0104 Determine type of duct to be used and draw runs.

20.0105 Obtain equivalent length of fittings.

20.0106 Determine total effective length of ducts.

20.0107 Determine external static pressure drops per 100 ft.

20.0108 Size duct using appropriate charts.

PERFORMANCE STANDARDS:

-Design a duct system for a structure represented in a blueprint, using the duct calculation chart and the necessary measuring tools. The duct system must deliver air at designed temperatures, CFM, and velocity required for the structure described in the blueprint.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Explain the importance of duct sizing and design to the efficient operation of the system.
-Describe how undersized and oversized ducts effect overhall system performance (detrimental results).
-Describe/demonstrate how to correctly use a duct calculator if the volume and velocity of air are known.
-Identify safety considerations.

UNIT 20.0 DUCT DESIGN AND SIZING

TASK 20.02 SELECT REGISTERS AND GRILLES FOR HEATING AND COOLING SYSTEMS

PERFORMANCE OBJECTIVE:

Given a blueprint of a residence, select registers and grilles for heating and cooling. The system must cause air to sweep the outside walls of the structure, not restrict air flow, will be the same size as duct outlets, and are adjustable for dampering air flow.

PERFORMANCE ACTIONS:

20.0201 Examine floor plan to determine appropriate outlet register.

20.0202 Select appropriate registers based on correct distribution patterns.

20.0203 Select proper return air grille size.

PERFORMANCE STANDARDS:

-Select registers and grilles for heating and cooling systems. The registers and grilles must cause air to sweep the outside walls of the structure, not restruct air flow, will be the same size as duct outlets, and are adjustable for dampering air flow.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Identify/describe typical types and sizes of grills registers.
Identify the advantages and disadvantages of various types of grilles and registers.
-Describe how to locate registers and grilles: Perimeter, high inside wall, low inside wall, ceiling.
-Identify advantages and disadvantages of register and grille locations.

UNIT 20.0 DUCT DESIGN AND SIZING

TASK 20.03 MEASURE AIR FLOW THROUGH DUCT SYSTEM

PERFORMANCE OBJECTIVE:

Given a duct system stop watch, anemometer, and other needed supplies; measure the air flow at each duct outlet. The measurement result will be within 10 percent of a predetermined actual value or the value measured by the instructor.

PERFORMANCE ACTIONS: (Measure air velocity and air flow pattern at grille opening using anemometer).

20.0301 Determine grille sizes by measuring width and length.

20.0302 Start unit and measure velocities (16-20 readings per grilles are recommended)*

*Note correct positions and record correct readings.

PERFORMANCE STANDARDS:

- -Describe how to use air velocity indicators.
- -Describe how to traverse a register or grille.
- -Explain how to calculate air volume if velocity is known.
- -Describe how to measure static pressure.
- -Explain how to use an incline manometer.
- -Identify safety considerations.
- -Explain how to use the friction loss per 100 Feet Chart.
- -Explain how to use the Friction Chart.

DATA READINGS:

Fresh Air Grille	Position 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Feet-Start																				
Feet-End																				
Difference																				
Time																				
Velocity																				

Return Air Grille																				
Feet-Start																				
Feet-End																				
Difference																				
Time																				
Velocity																				

Record data for each opening using a form similar to the one above.

Duct Dimensions:	Fresh Air	Return Air
Width		
Length		
Area		
Grille Bars Area		
Effective Areas = Area - Grille Bars Area		
Volume: Eff. Area x Velocity		

Is the fresh air MORE or LESS than the return air? ____________

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HOW TO DETERMINE AIRFLOW

Method 1: Airflow (C.F.M.) can be determined with the use of service information, from the table below, which gives external static pressure and motor pulley opening verified by motor power watts.

1. Obtain external static pressure. (See instruction — Page 2)
2. Inspect motor pulley and determine number of turns open.
3. Clock watt hour meter if practical, (see Pub. No. 22-8063). The use of a volt and amp meter should not be used if possible for the power factor of the motor is not readily available. Power is a third factor which is not required.
4. Consult service information for model involved and determine C.F.M. from applicable chart.

AIRFLOW CFM ②	MOTOR PULLEY SETTINGS, TURNS OPEN ① 0		1		2		3		4		5	
	EXTERNAL STATIC PRESSURE (INCHES WATER GAUGE) ③ AND MOTOR POWER (KW) ④											
	PRESS.	PWR.	PRESS.	PWR.	PRESS.	PWR.	PRESS.	PWR.	PRESS.	PWR.	PRESS.	PWR.
3500	1.21	1.95	1.12	1.84	1.01	1.72	0.91	1.60	0.82	1.48	0.74	1.32
4000	1.21	2.10	1.11	1.98	1.00	1.86	0.90	1.73	0.81	1.60	0.72	1.46
4500	1.20	2.26	1.10	2.13	0.98	2.01	0.89	1.87	0.80	1.73	0.69	1.59
5000	1.18	2.43	1.08	2.28	0.96	2.16	0.88	2.02	0.78	1.87	0.66	1.73
5500	1.16	2.61	1.06	2.44	0.93	2.32	0.86	2.18	0.75	2.02	0.62	1.88
6000	1.13	2.79	1.03	2.61	0.90	2.48	0.83	2.35	0.72	2.18	0.58	2.03
6500	1.08	2.98	0.98	2.80	0.85	2.65	0.78	2.52	0.66	2.34	0.52	2.18
7000	1.02	3.19	0.93	3.00	0.80	2.82	0.72	2.70	0.60	2.50	0.46	2.34
7500	0.95	3.41 ④	0.85	3.21	0.73	3.02	0.65	2.88	0.53	2.67	0.38	2.50
8000	0.87	3.63 ④	0.77	3.42 ④	0.65	3.22	0.57	3.06	0.44	2.84	0.30	2.67

① Factory setting is 5 turns open.
② Water blow-off limit is 10,000 cfm.
③ With filters and wet coil.
④ Motor power limits: 3.6 KW @ 230V & 460V; 3.3 KW @ 200V.

Method 2: Airflow (C.F.M.) can be determined with the use of service information, from the table below, which gives external static pressure and blower R.P.M.

To determine blower R.P.M., a hand-held digital photo tach is required.

AIR FLOW CFM	EXTERNAL STATIC PRESSURE — in. w.g. .15		.3		.45		.6		.75		.9		1.05		1.2	
	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
4000	252	.44	314	.64	376	.83	437	1.03	498	1.22	559	1.41	621	1.61	682	1.8
4250	272	.47	332	.67	392	.86	452	1.06	512	1.26	571	1.46	631	1.65	691	1.85
4500	291	.51	350	.71	408	.92	467	1.12	526	1.32	584	1.52	643	1.73	701	1.93
4750	310	.58	368	.78	426	.99	483	1.2	540	1.4	598	1.61	655	1.82	712	2.02
5000	330	.66	386	.87	443	1.08	499	1.29	556	1.5	612	1.72	668	1.93	724	2.14
5250	350	.76	405	.97	461	1.19	516	1.41	572	1.62	627	1.84	682	2.05	737	2.27
5500	369	.87	424	1.09	479	1.31	533	1.53	588	1.75	642	1.98	697	2.2	751	2.42
5750	389	.99	443	1.22	497	1.45	551	1.67	604	1.9	658	2.13	712	2.35	765	2.58
6000	409	1.13	462	1.36	515	1.6	568	1.83	621	2.06	674	2.29	727	2.52	780	2.76
6250	429	1.28	482	1.52	534	1.75	586	1.99	639	2.23	691	2.47	743	2.71	795	2.94
6500	449	1.43	501	1.68	553	1.92	605	2.17	656	2.41	708	2.66	760	2.9	811	3.14
6750	469	1.6	521	1.85	572	2.1	623	2.35	674	2.6	725	2.85	776	3.1	827	3.35
7000	490	1.77	540	2.03	591	2.29	641	2.54	692	2.8	743	3.06	793	3.32	844	3.57
7250	510	1.95	560	2.22	610	2.48	660	2.75	710	3.01	760	3.27	810	3.54	860	3.8
7500	530	2.14	580	2.41	629	2.68	679	2.95	728	3.23	778	3.5	828	3.77	877	4.04
7750	550	2.33	599	2.61	649	2.89	698	3.17	747	3.45	796	3.73	845	4.01	894	4.28
8000	570	2.54	619	2.82	668	3.11	717	3.39	766	3.68	814	3.96	863	4.25	912	4.54

UNIT 20.0 — DUCT DESIGN AND SIZING

TASK 20.04 — MEASURE AIR VELOCITY IN DUCT USING ANEMOMETER

PERFORMANCE OBJECTIVE:

Given anemometer, mechanic's tools, psychrometer, stop watch, cleaning cloth, and other materials; measure the air velocity in a duct system with a fan and one inlet and one outlet.

PERFORMANCE ACTIONS:

20.0401 Obtain air velocities at one outlet grille and one inlet grille. (Hold anemometer in correct position. Allow anemometer fan to reach constant speed. Start anemometer readings and stop watch at same time.)*

20.0402 Measure db and wb temperatures at inlet and outlet openings.

20.0403 Calculate air volume and air weight passing through openings.

* High velocities: measure in 1/2-minute intervals.
  Low velocities: measure in 1-minute intervals.

PERFORMANCE STANDARDS:

-Measure air velocity in duct using anemometer. Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

TASK WORKSHEET

Blower Inlet Dimensions: ____X____= area_____sq. ft.

Blower Outlet Dimensions: ____X____= area____sq. ft.

Inlet Readings:
1.____
2.____
3.____

Outlet Readings:
1.____
2.____
3.____

Total

Ave.

Volume:
Air Inlet ________cfm
Air Outlet _________cfm

Weight:	Inlet	Outlet
	db____	db____
	wb____	wb____
	Sp. Vol____	Sp. Vol____
	Wt.____	Wt.____

Outlet: DB Temp. ________
Specific Vol.________

WB Temp.________________

Outlet: Weight of Air Outlet - $\frac{\text{Outlet Vol.}}{\text{Outlet Sp. Vol.}}$ = ________________

UNIT 20.0 — DUCT DESIGN AND SIZING

TASK 20.05 — MEASURE AIR VELOCITY AND AIR FLOW PATTERN IN OPEN ROOM USING SMOKE DRAFT INDICATOR

PERFORMANCE OBJECTIVE:

Given an air conditioning duct and fan system and open room, method of generating "smoke", stop watch, steel or other measuring tape (25-50'), and other supplies as needed (such as aqua ammonia, dilute hydrochloric acid, etc., as recommended by instructor); measure the air velocity and airflow pattern in the given space using a smoke draft indicator.

PERFORMANCE ACTIONS:

20.0501 Prepare smoke generator (clean, fill, etc.).

20.0502 Measure drafts. Measure air approximately 10' from exhaust opening. Determine direction of draft. Measure 20' along this direction. Aspirate smoke into air and time its travel for the 20'. Take five readings and calculate the average.

20.0503 Repeat above steps at second test spot.

20.0504 Close operation, clean up materials, etc.

PERFORMANCE STANDARDS:

-Measure air velocity and airflow pattern in open room using smoke draft indicator.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Identify methods of generating smoke.
-Describe method of generating smoke recommended by instructor.
-Describe use of instruments.
-Identify safety considerations.

DATA:

FIRST TEST: Place

	1	2	3	4	5	
Feet						
Time						
Feet/Min.						Average Feet/Min.

Comments:

SECOND TEST: Place

	1	2	3	4	5	
Feet						
Time						
Feet/Min.						Average Feet/Min.

UNIT 20.0 DUCT DESIGN AND SIZING

TASK 20.06 BALANCE SYSTEM

PERFORMANCE OBJECTIVE:

Adjust the size of ducts and adjust the dampers of a given system so that each room receives the correct amount of air. Rooms must maintain desired temperatures. Ducts should not be noisy. Humidity should be correct for system. No stale air should be developed.

PERFORMANCE ACTIONS:

20.0601 Inspect complete system: Locate;
a. Ducts
b. Openings
c. Dampers

20.0602 Open all dampers in ducts and at grilles.

20.0603 Check velocities at each outlet.

20.0604 Measure "free" grille area.

20.0605 Calculate volume at each outlet:
a. Velocity x area = volume

b. $\text{Fpm} \times \frac{\text{area in sq. in.}}{144} = \text{cu. ft./min.*}$

20.0606 Find total cu. ft./min.

20.0607 Determine floor areas of reach room. Add to derermine total area.

20.0608 Find out the proportion each room should have.

$\frac{\text{Area of Room}}{\text{Total Floor Area}} \times \text{Total cfm} - \text{cfm for room}$

20.0609 Adjust duct dampers and grille dampers to obtain desired values.

20.0610 Recheck all outlet grilles.

* Volume Per Minute.

PERFORMANCE STANDARDS:

-Balance a given duct system so that each room receives correct amount of air. Rooms must maintain desired temperatures. Ducts should not be noisy. Humidity should be correct for system. No stale air should be developed.

UNIT 20.0 DUCT DESIGN AND SIZING

TASK 20.06 BALANCE SYSTEM (CONTINUED)

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe purpose of installing air duct booster (to overcome excess duct resistance).

SYSTEM SELECTION AND LOCAL CLIMATE

Local climatic conditions are a most important factor for the proper selection of the air distribution system. Certain performance characteristics are needed in certain areas of extreme climatic conditions in order to maintain year round "indoor comfort" conditions. Cold climate areas require warm floors in winter. Hot summer areas require comfortable cooling. In areas of both extremes, summer and winter, it may be essestial to have warm floors and comfortable cooling. A distribution system performing satisfactorily in one area, may not perform satisfactorily in another area. A perimeter floor warming system might be recommended in the North, but an overhead system without floor warming might be recommended for a similar home in the South. Winter and summer outdoor design temperatures determine the capacity ratings of the heating and cooling equipment; however, it is the over-all season considerations that determine the type of distribution system to be used.

As an aid in determining the type of system which should be selected, climatic zones, defined in terms of degree days, can be established. Figure 1 (preceding page) shows the continent divided into three areas:

Zone I	More than 3500 degree days
Zone II	2000 to 3500 degree days
Zone III	Less than 2000 degree days

The air distribution system must be selected, as stated earlier, on the basis of its performance characteristics, the local climate, and the type of structure.

SLAB FLOOR STRUCTURES

Zone I — Practically all slab-floor structures must have floor warming if the home is to be comfortable. A perimeter loop or radial system is recommended in this zone.

Zone II — Floor warming is recommended through the use of perimeter systems, although non-perimeter systems without floor warming are acceptable.

Zone III — Systems using ceiling diffusers on high inside wall supply outlets are recommended in this zone.

CRAWL SPACE STRUCTURES

Zone I — Perimeter systems are recommended in this zone, with a choice between a radial or extended plenum system.

Zone II — Perimeter systems are recommended in this zone, although non-perimeter systems may be used with floor warming. Systems using the crawl space as a return air plenum are not acceptable.

Zone III — All non-perimeter systems are recommended for this zone.

BASEMENT STRUCTURES

Zone I — Perimeter systems are recommended in this zone and the basement area must be heated to provide warm floors. Non-perimeter systems are acceptable with floor warming provisions.

Zone II — Perimeter systems are recommended in this zone. Non-perimeter systems are acceptable without floor warming.

Zone III — Any of the previously described systems are recommended for this zone. Overhead ceiling or high wall supplies are most favorable.

SPLIT LEVEL AND MULTI-LEVEL HOMES

Zone I — Slab-floor areas at grade level should use perimeter systems in the floor. Crawl space areas should have provisions for floor warming. Full perimeter systems are usually recommended in this zone.

Zone II — Perimeter systems are usually recommended in this zone. Non-perimeter systems are acceptable.

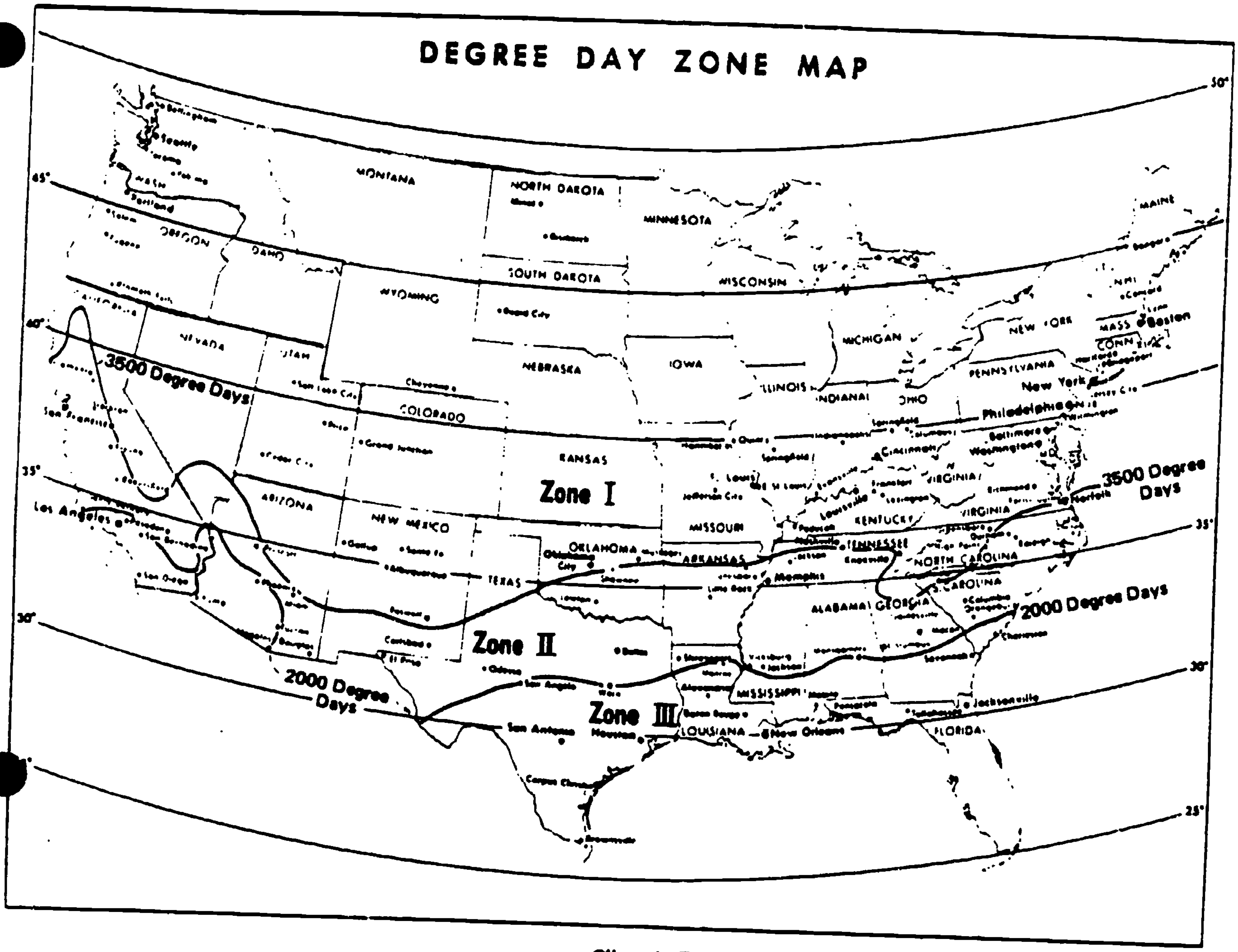
Zone III — Non-perimeter systems are recommended in this zone.

APARTMENTS

Zone I — Perimeter systems are usually recommended in this zone. Overhead or high wall supplies are acceptable for apartments on intermediate floors.

Zone II — Overhead or high wall supplies are acceptable, particularly for intermediate and top-floor apartments.

Zone III — Overhead or high wall supplies are most favorable.



Climatic Zones

UNIT 21.0

AIR TREATMENT

Air treatment is designed to provide the secondary student with an introduction to air contaminants, the advantages of proper humidity, factors which affect humidity, features of residential filtering equipment, the principles of operation of an electronic filter, the theory of a dehumidifier operation, and the principles of the operation of a humidifier.

MINIMUM SUGGESTED TERMINOLOGY

Plenum	"Terms are defined in other units."
Condensate Line	"
Dehumidifier	"
Dew Point	"
Duct	"
Filter	"
Freeze-Up	"
Heat Load	"
Humidistat	"
Humidity	"
Relative Humidity	"
F.P.M.	"
C.F.M.	"
Grille	"
Register	"
Diffuser	"
Static Pressure	"

HVAC
AIR TREATMENT
SUGGESTED INSTRUCTION TIME

HAVC Unit/Task		SUGGESTED HOURS
21.0	AIR TREATMENT	
21.01	Indentify Common Residential Air Treatment Techniques	*
21.02	Install Humidifier with Voltage Control	*
21.03	Install Power Humidifier In Duct System	*
21.04	Install an Electronic Filter	*
21.05	Wire Compressor and Fan Motor	*
21.06	Charge a Dehumidifier	*

*Times not broken down into individual units

UNIT/TASK	DESCRIPTION
Unit 21.0	AIR TREATMENT
21.01	(IDENTIFY COMMON RESIDENTIAL AIR TREATMENT TECHNIQUES) Given an introduction to air treatment in residences, identify common residential air treatment techniques to the instructor's standards.
21.02	(INSTALL HUMIDIFIER WITH LOW VOLTAGE CONTROLS) Given a humidifier, hand tools and necessary test instruments, copper tubing, electrical wire and thermostat cable, low voltage relay fasteners, and other material required and a forced air heating system; install the humidifier with low voltage controls. The unit must meet the instructor's standards.
21.03	(INSTALL POWER HUMIDIFIER IN DUCT SYSTEM) Given a duct type warm air heating system and power type humidifier (or other system for training), mechanic's tools, torch, tubing cutter, spirit level, steel tape, solder, copper tubing, humidistat, and other materials and supplies needed; install power humidifier in duct system. Locate and adjust the mechanical control to maintain a 35-40 percent relative humidity. The control should be mounted 60 inches off the floor and level and properly installed. Installation must be to manufacturer's specifications, meet NEC and local codes, and be to specifications and standards of the instructor.
21.04	(INSTALL AN ELECTRONIC FILTER) Given an electronic filter and accessroies, necessry hand tools, fasteners, and other materials, install the electronic filter in a given system. Performance must be to the manufacturer's and instructor's standards.
21.05	(WIRE COMPRESSOR AND FAN MOTOR) Given a dehumidifier, wire, electrical terminals, the necessary tools, and other materials; wire the compressor and fan motor on a given dehumidifier (alternate system may be used for training). The unit will operate and perform as designed.
21.06	(CHARGE A DEHUMIDIFIER) Given a dehumidifier, refrigerant, and the necessary tools and materials, charge the system so that it maintains evaporator design temperature and pressure that correspond to the evaporator design temperature and the ambient.

Unit 21.0 AIR TREATMENT

TASK 21.01 IDENTIFY COMMON RESIDENTIAL AIR TREATMENT TECHNIQUES

PERFORMANCE OBJECTIVE:

Given an introduction to air treatment in residences, identify common residential air treatment techniques to the instructor's standards.

PERFORMANCE ACTIONS:

21.0101 Describe contaminants which affect humans:
a. Larger than 2 microns expelled by lungs.
b. Smaller than 2 microns retained in lungs. (.1-1 micron particles usually remain in the air; 99% of particles in air are smaller than 1 micron).

21.0102 List some advantages of maintaining proper humidity in a residence.
a. Promotes health by maintaining moisture needed by mucous membrane in nasal passages.
b. Reduces static electricity in floor coverings.
c. Prolongs life of wooden furniture by preventing drying of glued joints.
d. Prolongs life of textiles.
e. Reduces house dust.
f. Prolongs life of window sills, doors, and other construction materials (excess humidity can cause rotting, mold, or mildew).
g. Promotes human comfort.

21.0103 Identify the major factors affecting humidity in a residence:
a. Outside air temperature.
b. Temperature of conditioned air.
c. Appliance use.
d. Food preparation.
e. Number of occupants and activities.
f. Plumbing and water usage.
g. Type of Construction
h. Quality of Components

21.0104 Identify common types of residential filtering equipment:
a. Permanent Filter.
b. Throw-away Filter.
c. Electronic

UNIT 21.0 AIR TREATMENT

TASK 21.01 IDENTIFY COMMON RESIDENTIAL AIR TREATMENT TECHNIQUES

PERFORMANCE ACTIONS: (CONTINUED)

COMMON TYPES OF RESIDENTIAL FILTERING EQUIPMENT

TYPE	PERMANENT FILTER	THROW-AWAY FILTER	ELECTRONIC
Initial cost	Average	low	high
Service or maintenance	average -- (clean & recoat plates)	simple -- (replace filter)	average -- (wash elements)
Operating cost	average	low	high
Effectiveness	good	average	excellent

21.0105 Describe the operation of an electronic air filter:

a. Return air passes through a throw away filter to remove larger particles.
b. Partially filter air returns and ionized field.
c. A wire grid with high positive voltage charges the particles in the air.
d. Negatively charged plates atrract the particles that have been positively charged.
e. Particles are held on collector plates until unit is de-energized and cleaned.
f. Filtered air is ready to be conditioned by heating or cooling system.

21.0106 Describe operation of a dehumidifier:

a. Room or conditoned air drawn into unit by blower.
b. Air is cooled as it passes over the evaporator coil.
c. Water vapor in air condenses as it is cooled below its dew point.
d, Condensation collects on evaporator and drips into a collector tray and is removed.
e. Cooled air is passed over the condensor coil to reheat it to a comfortable RH.
f. Treated air is blown into room or ductwork.

UNIT 21.0 AIR TREATMENT

TASK 21.01 IDENTIFY COMMON RESIDENTIAL AIR TREATMENT TECHNIQUES

PERFORMANCE ACTIONS: (CONTINUED)

2101.07 Outline the operation of a typical humidifier that might be used with a forced air furnace:

a. The humidifier is installed on the return air plenum or duct and connected to the supply air plenum with flexible pipe.
b. The by-pass supply (warm) air flows over a moist foam filter which rotates in a water reservoir.
c. The moistened warm air reenters the air stream on the return air side of the furnace.
d. A humidifier with a separate fan is controlled by a humidistat.
(Alternate systems may be used to increase the RH of the supply air when heating makes the residence air too dry).

PERFORMANCE STANDARDS:

-Identify common residential air treatment techniques to the instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

UNIT 21.0 AIR TREATMENT

TASK 21.02 INSTALL HUMIDIFIER WITH LOW VOLTAGE CONTROLS

PERFORMANCE OBJECTIVE:

Given a humidifier, hand tools and necessary test instruments, cooper tubing, electrical wire and thermostat cable, low voltage relay, fasteners, and other material required and a forced air heating system; install the humidifier with low voltage controls. The unic must operate as designed and performance and product must meet the instructor's standards.

PERFORMANCE ACTIONS:

21.0201 Assemble materials.

21.0202 Disconnect power source to system.

21.0203 Mount humidistat next to thermostat.

21.0204 Install low voltage relay according to diagram provided or to complete circuit described by instructor.

21.0205 Mount humidifier according to manufacturer's instructions.

21.0206 Install saddle valve in cutoff.

21.0207 Connect cutoff to humidifier with copper tubing.

21.0208 Connect electrical components.

21.0209 Reconnect power source.

21.0210 Start system and humidifier and verify proper operation.

PERFORMANCE STANDARDS:

-Install humifier with low voltage controls in a give system according to instructions and diagrams provided. Performance must be to the manufacturer's and instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe/demonstrate how to install low voltage control systems.
-Describe/demonstrate how to install devices such as humidifiers using hand tools and typical fasteners.
-Demonstrate the use of the VOM to check electrical circuits.

UNIT 21.0 AIR TREATMENT

TASK 21.03 (ORIENTATION) INSTALL POWER HUMIDIFIER IN DUCT SYSTEM

PERFORMANCE OBJECTIVE:

Given a duct type warm air heating system and a power type humidifier (or other system for training), mechanic's tools, torch, tubing cutter, spirit level, steel tape, solder, cooper tubing, humidistat, and other materials and supplies needed; install a power humidifier in the duct system. Locate and adjust the mechanical control to maintain a 35-40 percent relative humidity. The control should be mounted 60 inches off floor and level and properly installed. Installation must be to manufacturer's instructions, meet NEC and local codes, and be to specifications and instructor's standards.

PERFORMANCE ACTIONS:

21.0301 Select place on duct for mounting power humidifier.

21.0302 Layout opening to be cut in duct.

21.0303 Drill and cut duct opening. File sharp edges.

21.0304 Locate mounting holes: Drill Holes: Remove chips.

21.0305 Mount humidifier and level it.

21.0306 Install water line: Carefully pierce water supply line and check for leaks.

21.0307 Install drain line to nearest drain. (Line must continuously slope).

21.0308 Connect solenoid valve to furnace electrical supply: Mount humidistat.

21.0309 Open water valve: Adjust humidistat to desired setting.

21.0310 Operate system.

21.0311 Check for leaks.

21.0312 Clean up.

21.0313 Instruct the owner in operation of unit.

UNIT 21.0 AIR TREATMENT

TASK 21.03 (ORIENTATION) INSTALL POWER HUMIDIFIER IN DUCT SYSTEM (CONTINUED)

PERFORMANCE STANDARDS:

-Install power humidifier in duct system following manufacturer's recommendations and so that all mechanical, electrical, and water connections are correctly made. Duct location and humidistat location must be appropriate. Installation must be to the instructor's standards. System must operate as intended. No leaks must result to endanger other systems, etc. Properly locate humidistat and install it satisfactorily. Adjust system to 35-40 percent relative humidity.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Sheet metal work
-Principles of humidifier
-Tubing work
-Electrical installations
-Describe types of humidity controls
-Explain how to locate humidistat
-Explain how humidistat operates as a control
-Identify safety considerations

UNIT 21.0 AIR TREATMENT

TASK 21.04 INSTALL AN ELECTRONIC FILTER

PERFORMANCE OBJECTIVE:

Given an electronic filter and accessories, necessary hand tools, fasteners, and other materials, install the electronic filter in a given system. Performance must be to the manufacturer's and instructor's standards.

PERFORMANCE ACTIONS:

21.0401 Assemble materials.

21.0402 Disconnect system power source.

21.0403 Mount electronic filter in return air passage following manufacturer's instructions.

21.0404 Connect electrical supply to filter according to manufacturer's instructions.

21.0405 Reconnect system power source.

21.0406 Start and run system and electronic filter to verify proper operation.

PERFORMANCE STANDARDS:

-Install an electronic filter in a given system according to the standards of the manufacturer and instructor.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

UNIT 21.0 AIR TREATMENT: DEHUMIDIFIER

TASK 21.05 (ORIENTATION)* WIRE COMPRESSOR AND FAN MOTOR

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* Competency already may be established by similar tasks.

PERFORMANCE OBJECTIVE:

Given a dehumidifier, wire, electrical terminals, the necessary tools, and other materials, wire the compressor and fan motor on a given dehumidifier (alternate system may be used for training). The unit will operate and perform as designed.

PERFORMANCE ACTIONS: (See Basic Refrigeration)

Instructor to clarify actions.

PERFORMANCE STANDARDS:

-Wire compressor and fan motor of a given system so that electrical connections are mechanically and electrically secure and so that the system operates as designed.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Interpret wiring diagrams and schematics
-Demonstrate how to install electrical terminals using the crimp tool
-Locate, identify, and explain the purposes of control devices to meet the instructor's standards
-Identify safety considerations

UNIT 21.0 AIR TREATMENT: DEHUMIDIFIERS

TASK 21.06 (ORIENTATION)* CHARGE A DEHUMIDIFIER

* Competency alrady may be established by similar tasks.

PERFORMANCE OBJECTIVE:

Given a dehumidifier, refrigerant, and the necessary tools and materials, charge the system so that it maintains evaporator design temperature and pressures that correspond to the evaporator design temperature and the ambient.

PERFORMANCE ACTIONS: (See Basic Refrigeration)

Instructor to clarify actions.

PERFORMANCE STANDARDS:

-Charge a dehumidifier so that it maintains evaporator design temperature and pressure that corresponds to the evaporator design temperature and the ambient.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe the procedures for charging a dehumidifier
-Identify the service valves and charging ports
-Describe how to purge and leak test the system
-Identify types of dryers
-Explain/demonstrate how to use the gauge and manifold set
-Describe evaculation procedures
-Describe how to calculate high and low side pressures using the Temperature-Pressure Chart
-Identify safety considerations

UNIT 22.0

TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

The purpose of this unit is to provide additional training in the servicing of residential air conditioning cooling systems.

Residential room air conditioning units are covered adequately in an earlier unit and are not referred to in this unit.

Electrical installations are covered adequately in an earlier unit.

Basic refrigeration principles are covered in an earlier unit.

Refrigeration mechanic's hand tools, equipment, test instruments, and basic system servicing are covered in an earlier unit.

Emphasis in this unit is on troubleshooting and servicing residential air conditioning cooling systems.

STANDARDS

INSTALLATION OF RESIDENTIAL SYSTEMS

"Prior to start-up, ask instructor or supervisor to check work.

"SPLIT SYSTEM

-Check refrigerant lines and fittings for leaks.
-Check suction lines and fittings for proper insulation.
-Check refrigerant lines to be sure thay have been properly secured.
-Check passages through masonry to determine whether they have been sealed. (Motor should not be in direct contact with tubing.)
-Check to see if condensate drain lines are free of blockage*
-Check supply registers and return grilles to ensure that they are open and free of obstructions.
-Check return air filter(s) to be sure the proper type(s) are installed correctly.
-Check thermostat to be sure it is mounted properly and is recording accurately. (Adjust according to manufacturer's instructions.)*
-Check indoor blower and motor to be sure they are adequate to handle cooling airflow requirements.
-Check to be sure the indoor blower motor is set on the correct speed tap or pulley setting for the desired application. (Proper belt tension and pulley adjustment.)*
-Check electrical fusing to ensure complience with unit requirements and local electrical codes.*

*Check is applicable to below procedures.

"SINGLE PACKAGE AND ROOF TOP EQUIPMENT

*Above checks applicable.

-Check for secure anchorage if Roof Top or ground level application. If thru-wall application, make sure bracing is firmly fastened to foundation.
-Check all field wiring to ensure that connections are:
a. securely fastened
b. electrically insulated
c. isolated from each other and adjoining metal parts
d. grounded where indicated for unit protection
-Check to be sure duct connections through roof or wall and unit mounting pitch pans have been properly flashed to meet local codes
-Check to ensure that all tools, packing, and debris around the unit have been removed.
-Check to see if return air filter(s) are in place and supply and return registers are free from blockage

-Check to see if unit panels are secured and that unit electrical components are water tight.

"START-UP

Actual start-up should be a qualified serviceman (mechanic) having adequate knowledge of electrical, refrigeration, and charging techniques. For each unit start-up, the manufacturer's suggested procedures should be followed to assure the utilimate in performance and efficiency. The so-called "Rules of Thumb" present in the air conditioning industry should be forfieted for manufacturer's recommended procedures.

To prevent compressor damage, it is important...prior to start-up...to apply power to the unit allowing about 30 minutes for each pound of refrigerant in the system. This is necessary to evaporate any liquid refrigerant present in the crankcase. Failure do do so may result in liquid refrigerant slugging the compressor, which in turn may damage or destroy the compressor valves. This procedure should be followed at initial start-up and at any time the power is distrupted for 12 hours or more.

The following steps should be performed at initial start-up:

a. Make sure thermostat is in OFF position. (So compressor will not operate.)
b. Apply power by closing system disconnect switch. (Energies compressor heater which evaporates liquid refrigerant in crankcase.)
c. After proper elapse time, indoor thermostat may be set to operate compressor.
d. Except as required for safety while servicing, do not open system disconnect switch.

System can be switched on for the operational check-out after final evacuation and refrigerant charge adjustments. Refrigerant charge adjustments should be made according to charts attached to unit."

SOURCE: Inspection, Start-Up, Check-Out & Balancing. Tyler, TX: General Electric, pp 3-4.

HVAC
TROUBLESHOOT AND SERVICE
SUGGESTED INSTRUCTION TIME

HVAC UNIT/TASK		SUGGESTED HOURS
Unit 22.0	TROUBLESHOOT AND SERVICE	
22.01	Check out Air Condenser and Condenser Fan Motor	*
22.02	Check Evaporator: Pressure Drop Across it and Blower	*
22.03	Check-out Compressor: Electrical and Freon Pressure	*
22.04	Check Metering Devices	*
22.05	Install Electrical Drop For Residential AC Unit	*
22.06	Install Residential Central Cooling System	*
22.07	Check Installation of Central AC Unit	*
22.08	Locate Trouble in Residential Central Comfort Cooling System	*
	TOTAL HOURS	45

* Total Time Estimated.

RELATED TASKS
TO
TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

1. CHECK FILTERS IN CENTRAL AC UNIT
2. MEASURE RELATIVE HUMIDITY
3. CLEAN AND CHECK OUT CONDENSATE LINE
4. CHECK TRANSFORMER
5. CHECK: RELAYS AND VALVES
6. CONNECT FAN-COOLING RELAY
7. CONNECT COMPRESSOR CONTRACTOR
8. CHECK OUT ELECTRICAL PROTECTING DEVICES

These tasks are covered in other units in this Guide.

HVAC
TASK LISTINGS

UNIT/TASK	DESCRIPTION
Unit 22.0	TROUBLESHOOT AND SERVICE RESIDENTIAL CONDITIONER
22.01	(CHECK OUT AIR CONDENSER AND CONDENSER FAN MOTOR) Given a central air conditioner and thermometer, mechanic's tools, flashlights, and other materials needed; Check out the air condenser and condenser fan motor. Determine temperature rise across condenser to within 2 degrees of actual readings.
22.02	(CHECK EVAPORATOR: PRESSURE DROP ACROSS IT AND BLOWER) Given a residential central air conditioner, mechanic's tools, flashlight, inclined manometer, thermometer, and other materials needed; test air flow across evaporator and pressure drop across evaporator. Performance must be to instructor's standards.
22.03	(CHECK-OUT COMPRESSOR: ELECTRICAL AND FREON PRESSURE) Given compressor in central air-conditioning unit, refrigeration gauges, multi-meter, mechanic's tools and equipment, and other necessary materials, check the compressor effectiveness.
22.04	(CHECK METERING DEVICES) Given a residential central air conditioning unit, mechanic's test instruments and tools, and other materials as need; check the metering devices. Replace metering devices as needed.
22.05	(INSTALL ELECTRICAL DROP FOR RESIDENTIAL AC UNIT) Given an air conditioning unit/system, electrial power source such as circuit breaker panel, electrical wire and connectors, and the necessary tools and materials; provide electricity to the AC unit based on voltage and load requirements. The system must cool (or heat) properly when placed in cooling/heating function. Installation must meet NEC. Performance must be to instructor's standards.
22.06	(INSTALL RESIDENTIAL CENTRAL COOLING SYSTEM) Given a residential central cooling system consisting of an outdoor condenser, set of precharged liquid and suction lines with quick disconnects; forced warn air furnace; mechanic's tools, equipment, and test instruments including leak detector, VOM, ammeter, gauge manifold and

lines, electric drill and drill bits; and other materials needed such as sheet metal screws, drain hose, freon, etc.; install the central cooling system in conformance with local refrigeration and electrical codes, and adjust the system to the proper operating temperatures. Performance must be to the instructor's standards and must follow the manufacturer's recommendations/specifications/instructions.

22.07 (CHECK INSTALLATION OF CENTRAL AC UNIT) The air conditioning serviceman might possibly not be involved in installing a central air-conditioning system; however, the serviceman could be called to check a central AC unit that has been improperly installed.

22.08 (LOCATE TROUBLE IN RESIDENTIAL CENTRAL COMFORT COOLING SYSTEM) Given a malfunctioning residential central comfort cooling system, diagram orinstructions on system, mechanic's tools and equipment, gauge manifold, thermometer, vacuum pump, leak detector, VOM, ammeter, refrigerant, and other materials needed; diagnose, repair, and operate residential central comfort cooling system.

SUMMARY OF RELEVANT TASKS DESCRIBED IN OTHER UNITS

1. CHECK FILTERS IN CENTRAL AC UNIT
   a. Remove access door.
   b. Remove entire filter.
   c. If slab type filter, remove and insert new replacement filter.
   d. If filter media on a rack, remove from rack and install new one.
   e. If filter can be cleaned, clean, dry, and return it to unit.
   f. Clean out blower wheel and blower compartment.

2. MEASURE RELATIVE HUMIDITY

3. CLEAN AND CHECK OUT CONDENSATE LINE
   a. Remove evaporator access panel.
   b. Clean drip tray any accumulated dust/dirt.
   c. Probe drain hole with fish tape to ensure it is not clogged.
   d. If necessary, put air hose in drain hole. Tape condensate line where air hose is inserted to force air through line. Open air tank, unclog line, if applicable.
   e. Pour water in drip tray and observe if it drains easily.
   f. Replace evaporator access panel.

4. CHECK TRANSFORMER
   a. Locate transformer (in condenser unit or inside evaporate section).
   b. Check primary voltage with VOM: Check breaker box or fuse if voltage read.
   c. Check secondary voltage:
      (1) No voltage=check fused line.
      (2) Fused line OK, but no voltage = replace transformer.

5. CHECK: RELAYS AND VALVES
   a. Check Potential Relay:
      (1) Check coil (lugs/numbers 2 & 5)
      (2) Check points (lugs 1 & 2)
          (Field Expedient Test) Check relay, by removing wire from #1 and touching it to #2: Hold it for only several seconds. Motor should start.
   b. Check Start Capacitor:
      (1) Use instrument to check capacitor, <u>or</u>
      (2) Try a new one in its place (simple, fast check without instrument).
   c. Check Interlock Relay:
      (1) Disconnect wires from relay, check for continuity across points.

d. Check Airstat:
   (1) Disconnect wires.
   (2) Check continunity across points.
   (3) Continuity = points are closed.
   (4) No continuity = switch is bad.

e. Check Solenoid Valves:
   (1) Check voltage at coil.
   (2) Disconnect wires and check for open coil.
   (3) If voltage check is OK and coil is not open, check to see if valve is stuck.

6. CONNECT FAN-COOLING RELAY
   a. Connect wire from (F) or (G) terminal of thermostat.
   b. Connect above wire from theomstat to one side of relay coil
   c. Connect other side of coil to common side of transformer.
   d. Connect power line to one side of relay points.
   e. Connect other side of points to high lead of blower motor.
   f. Plug in and check for proper operation.

7. CONNECT COMPRESSOR CONTACTOR
   a. Connect wires from disconnected switch to line side of contactor L1 and L2.
   b. Connect common terminal and run terminal of compressor load side of contactor T1 and T2.
   c. Connect one side of contactor coil to (Y) or the cool side of transformer.
   d. Connect other side of contactor coil to common side of transformer.
   e. Check connections, test circuit.

8. CHECK OUT ELECTRICAL PROTECTING DEVICES
   a. Identify electrical protecting device which is open.
   b. Determine if device is doing its job ot if device is bad.
   c. Properly use VOM, clamp-on ammeter, and acceptable test procedures.
      (1) Disconnect unit when appropriate.
      (2) Interpret schematic diagram.
      (3) Identify electrical components.

UNIT 22.0 — TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

TASK 22.01 — CHECK OUT AIR CONDENSER AND CONDENSER FAN MOTOR

PERFORMANCE OBJECTIVE:

Given a central air conditioner and thermometer, mechanics tools, flashligth, and other materials needed; check out the air condenser and condenser fan motor. Determine temperature rise across condenser to within 2 degrees of actural reading.

PERFORMANCE ACTIONS:

(CHECK AIR CONDENSER)

22.0101 Disconnect unit, remove condensing unit access panel.

22.0102 Check condenser coil for dirt, debris, leaves.

22.0103 Check with flashlight across coil.

22.0104 If coil is dirty, clean with brush, or water. (Avoid wetting electrical parts.)

22.0105 Cut tall grass or shrubbery that might restrict flow of air.

(CHECK FAN MOTOR)

22.0106 Check fan blades to ensure they turn freely.

22.0107 Check fan motor to ensure it is not loose.

22.0108 Check bearings, if possible/appropriate.

22.0109 Make sure fan blade is tight on shaft.

(DETERMINE TEMPERATURE RISE ACROSS CONDENSER)

22.0110 Measure temperature rise across condenser to within 2 degrees of actual reading (thermometer.)

PERFORMANCE STANDARDS:

-Check out air condenser and condenser fan motor and check temperature rise across condenser. Air flow through condenser should be unrestricted, motor should perform to specifications/design, and temperature measurement should be within 2 degrees of actual reading.

UNIT 22.0 TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

TASK 22.01 CHECK OUT AIR CONDENSER AND CONDENSER FAN MOTOR (Con't)

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Identify typical/acceptable cleaning chemicals/materials
-Determine static pressure drop
-Describe typical cleaning procedures
-Locate evaporator and condenser
-Describe procedure for reading thermometer
-Explain where to take "temperature rise across condenser" readings
-Identify factors that can reduce fan efficiency
-Identify safety considerations

UNIT 22.0 — TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

TASK 22.02 — CHECK EVAPORATOR: PRESSURE DROP ACROSS IT AND BLOWER

PERFORMANCE OBJECTIVE:

Given a residential central air conditioner, mechanic's tools, flashlight, inclined manometer, thermometer, and other materials needed; test air flow across evaporator and determine temperature drop across evaporator and pressure drop across evaporator. Performance must be to instructor's standards.

PERFORMANCE ACTIONS:

22.0201 Check evaporator:
- a. Remove access panel.
- b. Using flashlight, see if evaporator is diryy.
- c. Brush or air pressure clean the evaporator

22.0202 Check blower and motor bearings following accepted procedures.

22.0203 Check pulley and drive alignment following accepted procedures.

22.0204 Lubricate motor and blower bearings as needed.

22.0205 Check belt tension.

22.0206 Check static pressure drop across coil.

22.0207 Check temperature drop across evaporator to within 2 degrees of actual temperature.

PERFORMANCE STANDARDS:

-Check air flow across evaporator and determine temperature drop across evaporator and pressure drop across evaporator. Performance must be to instructor's standards. Air flow should be within 10 percent of manufacturer's recommended CFM. Temperature drop across evaporator should be within 2 degrees of actual temperature.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:
-Identify test equipment used to measure air flow across evaporator
-Describe how to use air measuring test equipment
-Explain how to determine amout of air flow
-At instructor's request, demonstrate use of inclined manometer

REALTED TECHNICAL INFORMATION (CON'T.):

- At instructor's request, demonstrate use of air velocity indicator gauge (velocimeter)
- Determine CFM (cubic-feet-minute) air flow of given AC unit
- Describe procedure for reading thermometer
- Describe/demonstrate where to take temperature readings

UNIT 22.0 — TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

TASK 22.03 — CHECK-OUT COMPRESSOR: ELECTRICAL AND FREON PRESSURE

PERFORMANCE OBJECTIVE:

Given compressor in central air-conditioning unit, refrigeration gauges, multimeter, mechanic's tools and equipment, and other necessary materials; check the compressor effectiveness.

PERFORMANCE ACTIONS:

A. (CHECK EFFICIENCY)

22.0301 Stop unit.

22.0302 Install gauges.

22.0303 Check type of metering device on unit.

22.0304 Start unit.

22.0305 If unit has capillary tube and back pressure is higher than normal, compressor is probably not pumping.

22.0306 If compressor has suction service valve, front seat valve and pull efficiency test.

22.0307 If unit has T.X.V. and back pressure is higher than normal, check for stuck open T.X.V. If compressor has suction service valve, front seat and check for pumping efficiency. If compressor is not equipped with suction service valve, check out T.X.V. before determing if compressor is pumping or not.

22.0308 If compressor tests bad, let Freon out slowly.

22.0309 Remove compressor, put dryer in suction line, and install new compressor.

22.0310 Purge system with dry nitrogen. Pull good vacuum and recharge unit.

PERFORMANCE ACTIONS: (Con't)

B. CHECK ELECTRICAL

22.0301b Disconnect unit, let compressor cool off. (if compressor is equipped with internal winding thermostat, make sure compressor is cool.)

22.0302b Disconnect electrical wires from compressor.

22.0303b Check compressor for ground, open, or short.

PERFORMANCE STANDARDS:

-Determine pumping efficiency of compressor: The compressor must pump 25 inches vacuum while maintaining a 125 psi head. Check electrical circuit of compressor: Open, short, or ground must be identified. Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe procedures for reading gauges
-Identify high and low side of system
-Describe how to determine compression ratio
-Identify safety considerations
-Explain when back pressure is too high
-Identify what is normal for F-22 back pressure, under typical conditions

UNIT 22.0 TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

TASK 22.04 CHECK METERING DEVICES

PERFORMANCE OBJECTIVE:

Given a residential central air conditioning unit, mechanic's test instruments, and tools, and other materials as needed; check the metering devices. Replace metering devices as needed.

PERFORMANCE ACTIONS:

22.0401 Test metering device.
- a. Check operating pressures.
- b. Check charge in AC unit.

(IF METERING DEVICE IS DEFECTIVE, IDENTIFY PROPER REPLACEMENT SIZE CAPILLARY TUBE AND PROPER T.X.V.)

22.0402 Disconnect unit.

22.0403 Connect gauges

22.0404 Pump down unit, if applicable.

22.0405 Let refrigerant out.

22.0406 Remove metering devices.

22.0407 If T.X.V. is sweat type, place damp rag around valve before soldering lines.

22,0408 Change strainer ahead of capillary tube.

22.0409 When soldering in a capillary tube, be sure not to solder end of capillary tube.

22.0410 Test for leaks.

22.0411 Evacuate system.

22.0412 Charge system.

22.0413 Check refrigerant charge.

PERFORMANCE STANDARDS:

-Check metering devices. Check charge in AC unit: Charge should be within range specified on manufacturer's nameplate. Test operating pressures: Pressure reading should be within 2 psi of actual reading. Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe how deep a vacuum should be pulled down to check system
-For given head pressure and outside air temperature, identify suction pressure for given Freon
-Identify correct high and low side pressures
-Describe/demonstrate how to connect gauges
-Describe procedure for operating service valves
-Explain how to read/use temperature pressure chart
-Identify typical refrigerants that might be used in residential* systems (to instructor's standards)
-Describe procedure for connecting gauge and manifold set
-Describe/demonstrate how to read pressure gauges
-Identify high and low side service valves
-Explain procedure for operating service valves
-Explain use of pressure temperature charts
-Identify safety considerations

*(instructor may add commercial system to expand training)

UNIT 22.0 — TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

TASK 22.05 — INSTALL* ELECTRICAL DROP FOR RESIDENTIAL AC UNIT

PERFORMANCE OBJECTIVE:

Given an air conditioning unit/system, electrical power source such as circuit breaker panel, electrical wire and connectors, and the necessary tools and materials; provide electricity to the AC unit based on voltage and load requirements. The system must cool (or heat) properly when placed in cooling/heating function. Installation must meet NEC. Performance must be to instructor's standards.

*Install or repair electrical installation (if licensed)

PERFORMANCE ACTIONS:

(Electrical tasks for installation are described in a previous unit. Recommend: Action emphasize installation or repair of electrical installation to ground/pad mounted residential AC unit or heat pump.)

PERFORMANCE STANDARDS:

-Install or repair electrical installation to residential air conditioning unit (or heat pump) according to National Electrical Code or other local codes as applicable.
-The system must operate as designed, functioning properly in the cool or heat mode. Performance must be to instructor's standards. Safety precautions must be observed.

SUGGESTED INSTUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe how to electrically wire AC units to line voltage
-Describe how to install control voltage to AC unit
-Determine types and sizes of current protection devices
-Determine line voltage wire sizes
-Select control voltage components, wire, etc.
-Identify where to mount control devices
-Read wiring schematic
-Identify electrical terminals of unit
-Identify safety considerations
-Apply NEC to installation: NEC 250-25, 110-3(b), 440-3, 440-14, 440-61, 250-42(a-f), 250-45, 440-62 (a-c), 440-63

UNIT 22.0 TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

TASK 22.06 INSTALL RESIDENTIAL CENTRAL COOLING SYSTEM

PERFORMANCE OBJECTIVE:

Given a residential central cooling system, consisting of an outdooor condenser, set of precharged liquid and section lines with quick disconnects; forced warm air furnance; mechanic's tools, equipment, and test instruments including leak detector, VOM, ammeter, gauge manifold and lines, electric drill and drill bits; and other materials needed such as sheet metal screws, drain hose, freon, etc; install the central cooling system in conformance with local refrigeration and electrical codes, and adjust the system to the proper operating temperatures. Performance must be to the instructor's standards and must follow the manufacturer's recommendations/specifications/instructions.

PERFORMANCE ACTIONS:

22.0601 Install condensing unit on support platform.

22.0602 Install evaporator in furnace plenum chamber. (Add new duct as needed.) (Install condensate drain or pump.)

22.0603 Install suction and liquid lines. (Liquid line filter-drier and sight glass is recommended)

22.0604 Install thermostat.

22.0605 Install electrical wiring for motor compressor and duct fan according to local electrical code and manufacturer's instructions.

22.0606 Install gauge manifold.

22.0607 Operate system. Check pressures, temperatures, and inspect for leaks.

22.0608 Clean up after installation, put tools away, etc.

PERFORMANCE STANDARDS:

-Install residential central cooling system in conformance with local refrigeration and electrical codes and adjust the system to the proper operating temperatures. Pressurs and temperatures must be to specifications and there must be no leaks in system.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

DATA:

System, Make ________ Model ________ Serial No. ________ Type ________
Voltage ________ Hertz ________ HP ________ Starting Current ________ Running Current ________
Btu Rating ________ Refrigerant ________ Amount ________
Operating Conditions. Pressures: High ________ Low ________ Outlet Temp. ________
Condensing Unit Connections, Liquid Line Size ________
Suction Line Size ________
Type ________
Evaporator Connections, Liquid Line Size ________ Type ________
Suction Line Size ________ Type ________
EER ________

UNIT 22.0 — TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

TASK 22.07 — CHECK INSTALLATION OF CENTRAL AC UNIT*

PERFORMANCE OBJECTIVE:

*The air conditioning serviceman might possibly not be involved in installing a central air-conditioning system; however, the serviceman could be called to check a central AC unit that has been improperly installed.

Given a residential central air conditioning unit installation, echanic's tools and equipment, test equipment, gauges, etc.; check if the central AC unit is properly installed.

PERFORMANCE ACTIONS: (CHECKS)

22.0701 Condenser on a slab?

22.0702 Condenser located proper distance from building?

22.0703 Lines of correct size?

22.0704 Lines insulated?

22.0705 Lines supported by hangers?

22.0706 Correct size condensate line?

22.0707 Condensate line have trap in it?

22.0708 Air escaping around evaporator?

22.0709 Is hot air getting into return air?

22.0710 Return air grille of proper size?

PERFORMANCE STANDARDS:

-Given a residential central air conditioning installation, check to see if the system is properly installed. Performance must meet the standards of the instructor.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 22.0 — TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

TASK 22.08 — LOCATE TROUBLE IN RESIDENTIAL CENTRAL COMFORT COOLING SYSTEM

PERFORMANCE OBJECTIVE:

Given a malfunctioning residential central comfort cooling system, diagram or instructions on system, mechanic's tools and equipment, gauge manifold, thermometer, vacuum pump, leak detector, VOM, ammeter, refrigerant, and other materials needed; diagnose, repair, and operate residential central comfort cooling system.

PERFORMANCE ACTIONS:

22.0801 Test external circuit: Power in, thermostat, relay, capacitor, overload protector, motor compressor, filter, air flow, condensate drain, fresh air supply, and condenser cooling medium.

22.0802 Install gauges: Check pressures, and test for leaks. Oil fan motors.

22.0803 Run unit for about 15 minutes: Check TEV operation, Condenser operation, fans and motors and temperatures.

22.0804 Diagnose possible problems:

a. If evaporator is frosting: Check if TEV is leaking, thermostat not shutting off, or TEC bulb is loose.
b. If evaporator is starved, valve may be partially clogged with moisture, or dirt or screen may be partially clogged, or there may be a lack of refrigerant.

22.0805 Repair as necessary, (Remove refrigerant as necessary.)

22.0806 Assemble unit. Evacuate air, charge, and test for leaks.

22.0807 Test unit operation.

22.0808 Clean up after work.

PERFORMANCE STANDARDS:

-Locate trouble in residential central comfort cooling system. System must operate at proper temperatures, have no leaks, and perform as designed. Performance must be to instructor's standards.

UNIT 22.0 TROUBLESHOOT AND SERVICE RESIDENTIAL AIR CONDITIONERS

TASK 22.08 LOCATE TROUBLE IN RESIDENTIAL CENTRAL COMFORT COOLING SYSTEM (Con't)

SUGGESTED INSTRUCTION TIME:

RELATED TECHNICAL INFORMATION:

DATA:

	At the Beginning	After 15 Minutes	After Repair
Low-Side Pressure			
High-Side Pressure			
Suction Line Temp., Approx.			
Liquid Line Temp., Approx.			
Evaporator Temperature			
Noise: Compressor			
Motor Evaporator			
Motor Condenser			

EER ______________________________

UNIT 23.0

COMMERCIAL REFRIGERATION

This unit primarily concerns the general principles and tasks involved with the installation, service, and repair of commercial refrigeration systems. Commercial refrigeration systems are represented by cases, coolers, and freezers typically found in supermarkets, grocery stores, and food preparation locations. Commercial systems are found also in florist shops, and for this unit of training, include commercial ice makers and water coolers.

Other special commercial systems may be added by the instructor based on local needs and available training equipment and materials.

This unit is based on the "compression refrigeration cycle" which is common to the residential room or window air conditioning unit. The refrigeration principles basically are the same, however, the controls in commercial refrigeration systems tend to be particular to commercial systems.

The principles described in this unit apply to self-contained commercial units (condensing unit mounted on case) and remote units (condensing unit located outside building).

Tasks that primarily concern special commercial refrigeration systems such as ice makers and water coolers are described at the end of this unit after the description of commercial refrigeration task that are broader in application.

The refrigerants typical to commercial refrigeration systems in this unit include R-12, R-22, and R-502. A temperature/pressure table is included for possible reference.

STANDARDS

COMMERCIAL REFRIGERATION

Typically, the refrigerants used in commercial refrigeration will be R-12, R-22, or R-502.

Manufacturer's temperatures typically are coil and not air temperatures (Important to remember when figuring low side operating pressure).

a. Very low temperature/pressure systems are used in locker plans where blast freezing is used prior to storage. Air temperature of a blast freeze system is about 5-6" of vacuum. Pressure and temperature are reached when the refrigerant is about to cycle.

b. Low temperature and low back pressure commercial units include walk-in freezers, open display cases, frozen food cases, and reach-in freezers. (Coil temperatures of -20 to -10 degrees F, cabinet temperatures of -5 to 0 degrees F, and average back pressure (R-12) of 5 to 0 psig.)

c. Medium teperature (back pressure) systems are represented by display cases, reach-in refrigerators, vegetable cases, and walk-in coolers. (Coil temperature of-5 to 25 degrees F, Air of 22 degrees F (meat display) to 36 degrees F (vegetable cooler), back pressure (R-12) of 5-20 psig.)

d. High temperature (back pressure) systems are used by florist, etc. (Coil temperature of 25-55 degrees F, Air temperature of 55-58 degrees F, and suction pressure of 18-52 psig (R-12.)

STANDARDS FOR INSTALLATION AND SERVICE PROCEDURES

All standards applicable to compression refrigeration systems, hand tools, instruments, test instruments, refrigerants, etc., apply to commercial refrigeration.

Electrical codes (National Electrical Code) apply.

Standards for installation:

a. Check codes concerning licensing requirements.
b. Obtain permit for installation where applicable.
c. Units should be located on 4-6" pad above grade to prevent flooding or to specifications.
d. Unit should be 5' from adjoining property.
e. Unit should not be located under down spout or in valley. A cover should be used to protect unit from sun and rain.
f. Foundation of system should not vibrate so as to cause a leak.
g. Unit should be inspected as required.
h. Other protection should be observed as appropriate.

Standards for electrical installation to commercial unit:

a. Disconnect electrical power when servicing.
b. Motor and other circuits should be appropriately fused.
c. Electrical line should be of proper size and type.
d. National Electrical Code applies.
e. Installation must be to specifications or manufacturer's instructions.

Standards for tubing/piping:

a. Piping should not leak.
b. Insulate suction lines to prevent condensation or heat transfer.
c. Tubing should be clean and of proper size.
d. Secure/strap tubing to prevent vibration.

SAFETY STANDARDS

HANDLING REFRIGERANTS

1. Do not heat cylinder above 125 degrees F.
2. Do not store refrigerant cylinder in direct sunlight.
3. Do not allow a direct flame to contact a refrigerant cylinder.
4. Never exceed 75% of the weight stamped on a refrigerant cylinder when refilling small cylinders.
5. Observe Federal law concerning refilling disposable cylinders.
6. Keep valve and head cap in place when cylinder is not in use.
7. Open all cylinder valves slowly.
8. Keep cylinders in upright position attached to stationary object with strap or chain if not mounted in appropriate stand.
9. Remember, the pressure goes up in a tank as the temperature of the tank goes up.

SUGGESTED MINIMUM TERMINOLOGY

The minimum suggested terminology may be found in related units of study.

Heat	A basic form of energy.
Temperature	Intensity of degree of heat, rather than the quantity of heat.
B.T.U.	British Thermal Unit. Quantity of heat measurement = amount of heat required to raise one pound of water one degree F.
Specific Heat	Amount of heat required to warm one pound of a particular material one degree F.
Sensible Heat	Heat which can be felt or "sensed" and which changes the temperature of a substance.
Latent Heat	Hidden heat that causes a change in the state of a substance but produces no change in temperature. Refrigeration is based primarily on latent heat and thermodynamics.
Latent Heat of Fusion	Heat required to change a substance from solid state to a liquid state at the same temperature (e.g., ice to water at 32 degrees F.)
Latent Heat of Vaporazation	Heat required to change a liquid to a vapor at same temperature (e.g., water changes to steam at 212 degrees F.)
Sublimation	Change of some solids to vapor directly without going through a liquid state (e.g., solid carbon dioxide - dry ice.)
Latent Heat of Sublimation	Heat required to change a solid to a vapor at the same temperature.
Thermodynamics	Science of heat: How it occurs, is measured, laws that govern its actions, relationship between heat and mechanical action, etc. Refrigeration is based primarily on thermodynamics and latent heat.
Total Heat	Sum of sensible heat and latent heat (Enthalpy or Heat Content.)

Absolute Zero	Temperature at which a substance has no heat content(-459.7 degrees F.)
Temperature Difference	Difference in degrees in temperature of two substances, or in a substance at two different times.
Mean Temperature Difference	Mean or average temperature difference (M.T.D.)
Ambient Temperature	Temperature of surrounding air (such as room temperature.)
Coil	Any cooling element made of pipe of tubing.
Super Heat	Heat contained in a vapor above its heat conten at boiling point at existing pressure: Heat added to a gas after it has been evaporated.
Super Heated Gas	Gas whose temperature is higher than evaporatic temperature at exisiting pressure.
Thermostatic Expansion Valve	Most widely used metering device in commercial refrigeration. Meters correct amount of refrigerant in evaporator and acts as a dividi point between high side and low side. Drops pressure so refrigeration will take place
Automatic Expansion Valve	(As found on some ice machines) Maintains a constant back or suction pressure. Closing and opening function to keep suction pressure constant.
Capillary Tube	Metering device (in commercial refrigeration such as water coolers, salad bars, etc.), similar to domestic refrigeration system.

HVAC
COMMERCIAL REFRIGERATION
SUGGESTED INSTRUCTION TIMES

HVAC Unit/Task		SUGGESTED HOURS
Unit 23.0	COMMERCIAL REFRIGERATION	
23.01	Check Superheat	*
23.02	Adjust Thermostat in Commercial Refrigerator	*
23.03	Adjust Low Pressure Control On Commercial Refrigeration Unit	*
23.04	Service Hot-Gas Defrost System	*
23.05	Determine Condition of Electric Defrost System	*
23.06	Clean Out Water Tower	*
23.07	Service Two Temperature Valves	*
23.08	Install A Pump Down Control System	*
23.09	Remove and Replace Evaporator Pressure Regulator Valve	*
23.10	Evacuate and Charge a Commercial Refrigeration System	*
23.11	Clean out System After Burn out	*
23.12	Calculate Heat Load of Typical Walk-In Cooler	*
23.13	Troubleshoot Commercial Refrigeration System	*
	WATER COOLERS	
23.14	Adjust Water Temperature	*
23.15	Charge a Water Cooler	*

23.16	Adjust A Bubbler	*
23.17	Install A Water Cooler	*
	ICE MAKERS	
23.18	Test Circulating Pump	*
23.19	Adjust Water Level	*
23.20	Adjust Harvest Thermostat	*
23.21	Adjust Storage Bin Thermostat	*
23.22	Trobuleshoot Ice Maker	*
	TOTAL HOURS	165

* Total Time Estimated

UNIT/TASK	DESCRIPTION
Unit 23.0	COMMERCIAL REFRIGERATION
23.01	(CHECK SUPERHEAT) Given a commercial refrigeration system, necessary hand tools and equipment, thermometer, and pressure-temperature chart, - properly checked on the unit equipped with a TEV (T.X.V.)
23.02	(ADJUST THERMOSTAT IN COMMERCIAL REFRIGERATOR) Given a commercial refrigeration unit with a coil sensing thermostat thermometer, and other materials needed; adjust the thermostat.
23.03	(ADJUST LOW PRESSURE CONTROL ON COMMERCIAL REFRIGERATION UNIT) Given a commercial refrigera tion system by controlled by low pressure control necessary hand tools, gauges, thermoter, typical pressure motor control settings chart, set the temperature on the commercial refrigerator by adjusting the low pressure control
23.04	(SERVICE HOT-GAS DEFROST SYSTEM) Given a commercial refrigeration unit with a hot-gas defrost system, mechanic's tools, ammeter, VOM electrical diagram of unit, and other materials needed, test or service the hot-gas defrost system so that the evaporator defrosts when conditions are appropriate.
23.05	(DETERMINE CONDITIONS OF ELECTRIC DEFROST SYSTEM) Given a commercial refrigeration system with an electric defrost system, if the electric defrost system will turn on a heater at a selected time, remove frost, and terminate at a predetermined temperature.
23.06	(CLEAN OUT WATER TOWER) Given a water tower, identify the type of water tower, identify the key parts of the tower, and observe (orienta tion) how to clean a water tower using proper procedures and products.
23.07	(SERVICES TWO TEMPERATURE VALVES) Given a commer cial, refrigeration unit required tools and equi ment; remove and replace the two-temperature val The unit will maintain the design evaporator temeperature.

23.08 (INSTALL A PUMP DOWN CONTROL SYSTEM) Given a commercial refrigeration system, install a pump down control. The system must pump down on the off cycle.

23.09 (REMOVE AND REPLACE EVAPORATOR PRESSURE REGULATOR VALVE) Given a commercial refrigeration unit vacuum pump, remove and replace the EPR valve. The unit will maintain an evaporator pressure that corresponds to the design evaporator temperature.

23.10 (EVACUATE AND CHARGE A COMMERCIAL REFRIGERATION SYSTEM) Evacuate and charge a given commercial refrigeration system using tools and materials provided. The system must operate and maintain temperatures and pressures within 2 degrees and 5 psi of design specifications.

23.11 (CLEAN OUT SYSTEM AFTER BURN OUT) Given a commercial refrigeration system with a burnout, mechanic's tools and test instruments, vacuum pump, safety goggles and rubber gloves, dry nitrogen, liquied line filter drier, suction line filter drier with gauge port, new/replacemen compressor, freon, clean up rags, and other materials needed; remove the burned out compress clean out the system, and install a new/replacement compressor.

23.12 (CALCULATE HEAT LOAD OF TYPICAL WALK-IN COOLER) Given a typical walk-in cooler or freezer, necessary instruction, necessary charts (R.S.A., manufacturer's or ASHRAE Handbook), refrigeratio load estimate form and other materials required; calculate the head load of the walk-in refrigeration system.

23.13 (TROUBLESHOOT COMMERCIAL REFRIGERATION SYSTEM) Given a commercial refrigeration with symptoms of faulty operation, a troubleshoot chart, mechanic's tools and test instruments, and the necessary equipment or materials; identify the possible cause(s) and remedy (remedies) of the symptoms.

WATER COOLERS

23.14 (ADJUST WATER TEMPERATURE) Given an operating water cooler, thermomter, and necessary tools, test if the water temperature is in the 45-50 degree range.

23.15 (CHARGE A WATER COOLER) Given a water cooler, refrigerant, and proper tools, charge the water cooler with the correct amount of refrigerant. The high and low side pressures will correspond to the design evaporator temperature and the ambient temperature.

23.16 (ADJUST A BUBBLER) Given a water cooler drink fountain, adjust the bubbler so that it allows a water stream between four and five inches high without spill over on the floor.

23.17 (INSTALL A WATER COOLER) Given a water cooler, necessary tools and materials, install the water cooler in a specified location so that it is lev the fresh water line is leakprooof, and the drai line is leakproof and trapped.

ICE MAKERS

23.18 (TEST CIRCULATING PUMP) Given an operating ice machine, test the circulating pump for correct amount of water flow. The circulating pump will deliver the GPM as specified by the manufacturer's design.

23.19 (ADJUST WATER LEVEL) Given an ice machine and the necessary tools, adjust the water level in the reservoir so that it is 75 percent filled with water or to manufacturer's specifications.

23.20 (ADJUST HARVEST THERMOSTAT) Given an ice machine the necessary tools, and required materials; adjust the harvest thermostat so that it initia the harvest cycle when the ice is frozen solid.

23.21 (ADJUST STORAGE BIN THERMOSTAT) Given an ice machine with adjustable storage bin thermostat, adjust the storage bin thermostat so that it cuts off the machine when the ice level reaches the sensor bulb and cuts in when the ice level falls.

23.22 (TROUBLESHOOT ICE MAKER) Given a commercial ic maker, mechanic's tools, calibration thermomete gauge manifold, VOM, ammeter, cleaning cloth, and other materials needed; locate, solve, and correct problems found in a malfunctioning ice maker. Adjust the ice maker to the proper operating conditions. Performance must be to instructor's standards.

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.01 CHECK SUPERHEAT

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration system, necessary hand tools and equipment, thermometer, and pressure-temperature chart; properly check the superheat on the unit equipped with a TEV (T.X.V.).

PERFORMANCE ACTIONS:

23.0101 a. Review manufacturer's manunal on unit
b. Assemble tools, equipment, etc.

23.0102 Measure temperature of suction line at point bulb is clamped.

23.0103 Obtain suction pressure that exists in suction line at bulb location. (Insert "T" in external equalizer line or read gauge pressure at suction valve of compressor and add estimated 2-3 psig suction loss. Sum of gauge reading and estimated pressure drop will equal the approximate suction line pressure at bulb.)

23.0104 Using temperature pressure chart, convert pressure obtained in previous step to temperature.

23.0105 Substrat temperature obtained above from temperature previously obtained (Step 2). The difference in temperature is the superheat. (Note: Superheat of 10 degrees F is recommended.)

PERFORMANCE STAMDARDS:

-Check the superheat of a given commercial refrigeration unit. A superheat of 10 degrees is recommended.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:
-Define "superheat"
-Describe how to adjust superheat
-Describe how to use the gauge and manifold set
-Describe how to measure refrigerant line temperatures
-Describe how to adjust superheat
-Identify safety considerations

TASK EXPANSION: (Optional-orientation)

1. ADJUST SUPERHEAT
   Adjust superheat on a given refrigeration unit according to procedures provided by the instructor or found in the testbook references (e.g. Althouse, Turnquist, and Bracciano, MODERN REFRIGERATION AND AIR CONDITIONING, Goodheart-Wilcox Co., Inc1982, Chapter 14, Sections: 14-6 Through 14-72)

2. TROUBLESHOOT UNIT WITH T.X.V.
   a. Install gauges on unit
   b. Operate unit for brief period of minutes
   c. Visually observe T.X.V. (T.E.V.) for:
      (1) Bulb location and termal contact
      (2) External equalizer line connection
   d. Check superheat
   e. Check gauge pressure
   f. Use "troubleshooting chart" to help diagnose problem:
      (1) Load temperature is too high and valve does not appear to feed enough refrigerant, superheat is high and back pressure is lower than normal (check chart).
      (2) Valve feeds too much refrigerant or if liquid returns to compressor, superheat is low with normal or higher than normal pressure. (Check Chart).
      (3) Superheat is normal or low with lower than normal Suction pressure. (Check Chart).
      (4) Superheat and suction pressure fluctuate (cycling or hunting). (Check chart)
      (5) Valve does not regulate at all. Check enternal equalizer line connection or check for plugged line.

(NOTE: Troubleshoot chart omitted)

3. REMOVE AND REPLACE POWER ELEMENT (HEAD)

   Give a T.E.V. (TEV) - (thermostatically controlled expansion valve), mechanic's tools, gauges, and other necessary test equipment and materials including replacement power element (head); replace power element. The TEV must maintain desired superheat setting. Performanc must be to the instructor's standards.
   -Describe operation of power element
   -Identify safety considerations

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.02 ADJUST THERMOSTAT IN COMMERCIAL REFRIGERATOR

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration unit with a coil sensing thermostat *, thermometer, and other materials needed; adjust the thermostat.

PERFORMANCE ACTIONS:*

23.0201 Determine proper setting for unit (manufacturer's recommendation).

23.0202 Run unit.

23.0203 Place thermometer in center of unit.

23.0304 Adjust thermostat until desired temperature is reached.

PERFORMANCE STANDARDS:

-Adjust thermostat in commercial refrigerator system using thermometerreference. Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Identify different types of thermostats used in commercial systen
-Identify where a typical thermostat would be located in a commercial refrigerator or freezer and how it would typically be installed/mounted (4" from floor, 2" from wall).

* Same actions apply to an air sensing thermostat.

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.03 ADJUST LOW PRESSURE CONTROL ON COMMERCIAL REFRIGERATION UNIT

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration system controlled by low pressure control, necessary hand tools, gauges, thermometer, typical pressure motor control settings chart; set the temperature on the commercial refrigerator by adjusting the low pressure control.

PERFORMANCE ACTIONS:

23.0301 Install gauges.

23.0302 Look up control setting on pressure chart

23.0303 Set low pressure control

23.0304 Run unit

23.0305 Front seat suction service valve. .(To bring suction pressure down to cut-out point).

23.0206 Compare actual cut-out pressure on gauges to low pressure control setting.

23.0307 If pressure is not same, make correct adjustment.

23.0308 Put suction pressure service valve in cracked position.

23.0309 Let unit run until the determined temperature is reached.

23.0210 Check differential. (Set so unit will not cycle off too long and become warm or where there is too short a cycle time).

PERFORMANCE STANDARDS:
-Adjust low pressure control of a commercial refrigeration system so that the unit cycles properly and maintains proper temperatur-

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe purpose of high and low pressure controls
-Explain range and differential adjustments
-Demonstrate how to adjust high and low pressure controls

RELATED TECHNICAL INFORMATION: (Con't)

-Identify/determine recommended settings of high and low pressure controls
-Identify safety considerations

EXTENDED TRAINING:

-Adjust high pressure control.

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.04 SERVICE HOT-GAS DEFROST SYSTEM

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration unit with a hot-gas defrost system, mechanic's tools, ammeter, VOM, electrical diagram of unit, and other materials needed; test or service the hot-gas defrost system so that the evaporator defrosts when conditions are appropriate.

PERFORMANCE ACTIONS:

23.0401 Determine that there is something faulty with defrost system and not something obstructing air flow over evaporator (e.g., check to be sure evaporator fan is operating).

23.0402 Check voltage to defrost clock.

23.0403 Put ammeter on line going to hot-gas solenoid: Check current.

23.0404 Turn clock into defrost cycle.

23.0405 Check voltage going to hot gas solenoid: If no voltage, replace clock.

23.0406 Check ampere reading: If solenoid valve is pulling current, clock may not be advancing.

23.0407 Make sure termination thermostat has continuity.

23.0508 If voltage is going to solenoid valve, but no current is pulled, replace solenoid valve.

PERFORMANCE STANDARDS:

-Service a hot gas defrost system so that it defrost the evaporato when conditions are appropriate. Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME Hours

RELATED TECHNICAL INFORMATION:

-Locate the hot gas line, hot gas solenoid, defrost timer, defrost termination thermostat
-Describe how the hot-gas defrost system operates

RELATED TECHNICAL INFORMATION: (CON'T)

-State the need for defrosting
-Identify safety consideration
-See: Althouse, Turnquist, and Bracciano. Modern REFRIGERATION AND AIR CONDITIONING IL: Goodheart-Wilcox Co., Inc.,1982, Chapter 12, Section 12-29.

UNIT 23.0 — COMMERCIAL REFRIGERATION

TASK 23.05 — DETERMINE CONDITION OF ELECTRIC DEFROST SYSTEM

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration system with an electric defrost system, mechanic's hand tools, ammeter, VOM, electrical diagram, and other necessary materials; determine if the electric defrost system will turn on a heater at a selected time, remove frost, and terminate at a predetermined temperature.

PERFORMANCE ACTIONS:

23.0501 Refer to manufacturer's "troubleshooting chart"

23.0502 Determine that problem is electric defrost system and not obstructed air flow over evaporator (such as faulty evaporator fan).

23.0503 Check voltact to defrost clock.

23.0504 Check current to electric heaters.

23.0505 Turn clock into defrost cycle.

23.0506 Check voltage to electric heaters (No voltage=replace clock).

23.0507 Check current: (If electric heaters are pulling current, check if clock is advancing).

23.0508 Make sure termination thermostat has continuity.

23.0509 If voltage is to electric heaters, but no current is pulled, replace electric heaters.

PERFORMANCE STANDARDS:

-Determine if the electric defrost system of a commercial refrigeration unit iwll turn on a heater at a selected time, remove frost, and terminate at a predetermined temperature.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Locate the electric defrost system
-Identify defrost components
-Describe the defrost sequence
-Describe the procedure for testing the defrost timer
-Describe the procedure for testing a defrost termination thermos
-Identify safety considerations

Unit 23.0 COMMERCIAL REFRIGERATION

TASK 23.06 (Orientation) CLEAN OUT WATER TOWER

PERFORMANCE OBJECTIVE

Given a water tower, identify the type of water tower, identify the key parts of the tower, and observe (orientation) how to clean a water tower using proper procedures and products.

PERFORMANCE ACTIONS:

23.0601 Identify type of water tower:
- a. Natural draft
- b. Mechanical draft:
  - (1) Forced draft: Fan pulls air thru tower
  - (2) Induced draft: Fan pulls air thru tower

23.0602 Identify major components of typical tower:
- a. Pump
- b. Connecting pipes from tower to water cooled condenser and back
- c. Spray nozzles
- d. Tower basin
- e. Supply water faucet
- f. Float
- g. Bleed line

23.0603 Identify (orientation to) how water tower cools water:
- a. Through walls of tower
- b. By transferring the air passing through towe (sensible heat)
- c. By part of the water evaporating in the moving air (laten heat)

(FOLLOWING STEPS ARE TO CLEAN A SAMPLE TOWER)

23.0604 Disconnect unit, tower pump and fan.

23.0605 Drain water.

23.0606 Clean with brush.

23.0607 If connecting tubing and condenser are too clogg with scale, refill with water and add inhibitive acid. Circulate acid and water until scale is removed.

23.0608 Drain solution.

23.0609 Flush unit with any acid neutralizer that is necessary.

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.06 CLEAN OUT WATER TOWER

PERFORMANCE ACTIONS:

23.0610 Refill tower and add any water treatment that is necessary.

(FOLLOWING STEPS ARE FOR PERIODIC CHECK ON SAMPLE TOWER)

23.0611 Periodically check to see if tower needs cleaning:

a. Sufficient overflow?
b. Check and clean overflow strainer.
c. Drain and flush out pan to remove dirt and concentrate deposits.
d. Check spray nozzles.
e. Check glassy phosphate: Stir it up and renew it monthly.

PERFORMANCE STANDARDS:

-Identify the type of water and the key parts of the water tower during an orientation to water towers. Describe/identify steps and procedures for cleaning a water tower. Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Identify typical water treatment methods:
a. Lime deposits: Add calgon or increase bleed-off
b. Scaling: Add glassy phosphate compound
c. Corrosion: Add glassy phosphate compound
d. Algae growth: Use commercial algicide
e. Dirt and pollution: Clean water tower

-Instructor will identify other related information necessary for entry level competence

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.07 (Orientation) SERVICE TWO TEMPERATUE VALVES

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration unit, required tools and equipment; remove and replace the two temperature valve. The unit will maintain the design evaporator temperature.

PERFORMANCE ACTIONS: (Actions to be clarified by instructor)

ORIENTATION TRAINING:

23.0701 Identify types of two temperature valves:
- a. Metering
- b. Snap-action
- c. Thermostatic
- d. Solenoid

23.0702 Determine design evaporator temperature: Describe the operation of a two temperature valve

23.0703 Identify safety considerations.

23.0704 Identify four common problems experienced with two temperature valves:
- a. Leaky needle
- b. Valve stuck shut
- c. Valve out of adjustment
- d. Frost accumulation on bellows

PERFORMANCE STANDARDS:

-Remove and replace a two temperature valve on a commercial refrigeration unit. The unit will maintain the design evaporator temperature.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.08 (Orientation) INSTALL A PUMP DOWN CONTROL SYSTEM

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration system, install a pump down control. The system must pump down on the off cycle.

PERFORMANCE ACTIONS: (Instructor to clarify actions)

ORIENTATION TRAINING:

23.0801 Describe the advantages of the pump down system.

23.0802 Describe the operating sequence of a pump down system.

23.0803 Locate the liquid line solenoid valve.

23.0804 Identify safety considerations.

PERFORMANCE STANDARDS:

-Install a pump down control system that pumps down on the off cycle.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.09 (Orientation) REMOVE AND REPLACE EVAPORATOR PRESSURE REGULATOR VALVE

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration unit, vacuum pump, remove and replace the EPR valve. The unit will maintain an evaporator pressure that corresponds to the design evaporator temperature.

PERFORMANCE ACTIONS:

23.0901 Pump down unit to replace valve

23.0902 Remove defective EPR valve

23.0903 Join EPR valve to suction line

23.0904 Leak check installation

23.0905 Evacuate system

23.0906 Operate system

PERFORMANCE STANDARDS:
-Remove and replace evaporator pressure regulator valve on a given commercial refrigeration unit. The unit must maintain an evaporator pressure that corresponds to the design evaporator temperature.

SUGGESTED INSTRUCTION TIME: Hours - Orientation Training

RELATED TECHNICAL INFORMATION:

-Describe the operation of an EPR
-Identify/determine design evaporator temperature
-Identify EPR valves and their proper use
-Identify safety considerations

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.10 (Orientation) EVACUATE AND CHARGE A COMMERCIAL REFRIGERATION SYSTEM

PERFORMANCE OBJECTIVE:

Evacuate and charge a given commercial refrigeration system using tools and materials provided. The system must operate and maintain temperatures and pressures within 2 degrees and 5 psi of design specifications.

PERFORMANCE ACTIONS: (Instructor will clarify actions)

ORIENTATION TRAINING:

23.1001 Describe methods of charging.

23.1002 Identify typical refrigerants, describe their proper uses, describe their characteristics.

23.1003 Determine application design temperatures and pressures.

23.1004 Locate/identify service valves, sight glass, and other components identified by the instructor.

23.1005 Explain/demonstrate how to use the vacuum pump.

23.1006 Explain/demonstrate how to use the gauge and manifold set.

23.1007 Explain the use of dry nitrogen.

23.1008 Explain how to use the temperature pressure chart

23.1009 Identify safety considerations.

PERFORMANCE STANDARDS:

-Evacuate and charge a commercial refrigeration system so that it operates and maintains temperatures and pressures within 2 degrees and 5 psi of design specifications.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.11 CLEAN OUT SYSTEM AFTER BURN OUT

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration system with a burnout, mechanic's tools and test instruments, vacuum pump, safety goggles and rubber gloves, dry nitrogen, liquied line filter drier, suction line filter drier with guage port, new/replacement compressor, freon, clean up rags, and other materials needed; remove the burned out compressor, clean the system, and install a new/replacement compressor.

PERFORMANCE ACTIONS:

23.1101 Disconnect electrical power.

23.1102 Discharge unit.

23.1103 Note if oil has a strong pungent odor (indicating burnout).

23.1104 Remove old compressor.

23.1105 Remove old filter driers.

23.1106 Blow system out with dry nitrogen. (Do <u>not</u> use oxygen).

23.1107 Install new compressor.

23.1108 Install:
a. new liquid line filter
b. suction line filter
(NOTE: Don't uncap dirers until ready to install

23.1109 Pull vacuum.

23.1110 Break vacuum with Freon.

23.1111 Repeat steps: Pull vacuum and break vacuum with Freon. (Repeat 3 Times).

23.1112 Recharge unit.

23.1113 Run unit about 2 hours: Check for pressure drop across suction line filter drier. (e.g., one gauge on service port of drier and one gauge on suction line of compressor: Remove filter drier and install new one if pressure difference is over 3 psig).

PERFORMANCE ACTIONS: (CON'T)

23.1114 Run unit for about a week: Check oil for discoloration or acidity. (If oil ia acid, remov oil and replace it, install a new suction line).

PERFORMANCE STANDARDS:

-Clean out a system after burnout, remove burned compressor, install new compressor, check system and restore system to proper operation. Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Safety in handling burned oil.

UNIT 23.0 COMMERCIAL REFRIGERATION

TASL 23.12 CALCULATE HEAT LOAD OF TYPICAL WALK-IN COOLER*

PERFORMANCE OBJECTIVE:

Given a typical walk-in cooler or freezer, necessary instruction, necessary charts (R.S.A., Manufacturer's, or ASHRAE Handbook), refrigeration load estimate form, and other materials required; calculate the head load of the walk-in refrigeration system.

PERFORMANCE ACTIONS: (ORIENTATION)

23.1201 Calculate head load for following:
Walk-in cooler
Used for general purpose (supermarket)
Dimensions: 12"x12"x7' (l,w,h)
Ambient temperature: 85 degrees F
Inside Temperature: 34 degrees F
Insulation: 4" expanded polystyrene molded beads.
Product load: 1,500 lbs of fresh beef at
85 degrees F

23.1202 Use refrigeration load estimate form.

23.1203 Use any manufacturer's equipment manual provided by instructor.

PERFORMANCE STANDARDS:

-Calculate heat load of typical walk-in cooler or freezer using information and materials provided by the instructor.
-Training is orientation.

SUGGESTED INSTRUCTION TIME: Hours

* Cooler or freezer

UNIT 23.0 COMMERCIAL REFRIGERATION

TASK 23.13 TROUBLESHOOT COMMERCIAL REFRIGERATION SYSTEM

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration with symptons of faulty operation, a troubleshoot chart, mechanic's tools and test instruments, and the necessary equipment or materials; identify the possible cause(s) and remedy (remedies) of the symptoms.

PERFORMANCE ACTIONS:

23.1301 Idenify application of unit (cooler or freezer).

23.1302 Determine if problem is electrical or gas oriented.

23.1203 If electrical problem:
a. Check power circuit to compressor
b. If previous check is good, check control circuit

23.1304 If previous check are OK, check compressor for: open, short or ground.

23.1305 If gas problem: Identify type of Freon used.

23.1306 Install gauges: If no Freon, put bottle pressure in unit.

23.1307 Find leak: Repair

23.1308 Unit has Freon, but does not cool:
a. Check metering device
b. Check pumping efficiency of compressor

23.1309 Using "troubleshooting chart", identify problem(s

PERFORMANCE STANDARDS:

-Troubleshoot commercial refrigeration system using "troubleshooti chart" to identify posisble cuases of symptoms reported.
-Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

SEE ACCOMPANYING "TROUBLESHOOTING CHART"

THE FOLLOWING TASKS CONCERN SPECIAL TYPES OF COMMERCIAL REFRIGERATION

The following tasks concerning special types of commercial refrigeration that are introduced during secondary training. These tasks are grouped and identified according to the special type of refrigeration (e.g., ice machine).

Special types of commercial refrigeration systems typically included in the articulted, performance-based curriculum are:

- -Water Cooler
- -Ice Machine

Additional special types of commercial refrigeration may be included by the instructor based on local needs (recommendations of "curriculum advisory committee") and the availability of training equipment.

WATER COOLERS

A water cooler is defined as a cabinet designed to hold a water cooling coil and a condensing unit, making it a complete refrigeration unit. The unit is connected to a water-feed, a drain, and to 110 VAC electrical power. Floor and wall mounted units are similar in basic design.

Training concerning water coolers is basically orientation.

UNIT 23.0 WATER COOLERS

TASK 23.14 (Orientation) ADJUST WATER TEMPERATURE

PERFORMANCE OBJECTIVE:

Goven an operating water cooler, thermometer, and necessary tools, test if the water temperature is in the 45-50 degree range.

PERFORMANCE ACTIONS: (Actions to be clarified by instructor or manufacturer's service manual)

ORIENTATION TRAINING:

23.1401 Explain about backup thermostats.

23.1402 Describe the danger of improperly adjusted temperature on the cold side (freezing of pipes and tanks).

23.1403 Locate the cycling thermostat and backup (safety) thermostat.

23.1404 Explain range and differntial.

23.1405 Identify safety consideration.

PERFORMANCE STANDARDS:

-Test if the water temperature of an operating water cooler is in the 45-50 degree range and adjust the water temperature as required.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 23.0 WATER COOLERS

TASK 23.15 CHARGE A WATER COOLER

PERFORMANCE OBJECTIVE:

Given a water cooler, refrigerant, and proper tools; charge the water cooler with the correct amount of refrigerant. The high and low side pressures will correspond to the design evaporator temperature and the ambient temperature.

PERFORMANCE ACTIONS: (Actions to be clarified by instructor or manufacturer's service manual)

(Actions are described in other units concerning basic refrigeration servicing)

ORIENTATION TRAINING:

23.1501 Demonstrate how to read the temperature pressure chart.

23.1502 Identify typical evaporator design temperatures.

23.1503 Calculate low and high side pressures using formulas given.

23.1504 Describe how to use service valves.

23.1505 Describe how to use the gauge and manifold set.

23.1506 Describe how to evacuate a system.

23.1507 Describe how to leak test a system.

23.1508 Describe how to purge a system.

PERFORMANCE STANDARDS:

-Charge a given water cooler with the correct amount of refrigerant so that the high and low side pressures will correspond to the design evaporator temperature and the ambient temperature.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 23.0 WATER COOLERS

TASK 23.16 (Optional) ADJUST A BUBBLER

PERFORMANCE OBJECTIVE:

Given a water cooler drink fountain, adjust the bubbler so that it allows a water stream between four and five inches high without spill over on the floor.

PERFORMANCE ACTIONS: (ORIENTATION TRAINING)

23.1601 Assemble necessary tools.

23.1602 Adjust water feed line pressure for proper operation.

23.1603 Locate bubbler adjustment.

23.1604 Explain about water feed line pressure variation and the need for adjustment.

23.1605 Identify safety considerations.

PERFORMANCE STANDARDS:

-Adjust bubbler on a water cooler drink fountain so that it allows a water stream between four and five inches high without spill over on the floor.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 23.0 (Orientation)* WATER COOLERS

TASK 23.17 (Optional Plumbing Task) INSTALL A WATER COOLER

PERFORMANCE OBJECTIVE:

Given a water cooler, necessary tools and materials, install the water cooler in a specified location so that it is level, the fresh water line is leakproof, and the drain line is leakproof and trapped.

PERFORMANCE ACTIONS: *(Actions to be clarified by instructor: Task may overlap into tasks typically performed by plumber)

ORIENTATION TRAINING

23.1701 Explain the importance of leveling a water cooler during installation.

23.1702 Demonstrate proper techniques and products for flare and compressor fittings.

23.1703 Explain the need for trapping the drain line.

23.1704 Describe how to make soft solder connections and joints.

23.1705 Identify safety considerations.

PERFORMANCE STANDARDS:

-Install a water cooler in a specified location so that it is level, the fresh water line is leakproof, and the drain line is leakproof and trapped.

SUGGESTED INSTRUCTION TIME: Hours

ICE MAKERS

This section concerning commercial refrigeration ice makers includes the basic fundamentals of most ice maker machines.

See the task "Troubleshoot Ice Maker" for a recommended reference source for theory, visual diagrams, electrical schematics, and servicing procedures.

MINIMUM SUGGESTED TERMINOLOGY

ICE MAKERS

Harvest	Process of harvesting the ice made by defrosting it off the evaporator, usually by the hot-gas method. Ithen is channell to the storage bin by a chute or plate.
Hot-Gas	(Defrost) Defrosting system in which hot refrigerant gas from high side is directe through evaporator for short period of time and at predetermined intervals in order to remove frost from evaporator.
End of Cycle	When bin is full, a device such as a bin thermostat cuts machine off.
Capacity	Amount of ice a machine will produce in a 24-hour period.
Water Supply	Usually tap water, controlled by solenoi or floa valve.
Refrigeration Cycle	Basic refrigeration cycle is used in wat coolers. Generally R-12 is used as the refrigerant. Suction typically is 25-30 psig after defrost cycle to 0-5 psig prior to defrost cycle as ice is ready to harvest.
Auger	Rotating shaft with screw shaped ridges used in flake ice makers.
Harvest Chute or Plate	Used to move harvested ice from evaporat to storage bin.
Sump Pump	Water pump used to move water from sump tank to water spray nozzles in evaporato during freeze cycle.
Agitator Motor	Used to drive linkage mechanism which in turn drives oscillating jet spray tube, in some types of ice makers.
Timer	Key part of cyclematic control system.
Actuator Motor	Lowers water plate during harvest cycle, separating it from evaporator and raise it to hold it against evaporator during freeze cycle.

UNIT 23.0 — COMMERCIAL REFRIGERATION: ICE MACHINE

TASK 23.18 (Orientation) — TEST CIRCULATING PUMP

PERFORMANCE OBJECTIVE:

Given an operating ice machine, test the circulating pump for correct amount of water flow. The circulating pump will deliver the GPM as specified by the manufacturer's design.

PERFORMANCE ACTIONS: (Actions to be clarified by instructor or manufacturer's service manual)

ORIENTATION TRAINING:

23.1801 Identify typical types of circulating pumps used in ice makers.

23.1802 Locate the circulating pump on given ice maker(s

23.1803 Describe procedures for testing circulating pump

23.1804 Identify safety considerations.

PERFORMANCE STANDARDS:

-Test the circulating pump of an operating ice machine. The circulating pump should deliver the GPM as specified by the manufacturer's design.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 23.0 COMMERICAL REFRIGERATION: ICE MACHINE

TASK 23.19 (Orientation) ADJUST WATER LEVEL

PERFORMANCE OBJECTIVE:

Given an ice machine and the necessary tools adjust the water level in the reservoir so that it is 75 percent filled with water or to manufacturer's specifications.

PERFORMANCE ACTIONS: (Actions to be clarified by instructor or manufacturer's service manual.)

ORIENTATION TRAINING:

23.1901 Describe how to adjust the water level in an ice machine.

23.1902 Explain the importance of maintaining a proper/ recommended water level.

23.1903 Identify safety considerations.

PERFORMANCE STANDARDS:

-Adjust the water level in a given ice machine so that the reservoir water level is 75 percent filled.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 23.0 COMMERCIAL REFRIGERATION: ICE MACHINE

TASK 23.20 (Orientation) ADJUST HARVEST THERMOSTAT

PERFORMANCE OBJECTIVE:

Given an ice machine, the necessary tools, and required materials; adjust the harvest thermostat so that it initiates the harvest cycle when the ice is frozen solid.

PERFORMANCE ACTIONS: (Actions to be clarified by instructor or manufacturer's service manual.)

ORIENTATION TRAINING:

23.2001 Locate the harvest thermostat in a given ice maker.

23.2002 Identify/describe different types of harvest thermostats.

23.2003 Describe the sequence of events leading up to the harvest cycle.

23.2004 Explain how to adjust the harvest thermostat.

23.2005 Identify safety considerations.

PERFORMANCE STANDARDS:

-Adjust the harvest thermostat so that it initiates the harvest cycle when the ice is frozen solid.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 23.0 COMMERCIAL REFRIGERATION: ICE MACHINE

TASK 23.21 ADJUST STORAGE BIN THERMOSTAT

PERFORMANCE OBJECTIVE:

Given an ice machine with adjustable storage bin thermostat, adjust the storage bin thermostat so that it cuts off the machine when the ice level reaches the sensor bulb and cuts in when the ice level falls.

PERFORMANCE ACTIONS: (Actions to be clarified by instructor or manufacturer's service manual.)

ORIENTATION:

23.2101 Explain purpose of storage bin thermostat.

23.2102 Locate the storage bin thermostat.

23.2103 Describe the types of sensors available.

23.2104 Explain the bellows type controls.

23.2105 Explain the operation of solid state type controls (thermisters).

23.21.06 Explain range and differential.

23.2107 Identify safety considerations.

PERFORMANCE STANDARDS:

-Adjust storage bin thermostat so that it cuts off the machine when the ice level reaches the sensor bulb and cuts in when the ice level falls.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 23.0 — COMMERCIAL REFRIGERATION: ICE MACHINE

TASK 23.22 — TROUBLESHOOT ICE MAKER

PERFORMANCE OBJECTIVE:

Given a commercial ice maker, mechanic's tools, calibration thermometer, gauge manifold, VOM, ammeter, cleaning cloth, and other materials needed; located, solve, and correct problems found a a malfunctioning ice maker. Adjust the ice maker to the proper operating conditions. Performance must be to instructor's standards.

PERFORMANCE ACTIONS:

23.2201 Check water system.

23.2202
a. Test water-in temperature.
b. Test float controlling water level.
c. Test cleanliness of water control devices.

23.2203 Check water pump.

23.2204
a. Check mechanism.
b. Clean condenser.
c. Oil fan motors.
d. Install gauge manifold.

23.2205 Check defrost system.

23.2206 Test for leaks.

23.2207 Check ice-making cycle.

23.2208 Record pressures after 15 minutes of operation.

23.2209 Remove gauge manifold.

23.2210 Shut down system.

PERFORMANCE STANDARDS:

-Troubleshoot an ice maker. Locate, solve, and correct problems found in a malfunctioning ice maker. Adjust the ice maker to the proper operating conditions. Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

- Principles of operation of ice maker
- Electrical control system
- Mechanical operation of system
- How the ice maker works

NOTE TO INSTRUCTOR:
The following publication is recommended as a learning reference concerning ice makers.

Commercial Refrigeration, Unit VI, Refrigeration and Air Conditioning, R.S.A., Natchitoches, LA (71457): Louisiana Vocational Curriculum Development and Research Center, 1980. (Pages 100-153 include theory, diagrams, drawings, electrical schematics, and practical information concerning servicing ice makers.) A test book is available to accompany the publication.

SERVICE DIAGNOSIS CHART

SYMPTOM	POSSIBLE CAUSE
1. Compressor hums, but not start	1. Improperly wired. 2. Low line voltage. 3. Defective run or start capacitor 4. Defective start relay. 5. Unequalized pressures on PSC motor. 6. Shorted or grounded motor windings 7. Internal compressor mechanical damage.
2. Compressor will not run, does not try to start (no hum)	1. Power circuit open due to blown fuse, tripped circuit breaker, or open disconnect switch. 2. Compressor motor protector open. 3. Open thermostat or control. 4 Burned motor winding--open circuit
3. Compressor starts, but trips on overload protector.	1. Low line voltage. 2. Improperly wiered. 3. Defective run or start capacitor. 4. Defective start relay. 5. Excessive suction or discharge pressure. 6. Tight bearings or mechanical damange in compressor. 7. Defective overload protector. 8. Shorted or grounded motor windings.
4. Unit short cycles	1. Control differential too small. 2. Shortage of refrigerant. 3. Discharge pressure too high. 4. Discharge valve leaking.
5. Starting relay burns out	1. Low or high line voltage. 2. Short cycling. 3. Improper mounting of relay. 4. Incorrect running capacitor. 5. Incorrect relay.
6. Contacts stick on starting relay	1. Short running cycle. 2. No bleed resistor on start capacitor.
7. Starting capacitor burn out	1. Compressor short cycling. 2. Relay contacts sticking. 3. Incorrect capacitor. 4. Start winding remaining in circuit for prolonged period.
8. Running capacitors burn out	1. Excessively high line voltage. 2. High line voltage, light compressor load. 3. Capacitor voltage rating too low.
9. Head pressure too high	1. Refrigerant overcharge. 2. Air in system. 3. Dirty condenser. 4. Malfunction of condenser fan (air cooled). 5. Restricted water flow (water-cooled). 6. Excessive air temperature enterin condenser. 7. Restriction in discharge line.

SYMPTOM	POSSIBLE CAUSE
10. Head pressure too low	1. Low ambient temperatures (air-cooled). 2. Refrigerant shortage. 3. Damaged valves or rods in compressor.
11. Refrigeranted space temperature too high	1. Refrigerant shortage. 2. Restricted strainer, drier, or expansion device. 3. Improperly adjusted expansion valve. 4. Iced or dirty evaporator coil. 5. Compressor malfunctioning.
12. Loss of oil pressure	1. Loss of oil from compressor due to: (a) Oil trapping in system. (b) Compressor short cycling. (c) Insufficient oil in system. (d) Operation at excessively low suction pressure. 2. Excessive liquid refrigerant returning to compressor. 3. Malfunctioning oil pump. 4. Restriction in oil pump inlet screen.

(OPTIONAL)
ADDITIONAL OBJECTIVES
COMMERCIAL REFRIGERATION

1. REMOVE, CLEAN, INSTALL, AND OPERATE AN OIL SEPARATOR
   a. Check unit.
   b. Install gauge manifold.
   c. Remove refrigerant from system: Balance pressures; Remove oil separator.
   d. Dismantle and clean separator.
   e. Assemble separator.
   f. Install separator: Test for leaks: Evacuate system: Charge system.
   g. Run unit for about 20 minutes to check it out.

2. REMOVE, INSPECT, INSTALL, AND ADJUST A COMMERCIAL TYPE MOTOR CONTROL
   a. Examine control and determine the cut-in and cut-out settings.
   b. Determine safety control setting using a hydraulic pump and gauge.
   c. Determine low-side control settings using vacuum pump with compound gauge.
   d. Adjust cut-in and cut-out points.
   e. Install the control in the system.
   f. Operate and test system for 20 minutes.

3. INSTALL A CHILLED WATER SYSTEM ON A BEVERAGE COOLER WITH MULTIPLE EVAPORATOR
   a. Install gauge manifold.
   b. Check operation of unit.
   c. Dismantle water and drain lines.
   d. Reinstall water-in and drain lines.
   e. Operate unit.

4. INSTALL A REFRIGERATED DISPLAY CASE
   a. Install condensing unit and evaporator.
   b. Install suction line and liquid line.
   c. Install electrical wiring to code standards.
   d. Evacuate system and charge with vapor to 25 psi (or to specifications.)
   e. Test for leaks.
   f. Deep evacuate system or triple evacuate system.
   g. Install filter-drier and sight glass.
   h. Start unit, charge, test for leaks. Run for 20 minutes
   i. Remove gauge manifold.

5. INSTALL A REACH-IN CABINET SYSTEM
   a. Install condensing unit and evaporator.
   b. Install thermostatic expansion valve. Connect blower motor to AC power source.
   c. Install suction line and liquid line.
   d. Install electrical wiring.

e. Install evaporator drain.
f. Install gauge manifold.
g. Either evacuate or purge evaporator (or both).
h. Test for leaks.
i. Produce a deep vacuum or use triple vacuum system.
j. Charge system.
k. Operate for 15 minutes. Test for leaks.
l. Remove aguage manifold.

6. INSTALL A LOW-TEMPERATURE (OPEN CASE) REFRIGERATION SYSTEM (E.G., FROZEN FOOD DISPLAY)
   a. Inspection equipment installation requirements.
   b. Positon cabinet and condensing unit.
   c. Connect suction line, liquid line, and AC power.
   d. Evacuate system charge to 25 psi (or specifications) refrigerant pressure and test for leaks.
   e. If no leaks are observed, charge to 70-100 psi pressure and test for leaks.
   f. If no leaks are found, evacuate using deep vacuum method or triple vacuum system.
   g. Balance pressures, remove liquid line connection of condensing unit end and install drier and sight glass.
   h. Purge liquid line.
   i. Charge system.
   j. Operate unit for 10-20 minutes and check pressures and temperatures.
   k. Remove gauge manifold.

7. INSTALL WALK-IN COOLER
   a. Inspect equipment installation requirements.
   b. Position cabinet and condensing unit.
   c. Connect suction line, liquid line, water lines, and electrical service.
   d. Evacuate system: Charge to 35 psi: Check for leaks.
   e. If no leaks, charge to 75 psi: Check for leaks.
   f. If no leaks, use deep vacuum method or triple vacuum system.
   g. Balance pressures, remove liquid line connection at condensing unit: Install drier and sight glass.
   h. Purge liquid line.
   i. Charge system.
   j. Operate system for about 15 minutes: Check pressures and temperatures.
   k. Remove gauge manifold.

8. INSTALL REMOTE AIR-COOLED CONDENSER
   a. Position remote air-cooled condenser and compressor uni
   b. Install condenser line and return line according to pla
   c. Connect electric devices according to plan.
   d. Evacuate system: Charge with vapor refrigerant to 25 p Test for leaks.
   e. If no leaks: Charge to 75 psi: Test for leaks.
   f. If no leaks: Evacuate by deep evacuation method or triple evacuation method.
   g. Charge system.

h. Operate system for about 15 minutes.
i. Remove gauge manifold.
j. Shut system down.

9. INSTALL AND TEST COMMERCIAL ROOFTOP UNIT
a. Inspect equipment requirements.
b. Position evaporator.
c. Position rooftop condensing unit: Check fi level.
d. Connect suction line, liquid line, and electrical service.
e. Install gauge manifold.
f. Evacuate system: Charge to 25 psi: Test for leaks.
g. If no leaks: Charge to 75 psi: Test for leaks.
h. If no leaks. Use a deep vacuum method of triple vacuum method.
i. Balance pressures: Remove liquid line connections at condensing unit: Install drier and sight glass.
j. Recharge system.
k. Operate system for 15-30 minutes: Check pressures and temperatures.
l. Remove gauge manifold.
m. Shut down system.

UNIT 24.0

COMMERCIAL AIR CONDITIONING

INITIAL DRAFT OF UNIT:
REVISIONS MAY BE NECESSARY

COMMERCIAL AIR CONDITIONING

(Advanced Air Conditioning)

The purpose of this unit is to recognize that there are task in the installation, maintenance, and servicing of commercial or industrial air conditioning systems that have not been covered in previous units.

For the purpose of this unit decription, commercial air conditioning systems, orientation training might include:

- -expansion-valve air conditioning system
- -package cooling units
- -rooftop heating and cooling units
- -direct multizone systems
- -evaporative cooling systems
- -absorption-type air conditioning systems
- -chilled water air conditioning
- -chillers
- -console-type air conditioning systems

While the basic principles of air conditioning and refrigeration and servicing may apply to commercial air conditioning systems, there are new tasks to which the student should be introduced, especially concerning the design, control, and maintenance of larg commercial air conditioning systems.

Primarily, the secondary student will be introduced (given orientation training) to aspects of commercial air conditioning systems including an orientation to industrial controls.

Consideration should be given to providing secondary students who excell with an "individualized study assignment" concerning advanced automatic controls, or other appropriate topics identified by the instructor as important in commercial air conditioning.

Unless the secondary air conditioning program has access to a local commercial air conditioning system for instruction, training probably will be concentrated on theory or fundamentals and an orientation using visual illustrations; classroom mock-ups of controls, etc.; and systems at shopping malls, high rise office buildings, hospitals, or industrial manufacturing plants.

One reference used in the development of this unit is:

Cooper, William B., Licensed Operator's Key to Refrigeration Troy, Mi: Business News Publishing Company, 1974. (Topics include: Refrigerants, compressors, condensers and receivers, metering devices, evaporators, controls and safety devices, piping and accessories, and system operation.)

HVAC
COMMERCIAL AIR CONDITIONING
SUGGESTED INSTRUCTION TIME

HVAC UNIT/TASK		SUGGESTED HOURS
Unit 24.0	COMMERCIAL AIR CONDITIONING	
24.01	Identify Different types of Commercial Air Conditioning Systems and Typical Applications	*
24.02	Inspect Electrical Wiring to a Commercial AC System	*
24.03	Inspect and Clean Evaporator and Condenser	*
24.04	Test Air Flow Across Evaporator	*
24.05	Determine Temperature Drop Across Evaporator	*
24.06	Determine Temperature Rise Acroos Condenser	*
24.07	Test Charge in Commercial AC Unit	*
24.08	Test Operating Pressures	*
24.09	Determine Pumping Efficiency of a Compressor	*
24.10	Test Supply and Return Temperatures on Chilled Water System	*
24.11	Test Pressure Differential on a Chiller Pump	*
24.12	Test Air Flow	*
24.13	Identify Cooling Tower Systems and Water Treatment Considerations	*
24.14	Inspect Screens and Water Level on a Tower.	*
24.15	Test Spray Nozzles on a Water Tower	*
24.16	Test Water Pump on Tower	*
24.17	Identify Primary and Secondary Controls in Commercial Systems	*

* Total Times Estimated

HVAC
TASK LISTINGS

UNIT/TASK	DESCRIPTION
Unit 24.0	COMMERCIAL AIR CONDITIONING
24.01	(IDENTIFY DIFFERENT TYPES OF COMMERCIAL AIR CONDITIONING SYSTEMS AND TYPICAL APPLICATIONS) Given an indroduction to different types of commercial air conditioning systems and their typical applications and field trips to different types of installations, identify common types of commercial air conditioning systems installed in the local community and identify some advantages and/or disadvantages of the systems. Performance must be to the instructor's standards.
24.02	(INSPECT ELECTRICAL WIRING TO COMMERCIAL AC SYSTEM) Given a commercial/industrial AC unit/system, necessary tools and materials, electrical wire and connectors, and power distribution panel; "inspect" the electrical wiring installation to the commercial AC unit. The electrical wiring must be able to carry the proper load and must deliver the proper voltage. The unit must operate as designed.
24.03	(INSPECT AND CLEAN EVAPORATOR AND CONDENSER) Given a commercial refrigeration system, necessa tools, and cleaning materials; inspect and clea the evaporator and condenser. The evaporator and condenser will be clean.
24.04	(TEST AIR FLOW ACROSS EVAPORATOR) Given an air conditioner unit and access to the necessary test equipment, test the air flow across the evaporator. The air flow will match the manufacturer's recommended volumn.
24.05	(DETERMINE TEMPERATURE DROP ACROSS EVAPORATOR) Given a commercial air conditioning unit and thermometers, determine the temperature drop across the evaporator. The measured temperature drop will be within 2 degrees of actual drop (+-20 degrees.)
24.06	(DETERMINE TEMPERATURE RISE ACROSS CONDENSER) Given a commercial air conditioner and thermome determine the temperature rise across the conde The temperature rise will be within 2 degrees o the manufacturer's recommended rise.

24.07 (TEST CHARGE IN COMMERCIAL AC UNIT) Given a commercial air conditioning unit and access to the necessary tools, equipment and test instruments; test the charge in the AC unit. The charge will be within 5 percent of the manufacture recommended charge.

24.08 (TEST OPERATING PRESSURES) Given a commercial air conditioning unit, gauge and manifold set, and necessary tools, equipment, and materials, test the operating pressures. The pressures must be within 2 psi of the actual pressures.

24.09 (DETERMINE PUMPING EFFICIENCY OF A COMPRESSOR) Given a commercial air conditioning system gauges, and necessary tools, determine the pumping efficiency of the compressor. The compressor will pump a 25 inch vacuum while maintaining a 125 psi head (or to system specifications.)

24.10 (TEST SUPPLY AND RETURN TEMPERATURES ON CHILLED WATER SYSTEM) Given a commercial chilled water air conditioning system and access to the proper equipment; test the supply and return temperatures on the chilled water system. The temperature difference between the chilled water leaving and returning will be to the manufacturer's specifications.

24.11 (TEST PRESSURE DIFFERENTIAL ON A CHILLER PUMP) Given a chiller water pump and the necessary tools and equipment, check the pump for correct pressure difference. The pump will deliver the G.P.M. as determined by the manufacturer.

24.12 (TEST AIR FLOW) Given a commercial air handling unit, test the air flow. The air flow must match the CFM of design according to the manufacturer's specifications.

24.13 (IDENTIFY COOLING TOWER SYSTEMS AND WATER TREATMENT CONSIDERATIONS) Given an orientation to different types of cooling tower installations and water treatment techniques, identify cooling tower installations generally used in the communi and identify water treatment considerations.

24.14 (INSPECT SCREENS AND WATER LEVEL ON A TOWER) Given a water cooling tower and the necessary too inspect the screens and water level on the tower. The screens must be clean and the water level bel the overflow pipe.

24.15 (TEST SPRAY NOZZLES ON A WATER TOWER) Given a water tower and access to the necessary tools, test the spray nozzles on the water tower. The spray will be spread so as to distribute the water evenly over the base of the drip pan.

24.16 (TEST WATER PUMP ON TOWER) Given a water pump, test for water flow through the tower. The pump must deliver the G.P.M. as designed.

24.17 (IDENTIFY PRIMARY AND SECONDARY CONTROLS IN COMMERCIAL SYSTEMS) Given instruction and orientation to controls and safety devices used in commercial iar conditioning systems, identify primary and secondary controls as type of device, typical location, and funtion. Performance must be to instructor's standards,

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.01 (Orientation) IDENTIFY DIFFERENT TYPES OF COMMERCIAL AIR CONDITIONING SYSTEMS AND TYPICAL APPLICATIONS

PERFORMANCE OBJECTIVE:

Given an introduction to different types of commercial air conditioning systems and ther typical applications and field trips to different types of installations, identify common types of commercial air conditioning systems installed in the local community and identify some advantages and/or disadvantages of the systems. Performance must be to the instructor's standards.

PERFORMANCE ACTIONS:(Orientation)

24.0101 Identify systems selected by instructor, such as:
- a. Expansion-Valve System
- b. Package Cooling Units
- c. Direct Multizone System
- d. Evaporative Cooling System
- e. Absorption-Type System
- f. Chilled Water System
- g. Chillers

24.0102 Identify characteristics of systems (selected by instructor:)
- a. Slab, roof, etc., mounted
- b. Cooling and Heating package
- c. Type of refrigerant
- d. Problems such as tower fungi, etc.
- e. Dangers such as ammonia refrigerant
- f. Mechanical requirements such as pumps, etc.
- g. ~~Requirements for specialized~~ personnel for operation and maintenance
- h. Special controls such as electronic or pneumatic
- i. Water considerations

24.0103 Identify maintenance considerations for entry level workers on systems selected by instructor:
- a. Maintenance considerations
- b. Troubleshooting considerations

PERFORMANCE STANDARDS:

-Identify different types of commercial air conditioning systems selected by the instructor and identify characteristics and maintenance considerations for the systems. Performance must be to the instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.02 INSPECT ELECTRICAL WIRING TO COMMERCIAL AC SYSTEM

PERFORMANCE OBJECTIVE:

Given a commercial/industrial AC unit/system, necessary tools and materials, electrical wire and connectors, and power distribution panel; "inspect" the electrical wiring installation to the commercial AC unit. The electrical wiring must be able to carry the proper load and must deliver the proper voltage. The unit must operate as designed.

PERFORMANCE ACTIONS: (See previous units)

Visit commercial Air Conditioning installation, possibly at a shopping mall, office complex-building, or manufacturuing plant to observe installation and operation of commercial AC system.

24.0201 Identify load and voltage requirements.

24.0202 Identify power source/distribution panel.

24.0203 Identify overload device rating.

24.0204 Note applicable NEC requirements.

24.0205 Describe how to wire the AC unit to the line sou

24.0206 Describe how to wire the AV unit to the control voltage.

24.0207 Describe how to install controls for the unit.

24.0208 Read the schematic of the unit (electrical schematic.)

24.0209 Explain the operating sequence of the system.

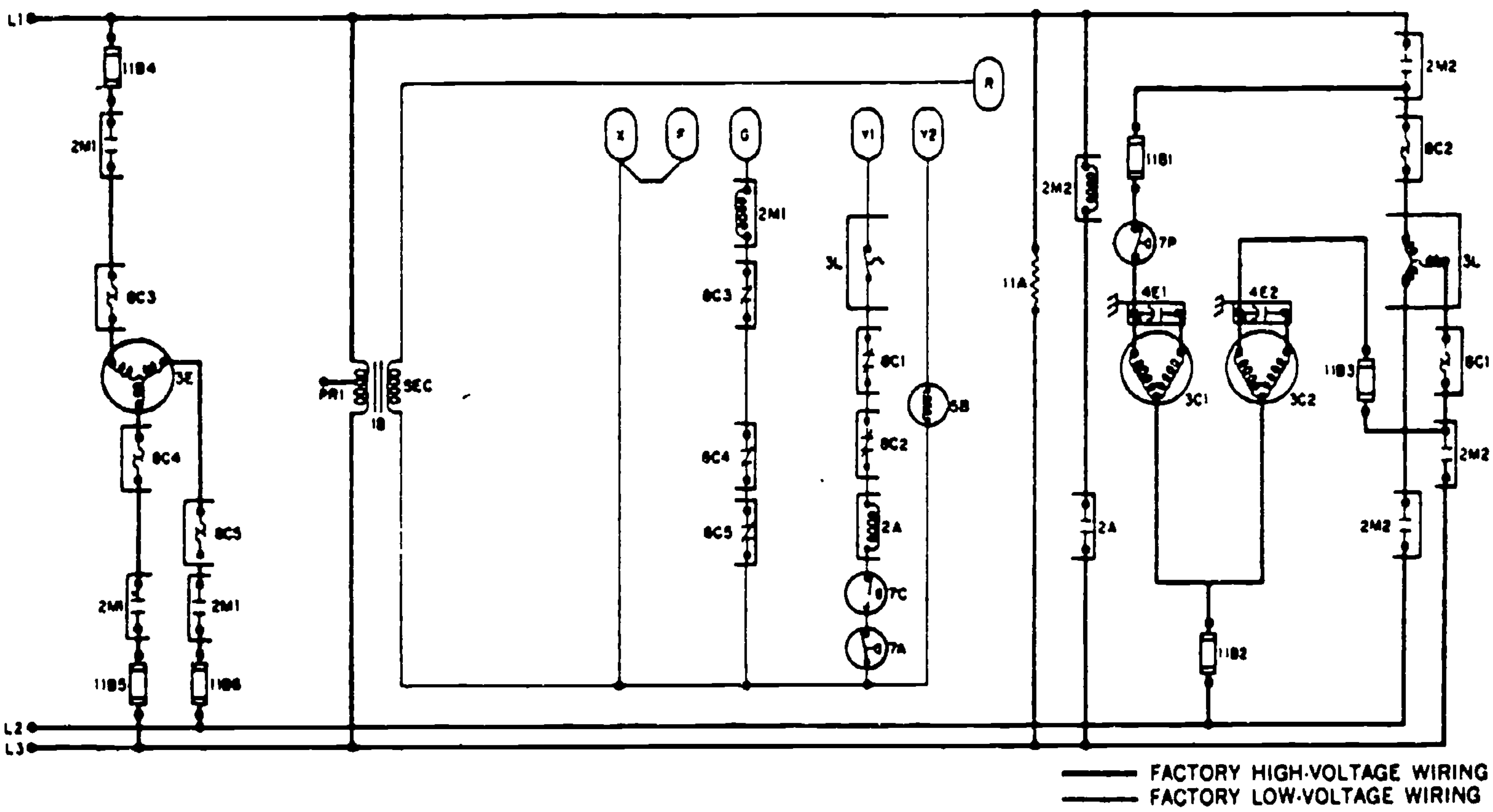
PERFORMANCE STANDARDS:

-Inspect installation of electrical wiring to commercial AC syste for proper voltage at the proper load, for proper overload devic and for compliance with the NEC. The AC system must operate as designed.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Low voltage circuits
-230V - 60 Hz - 1Ø (note 230 V = 240V)
-208 - 230V - 3Ø
-460V -3Ø



LEGEND

1B-Transformer (Tapped Primary)
2A-Cooling Relay N.O.
2M1-Blower Motor Contactor N.O.
2M2-Compressor Contactor N.O.
3C1 & 2-Fan Motors
3E-Blower Motor
3L-Compressor with Internal Overload
4E1 & 2-Run Capacitor
5B-Liquid Line Solenoid Valve
7A-High-Pressure Switch N.C.
7C-Low-Pressure Switch N.C.
7P-Low-Ambient Pressure Switch N.O.
8C1 & 2-Compressor Overloads
8C3, 4, & 5-Blower Motor Overload
11A-Crankcase Heater
11B1, 2, & 3-Fan Motor Fuses
11B4, 5, & 6-Blower Motor Fuses

WIRING DIAGRAM FOR A 208-240 VOLT OPERATION

UNIT 24.0 — COMMERCIAL AIR CONDITIONING

TASK 24.03 — INSPECT AND CLEAN EVAPORATOR AND CONDENSER

PERFORMANCE OBJECTIVE:

Given a commercial refrigeration system, necessary tools, and cleaning materials; inspect and clean the evaporator and condenser. The evaporator and condenser will be clean.

PERFORMANCE ACTIONS: (See previous unit descripiton)

"Instructor to describe typical actions for system."

24.0301 Locate the evaporator and condenser.

24.0302 Describe the procedure for inspecting the evaporator and condenser.

24.0303 Describe the procedure for cleaning the evaporato and condenser.

24.0304 Identify typical cleaning chemicals and their important characteristics.

24.0305 Identify safety considerations.

PERFORMANCE STANDARDS:

-Inspect and clean the evaporator and condenser on a commercial refrigeration system.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.04 TEST AIR FLOW ACROSS EVAPORATOR

PERFORMANCE OBJECTIVE:

Given an air conditioner unit and access to the necessary test equipment, test the air flow across the evaporator. The air flow will match the manufacturer's recommended volumn.

PERFORMANCE ACTIONS: (See previous unit description.)

"Instructor to identify typical actions for task."

24.0401 Describe how to use air measuring instruments

24.0402 Describe how to determine the amount of air flow.

24.0403 Identify safety considerations.

PERFORMANCE STANDARDS:

-Test air flow across a given evaporator (air conditioner.) The air flow must match the manufacturer's recommended volumn.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.05 DETERMINE TEMPERATURE DROP ACROSS EVAPORATOR

PERFORMANCE OBJECTIVE:

Given a commercial air conditioning unit and thermometers, determir the temperature drop across the evaporator. The measured temperatu drop will be within 2 degrees of actual drop (+-20 degrees.)

PERFORMANCE ACTIONS: (See previous unit descriptions)

PERFORMANCE STANDARDS:

-Determine temperature drop across given commercial/ industrial type air conditioning evaporator unit. Temperature drop must be within 2 degrees of 20 degree TD.*

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-*20 degree TD 1+/-2 degrees represents typical commercial/ industrial systems. Special systems may have a different TD.

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.06 DETERMINE TEMPERATURE RISE ACROSS CONDENSER

PERFORMANCE OBJECTIVE:

Given a commercial air conditioner and thermometers, determine the temperature rise across the condenser. The temperature rise will be within 2 degrees of the manufacturer's recommended rise.

PERFORMANCE ACTIONS: (See previous unit descriptions.)

24.0601 Explain temperature rise.

24.0602 Identify where/how to measure temperature rise.

24.0603 Identify safety considerations.

PERFORMANCE STANDARDS:

-Determine temperature rise across the condenser of a given commercial air conditioner using thermometers. The temperature rise will be within 2 degrees of the manufacturer's recommended rise.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.07 TEST CHARGE IN COMMERCIAL AC UNIT

PERFORMANCE OBJECTIVE:

Given a commercial air conditioning unit and access to the necessary tools and equipment and test instruments; test the charge in the AC unit. The charge will be within 5 percent of the manufacturer's recommended charge.

PERFORMANCE ACTIONS: (See previous unit descriptions)

24.0701 Describe the methods of checking the charge in an AC unit.

24.0702 Select the proper method to use for given conditon situations.

24.0703 Determine the manufacturer's recommended charge for the given unit.

24.0704 Explain how to use Pressure Temperature Charts.

24.0705 Identify safety considerations.

PERFORMANCE STANDARDS:

-Test charge in commercial AC unit. The charge must be within 5 percent of the manufacturer's recommended charge.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.08 TEST OPERATING PRESSURES

PERFORMANCE OBJECTIVE:

Given a commercial air conditioning unit, gauge, and manifold set, and necessary tools, equipment, and materials; test the operating pressures. The pressures must be within 2 psi of the actual pressures.

PERFORMANCE ACTIONS: (See previous unit descriptions)

24.0801 Describe how to use the Pressure/Temperature Char

24.0802 Describe the procedures for setting up pressure gauges.

24.0803 Describe how to read pressure gauges.

24.0804 Determine correct operating pressures.

24.0805 Identify safety considerations.

PERFORMANCE STANDARDS:

-Test operating pressures on a given commercial air conditioning system. The pressures must be within 2 psi of the actual pressures.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.09 (ORIENTATION) DETERMINE PUMPING EFFICIENCY OF A COMPRESSOR

PERFORMANCE OBJECTIVE

Given a commercial air conditioning system gauges, and necessary tools, determine the pumping efficiency of the compressor. The compressor will pump a 25 inch vacuum while maintaining a 125 psi head (or to system specifications.)

PERFORMANCE ACTIONS: (Orientation)

"During field trip to commercial system:"

24.0901 Identify high and low sides of system.

24.0902 Describe how to use service valves.

24.0903 Describe how to read gauges.

24.0904 Explain the operating characteristics of a low pumping capacity compressor.

24.0905 Identify safety considerations.

PERFORMANCE STANDARDS:

-Determine pumping efficiency of a compressor in a commercial air conditioning sysstem (or describe procedures for determining pumping efficiency.) The compressor should pump 25 inches vacuum while maintaining 125 psi head (or to specifications for system.)

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe procedure;
a. Discharge high side open to atmosphere, as applicable.
b. Low side to compound gauge.
c. Run compressor.
d. Compound gauge should pull down to +/-28 inches vacuum.
e. Stop Compressor: Compound gauge should stay where it (reading) is.

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.10 (ORIENTATION) TEST SUPPLY AND RETURN TEMPERATURES ON CHILLED WATER SYSTEM

PERFORMANCE OBJECTIVE:

Given a commercial chiled water air conditioning system and access to the proper equipment; test the supply and return temperatures on the chilled water system. The temperature difference between the chilled water leaving and returning will be to the manufacturer's specifications.

PERFORMANCE ACTIONS: (orientation Training)

"Instructor will clarify actions."

24.1001 Identify/determine manufacturer's specifications.

24.1002 Describe importance of supply and return temperatures.

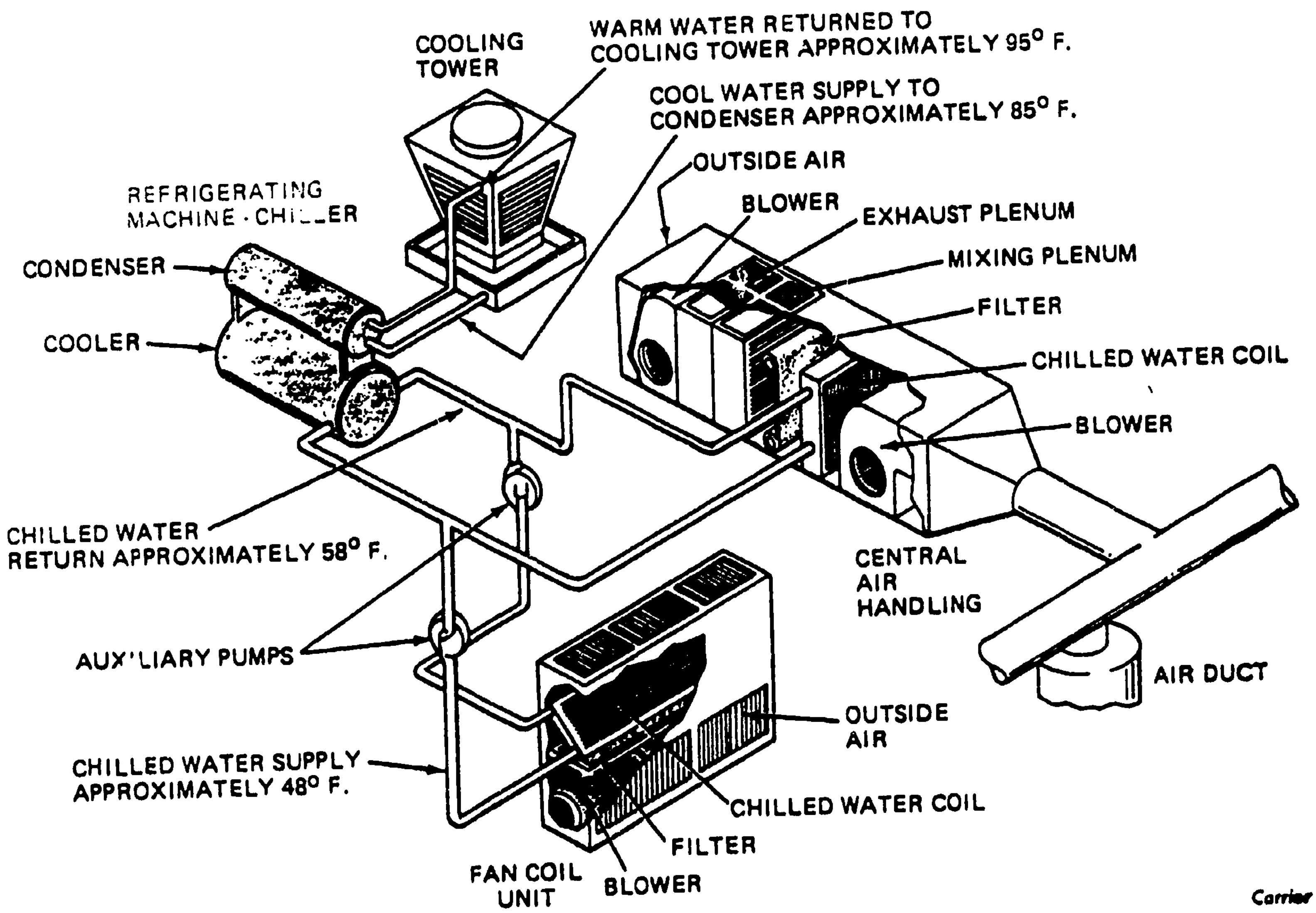
24.1003 Describe procedure for testing supply and return temperatures on a chilled water system.

24.1004 Identify safety considerations.

PERFORMANCE STANDARDS:

-Test supply and return temperatures on a chilled water system. The temperature difference (TD) between the chilled water leaving and returning will be at the manufacturer's specification
-TD will be 10 degrees on cooling tower and condenser.

SUGGESTED INSTRUCTION TIME: Hours



Complete air-conditioning system using chilled water.

UNIT 24.0 — COMMERCIAL AIR CONDITIONING

TASK 24.11 (ORIENTATION) — TEST PRESSURE DIFFERENTIAL ON A CHILLER PUMP

PERFORMANCE OBJECTIVE:

Given a chiller water pump and the necessary tools and equipment, check the pump for correct pressure difference. The pump will deliver the G.P.M. as determined by the manufacturer.

PERFORMANCE ACTIONS: (Orientation Training)

"Instructor will clarify actions."

24.1101 Describe how to test a chiller pump.

24.1102 Explain the importance of correct pumping capacit

24.1103 Describe procedure for checking pressure differential on a chiller pump.

24.1104 Identify safety considerations.

PERFORMANCE STANDARDS:

-Test pressure differential on a chiller pump. The pump must deliver the G.P.M. as determined by the manufacturer.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.12 (ORIENTATION) TEST AIR FLOW

PERFORMANCE OBJECTIVE:

Given a commercial air handling unit, test the air flow. The air flow must match the CFM of desgin according to the manufacturer's specifications.

PERFORMANCE ACTIONS: (Orientation Training)

"Instructor to clarify actions:"

24.1201 Identify air-measuring instruments.

24.1202 Describe how to use air-measuring instruments (selected by the instructor.)

24.1203 Describe/demonstrate how to read a tachometer.

24.1204 Identify the manufacturer's design specifications on given air handling units.

24.1205 Determine CFM (cubic-feet-minute) of a given air handling unit.

24.1206 Identify safety considerations.

PERFORMANCE STANDARDS:

-Test the air flow of an air handling unit. The air flow must match the CFM of design according to the manufacturer's specifications.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.13 (ORIENTATION) IDENTIFY COOLING TOWER SYSTEMS AND WATER TREATMENT CONSIDERATIONS

PERFORMANCE OBJECTIVES:

Given an orientation to different types of cooling tower installations and water treatment techniques, identify cooling tower installations generally used in the community and identify water treatment considerations.

PERFORMANCE ACTIONS: (Orientation)

24.1301 Identify:
- a. Natural-draft tower
- b. Forced-draft tower:
  - (1) Draw-through
  - (2) Blow-through

24.1302 Iden:ify considerations in locating a tower.

24.1303 Identify typical water piping and pump requirements.

24.1304 Identify typical electrical requirements.

24.1305 Identify water treatment considerations:
- a. scale
- b. Acid corrosion from atmosphere/water contact.
- c. Algae and Bacteria

24.1306 Identify hard and soft water considerations.

24.1307 Identify some methods to control or remove impuri ties, formations, etc.

PERFORMANCE STANDARDS:

-Identify typical cooling tower systems and typical water treatment considerations. Performance must be to the instructor' standards.

SI(GESTED OMSTRICTOPM TC,E: Hours

RELATED TECHNICAL INFORMATION:

-Identify terminology:

a Hard water
b. Soft water
c. Scale
d. Scale inhibitor
e. Corrosion formation
f. Corrosion control
g. Algecide

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.14 (ORIENTATION) INSPECT SCREENS AND WATER LEVEL ON A TOWER

PERFORMANCE OBJECTIVE:

Given a water cooling tower and the necessary tools, inspect the screens and water level on the tower. The screens must be clean and the water level below the overflow pipe.

PERFORMANCE ACTIONS: (Orientation training)

24.1401 Describe the results if the screens become clogged.

24.1402 Describe the importance of maintaining the correct water level.

24.1403 Describe typical water treatment procedures.

24.1404 Identify safety considerations.

PERFORMANCE STANDARDS:

- Inspect a given water cooling tower to determine if the screens are clean and if the water level is below the overflow pipe.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.15 (ORIENTATION) TEST SPRAY NOZZLES ON A WATER TOWER

PERFORMANCE OBJECTIVE:

Given a water tower and access to the necessary tools, test the spray nozzles on the water tower. The spray will be spread so as to distribute the water evenly over the base of the drip pan.

PERFORMANCE ACTIONS: (Orientation training)

24.1501 Describe the operation of a water cooling tower.

24.1502 Explain the importance of spray nozzles.

24.1503 Describe how to check proper operation of spray nozzles.

24.1504 Identify safety considerations.

PERFORMANCE STANDARDS:

-Test spray nozzles on a water tower. The spray must be spread so that the water is distributed evenly over the base of the drip pan.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.16 (ORIENTATION) TEST WATER PUMP ON TOWER

PERFORMANCE OBJECTIVE:

Given a water pump, test for proper water flow through the tower. The pump must deliver the G.P.M. as designed.

PERFORMANCE ACTIONS: (Orientation training)

"Visit industrial/commercial air conditioning system and identify water pump on tower."

24.1601 Describe water pump operation (system).

24.1602 Expalin the importance of maintaining correct G.P.M.

24.1603 Describe general procedure for testing water flow through tower.

24.16.04 Identify safety considerations.

PERFORMANCE STANDARDS:

-Test water pump on tower to determine if the pump is delivering the G.P.M as designed.

SUGGESTED INSTRUCTION TIME: Hours

TASK 24.17 IDENTIFY PRIMARY AND SECONDARY CONTROLS IN COMMERCIAL SYSTEMS

PERFORMANCE OBJECTIVE:

Given instruction and orientation to controls and safety devices used in commercial air conditioning systems, identify primary and secondary controls as to type of device, typical location, and funtion. Performance must be to instructor's standards.

PERFORMANCE ACTIONS:

24.1701 Identify:

a. PRIMARY CONTROLS
Suction pressure controls
Temperature controls
Humidity controls

b. SECONDARY CONTROLS
(1) Operating
-Metering devices
-Starters, contractors, and relays
-water regulating valves
-solenoid valves
-refersing valves
-evaporator pressure regulator
-discharge check valve

(2) Safety
-spring loaded relief valve
-diaphram type relief valve
-fusible plugs
-rupture discs
-high pressure cutout
-low pressure control
-safety thermostat
-electrical overloads
-oil safety switch
-low water cutout

24.1702 Identify maintenance or calibration consideratio of controls selected by instructor.

PERFORMANCE STANDARDS:

-Identify primary and secondary controls used in commercial air conditioning systems. Identify typical location, function, and maintenance or calibration considerations of controls selected by the instructor.

UNIT 24.0 COMMERCIAL AIR CONDITIONING

TASK 24.17 IDENTIFY PRIMARY AND SECONDARY CONTROLS IN COMMERCIAL SYSTEMS(Con'

RELATED TECHNICAL INFORMATION:

-Electrical low voltage circuits
-Electrical power circuits
-Pressure operated controls

UNIT 25.0 - 30.0

HEATING SYYTEMS

The units concerning heating systems and servicing feature: gas, oil, electric, heat pump, hydronics, and solar heating systems.

The combined units may be considered a module on heating systems and servicing.

Training emphasis concerning heating will be on those systems common to the Greenville County, SC region.

It is recognized that tasks may vary from one manufacturer's product to another's. The training tasks in these units therefore will concentrate on the fundamentals of heating systems and basic servicing, adjusting, and repairing of typical systems.

Secondary graduates who are interested in a career as an oil or gas burner mechanic or furnace installer should consider additiona training generally will be limited due to training time, facilitie and materials.

Typically, employers will require addtional on-the-job or manufacturer school training on the systems and equipment they represent.

The units of this heating systems and servicing section (module) include:

Unit 25.0 - Electric Resistance Heating
Unit 26.0 - Heat Pump Systems
Unit 27.0 - Gas Heating
Unit 28.0 - Oil Heating
Unit 29.0 - Hydronics Heating
Unit 30.0 - Solar Heating

Since there is <u>similarity between control systems</u>, the instructor may elect to teach controls as a unit that is applicable to variou types of heating and cooling systems.

The extended list of terms included in the Gas Heating unit may apply to other heating units.

HVAC
HEATING SYSTEM UNITS
SUGGESTED INSTRUCTION TIMES

HVAC UNIT/TASK		SUGGESTED HOURS
UNIT 25.0	ELECTRICAL RESISTANCE HEATING	
25.01	Determine Air Flow and Temperature Rise Across Electric Furnace	*
25.02	Determine Voltage to Heating Element	*
25.03	Determine Condition of Sequence Device	*
25.04	Determine Condition of Blower and Motor	*
25.05	Determine Condition of Safety Devices	*
	HEAT PUMPS	
26.01	Identify Components of Heat Pump	*
26.02	Check Reversing Valve	*
26.03	Check Solenoid Coil and Pilot Valve	*
26.04	Diagnose and Resolve 50V Problems	*
26.05	Test Check Valves	*
26.06	Check Temperature Differential Defrost Control	*
26.07	Check Time-Temperature Defrost Control	*
26.08	Check Pressure Differential Defrost Control	*
26.09	Determine Supplementary Heat Requirements	*

* - Total Time Estimated.

26.10	Install Indoor Thermostat	*
26.11	Determine Temperature Rise and Drop Across Coil	*
26.12	Determine Operating Pressures	*
26.13	Charge a Heat Pump	*
26.14	Inspect Strip Heaters	*
26.15	Install a Heat Pump	*
26.16	Locate Trouble in Heat Pump	*
27.0	GAS HEAT	
27.01	Light and Adjust Pilots	*
27.02	Check Temperature Rise Across Furnace	*
27.03	Determine Gas Pressure of Furnace	*
27.04	Troubleshoot and Replace Fan-Limit Control	*
27.05	Remove and Replace Gas Valve	*
27.06	Remove and Replace Transformer	*
27.07	Remove and Replace Room Thermostat	*
27.08	Remove and Replace Blower and Motor	*
27.09	Align Flue and Mount Draft Diverters	*
27.10	Align Gas Burners	*
27.11	Wire Gas Heating System as Required	*
27.12	Adjust Gas Pressure Regulator	*
27.13	Adjust Primary Air Flow on Burner	*
27.14	Identify Trouble Symptom	*
27.15	Compute Cubic Feet Per Hour Requirements for Furnace	*

* - Total Time Estimated.

28.0	OIL HEATING	
28.01	Clean or Replace Furnace Filter	*
28.02	Adjust Oil Burner	*
28.03	Troubleshooting Oil Heater	*
29.0	HYDRONICS	
29.01	Adjust Low Water Switch	*
29.02	Check Water Temperature of a Boiler	*
29.03	Circulating Pump	*
30.0	SOLAR HEATING SYSTEMS	
30.01	Identify Basic Types of Solar Heating Systems	*
30.02	Identify Basic "Rules of Thumb" for Adjusting Solar Installations	*
30.03	Identify Basic Components of Typical Flat Plate Collector	*
	TOTAL HOURS -	45

* - Total Time Estimated for Entire Heating Systems Units.

UNIT 25.0

ELECTRICAL RESISTANCE HEATING

Electric resistance heating introduces the secondary student to the basic installation and serving fundamentals of electric resistance heating systems.

Upon completing this unit, the student should be prepared to decribe a basic electrical resistance heating system, identify major components of an electrical resistance heating system, and list (or describe) areas of potential problems in electrical sequencing and relay equipment in a system.

Prior to beginning training in this unit, the student should demonstrate competence in use of the mechanic's hand tools, use of electrical instruments suc as the VOM and clamp-on ammeter, the ability to read electrical schematics or diagrams, and the ability to install, troubleshoot, and service basic electrical circuits.

UNIT/TASK	DESCRIPTION
Unit 25.0	ELECTRICAL RESISTANCE HEATING
25.01	(DETERMINE AIR FLOW AND TEMPERATURE RISE ACROSS ELECTRICAL FURNANCE) Given an electric furnace thermometers, tools and other materials/reference neeeded; determine the air flow and temperature rise across the electric furnace. The air flow and temperature rise will be within 10 percent of manufacturer's design specifications.
25.02	(DETERMINE VOLTAGE TO HEATING ELEMENT) Given an electric furnace and a VOM, measure the voltage to the heating element. The voltage should be within 10 percent of the rated voltage.
25.03	(DETERMINE CONDITION OF SEQUENCING DEVICE) Given an electric heating system, schematic, VOM and amprobe; determine the condition of the sequencing device(s). The sequencing device(s) will control the elements according to the manufacturer's design.
25.04	(DETERMINE CONDITION OF BLOWER AND MOTOR) Given an electric furnace, test instruments, tools, and necessary materials, determine the condition of the blower and motor. The blower and motor will deliver the CFM of air as specified by the manufacturer.
25.05	(DETERMINE CONDITION OF SAFETY DEVICES) Given an electric furnace, tools, test instruments, and necessary materials, determine the condition or the safety devices. The safety devices will turn the system off if the air column is reduced over the elements.

HVAC
ELECTRICAL RESISTANCE HEATING
SUGGESTED INSTRUCTION TIMES

HVAC UNIT/TASK		SUGGESTED HOURS
Unit 25.0	ELECTRICAL RESISTANCE HEATING	
25.01	Determine Air Flow and Temperature Rise across Electric Furnace.	
25.02	Determine Voltage To Heating Element.	
25.03	Determine Condition of Sequencing Device.	
25.04	Determine Condition of Blower and Motor.	
24.05	Determine Condition of Safety Devices.	

MINIMUN SUGGESTED TERMINOLOGY

Nichrome	Alloy used extensively as a heat source for electric heat.
Contactor	Relay capable of opening and closing power circuits of high amperage.
Line Voltage	Voltage source used in residential electric heating.
Sequencer	Time delay device.
Fan Relay	Relay which opens a furnace blower, frequently incorported as first stage of a sequencer in an electric furnace.
Fusible Link	Backup safety device designed to melt and open the circuit of an electric furnace at temperature higher than the limit.
High Limit Switch	Safety device which opens the circuit when there is excessive temperature rise.
Heat Relay	Normally open relay closed on call for heat from thermostat. Delays before closing.
Limit Switch	Electrically de-energizes heating element if air surrounding heating element exceeds limit switch setting, protecting heating element, etc.
Thermal Fuse	Back-up safety switch in case furace limit switch fails: Opens on above normal high temperatures around element.
Indoor Blower Delay Relay	Cycles blower on when there is call for heat. Delay on operation normally.
Fan Control	Operates blower when temperature around heating elements exceeds fan control's setting: Safety control.

* NOTE: SEE RELATED TERMINOLOGY IN GAS HEATING.

UNIT 25,0 ELECTRIC HEATING

TASK 25.01 DETERMINE AIR FLOW AND TEMPERATURE RISE ACROSS ELECTRIC EURNACE

PERFORMANCE OBJECTIVE:

Given an electrical furnace, thermometers, tools and other materials/references needed; determine the air flow and temperature rise across the electric furnace. The air flow and temperature rise will be within 10 percent of manufacturer's design specifications.

PERFORMANCE ACTIONS: (Instructor to clarify actions)

"Similar actions and task describe in previous unit."

PERFORMANCE STANDARDS:

-Determine air flow and temperature rise across electric furnace. The air flow and temperature rise will be within 10 percent of manufacturer's design specifications.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Explain procedure to measure temperature with thermometer
-Describe where temperature measurements are taken
-Identify manufacturer's specifications
-Identify safety considerations

UNIT 25.0 ELECTRIC HEATING

TASK 25.02 DETERMINE VOLTAGE TO HEATING ELEMENT

PERFORMANCE OBJECTIVE:

Given an electric furnace and a VOM, measure the voltage to the heating element. The voltage should be within 10 percent of the rated voltage.

PERFORMANCE ACTIONS: (Instructor to clarify actions)

"Similar actions outlined in previous unit of training."

PERFORMANCE STANDARDS:

-Using the VOM, determine that the voltage to the heating element of a given electric heater is within 10 percent of the rated voltage.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe how to use the voltmeter
-Locate/identify the heating element(s)
-Determine rated voltage for the heater
-Identify safety considerations

UNIT 25.0 ELECTRIC HEATING

TASK 25.03 DETERMINE CONDITION OF SEQUENCING DEVICE

PERFORMANCE OBJECTIVE:

Given an electric heating system, schematic, VOM and amprobe; determine the condition of the sequencing device(s). The sequencing device(s) will control the elements according to the manufacturer's design.

PERFORMANCE ACTIONS: (Instructor will clarify actions)

"Action will follow steps/procedures of servicing electrical circuits and components previously mastered."

PERFORMANCE STANDARDS:

-Determine if the sequencing device(s) in an electric heating system is controlling the elements according to the manufacturer' design. Properly use elelctrical test instruments, interpret schematic accurately, and follow acceptable testing procedures.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Explain purpose of a sequencer
-Locate sequencer(s) in furnace(s)
-Identify types of sequencers
-Describe how to test a sequencer
-Identify safety considerations

UNIT 25.0 ELECTRIC HEATING

TASK 25.04 DETERMINE CONDITION OF BLOWER AND MOTOR

PERFORMANCE OBJECTIVE:

Given an electric furnace, test instruments, tools, and necessary materials, determine the condition of the blower and motor. The blower and motor will deliver the CFM of air as specified by the manufacturer.

PERFORMANCE ACTIONS: (Instructor to clarify actions)

"Similar actions outlined in previous unit of training."

PERFORMANCE STANDARDS:

-Determine if a blower and motor are delivering the CFM as specified by the manufacturer and are operating properly.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Read electrical schematics
-Describe how to use the ohmmeter
-Describe how to use the voltmeter
-Describe how to use the amprobe
-Explain how to adjust belt tension
-Locate the blower and motor and retlated controls on a system
-Explain how to clean a blower and motor
-Identify safety considerations

UNIT 25.0 ELECTRIC HEATING

TASK 25.05 DETERMINE CONDITION OF SAFETY DEVICES

PERFORMANCE OBJECTIVE:

Given an electric furnace, tools, test instruments, and necessary materials, determine the condition of the safety devices. The safety devices will turn the system off if the air column is reduced over the elements.

PERFORMANCE ACTIONS: (Instructor to clarify actions)

"Similar actions outlined in previous unit of training."

PERFORMANCE STANDARDS:

-Determine if the safety devies in an electric heater will turn the system off if the air column is reduced over the elements.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

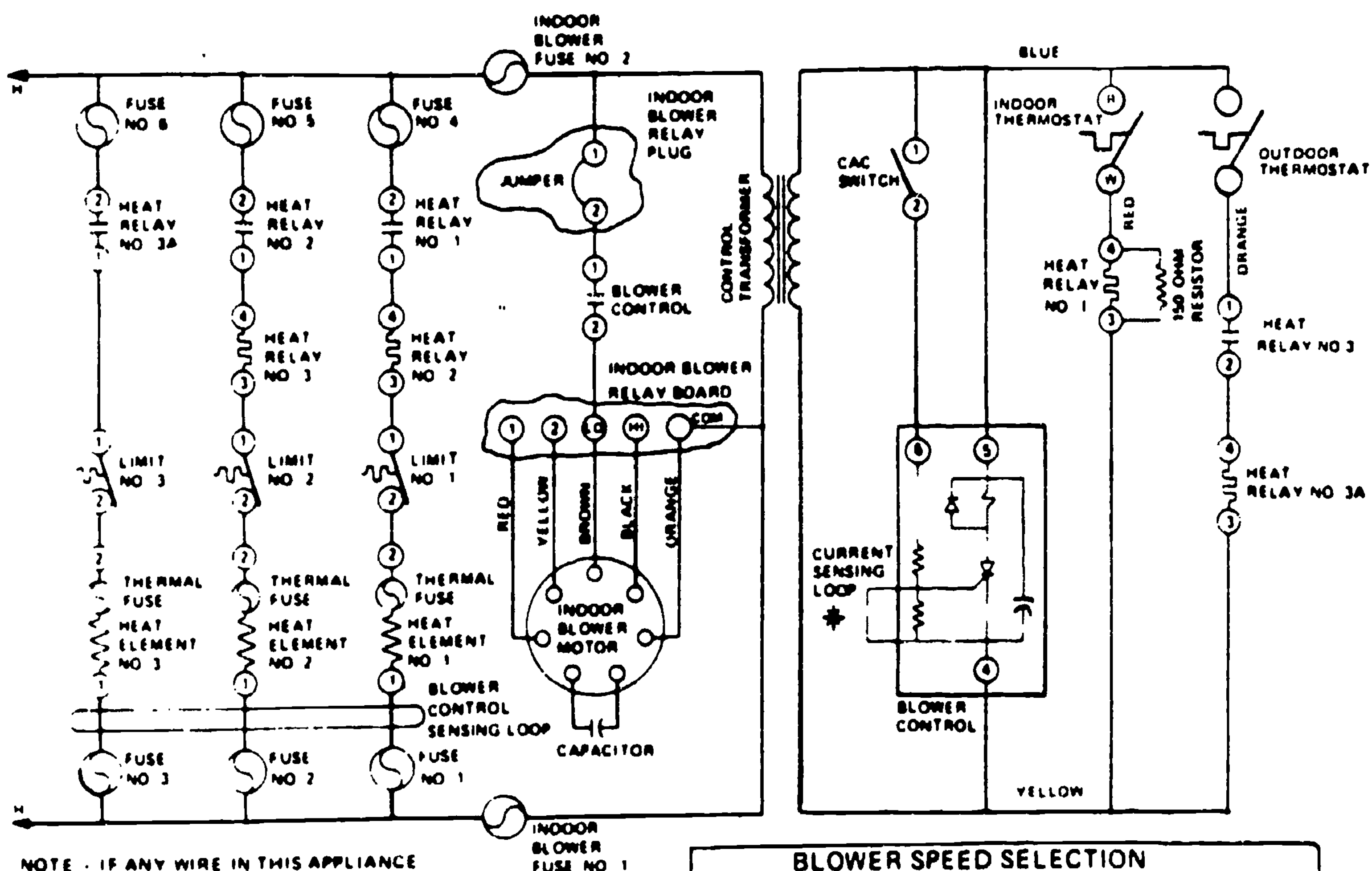
-Explain the puprose of safety devices
-Locate safety devices in the given heater
-Describe what happens (harmful effects) if there is low air movement across the heating element
-Identify safety considerations

ADDENDUM TO UNIT 25.0

Tasks which might be incorporated in this unit but which _may be described in other units_ of this guide include the following:

- -Check resistance of primary and secondary windings of low voltage transformer
- -Check continuity and grounding of blower power circuit
- -Check continuity of fan relay coil circuit
- -Check for continuity and grounding of heating element
- -Identify and check belt drive and direct drive blower motors, speed controllers, and tap would motors
- -Install troubleshoot, and repair low voltage control circuits
- -Install, troubleshoot, and repair single-stage heating thermostat and combination heating/cooling thermostat
- -Read schematic and pictorial digrams

SCHEMATIC DIAGRAM



NOTE - IF ANY WIRE IN THIS APPLIANCE IS REPLACED IT MUST BE REPLACED WITH WIRE OF LIKE SIZE RATING AND INSULATION THICKNESS. IF RATING AND INSULATION IS UNKNOWN USE SAME SIZE THERMOPLASTIC 105C WIRE WITH 4/64 INSULATION THICKNESS

✱ IMPORTANT

ALL WIRES RUNNING THROUGH BLOWER CONTROL SENSING LOOP MUST RUN IN THE SAME DIRECTION. IF BLOWER MOTOR FAILS TO OPERATE WITH ELEMENTS ENERGIZED SHUT OFF POWER AND REVERSE SECONDARY LEADS OF 24 VOLT TRANSFORMER

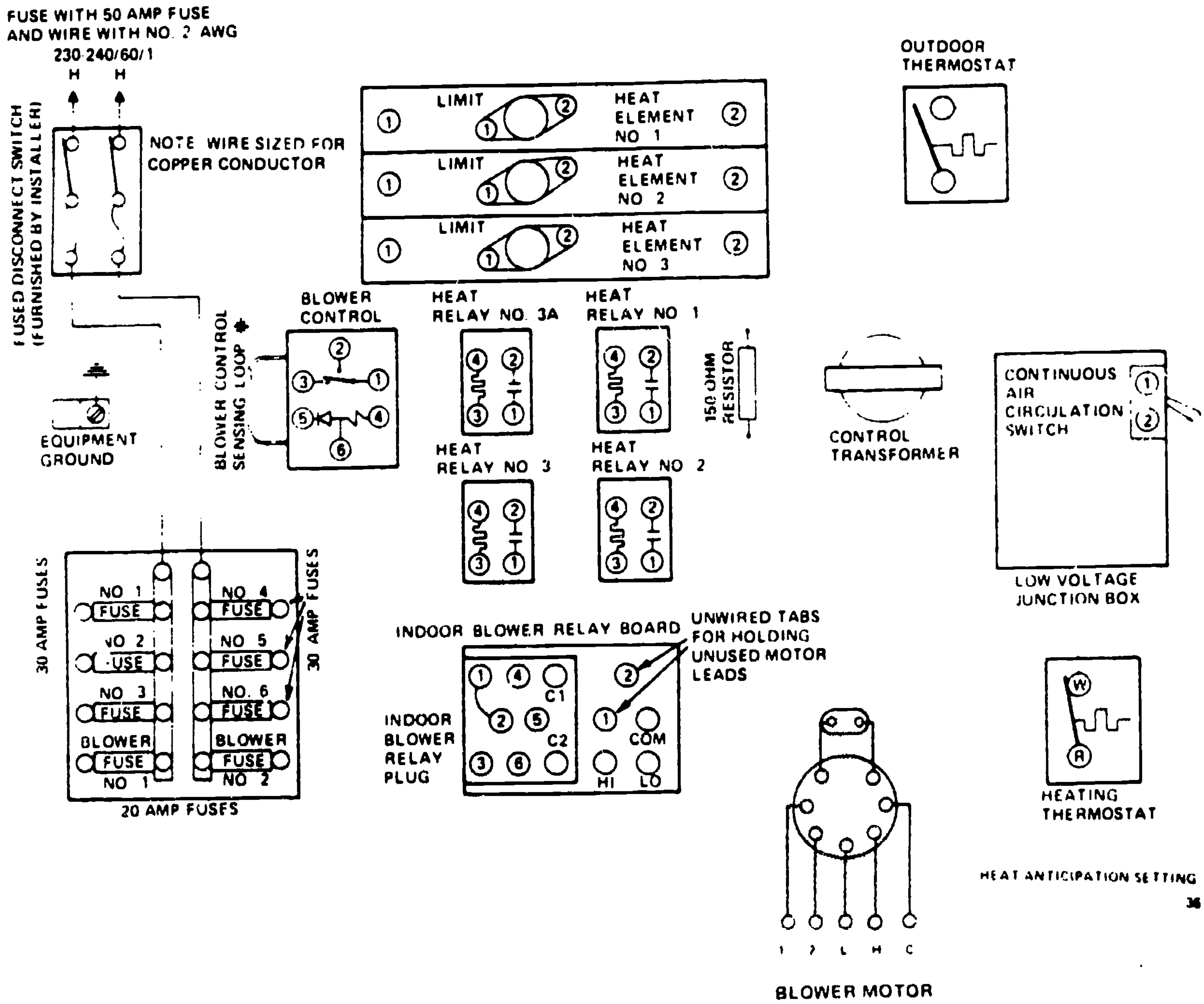
BLOWER SPEED SELECTION

IMPORTANT: TO PREVENT MOTOR BURNOUT NEVER CONNECT MORE THAN ONE MOTOR LEAD TO ANY ONE TERMINAL. CONNECT UNUSED MOTOR LEADS TO TERMINALS 1 and 2 WHICH ARE HOLDING TERMINALS

SPEED	HEATING BLOWER SPEED SELCTION
HIGH	CONNECT BLACK MOTOR LEAD TO TERMINAL Lo
MED Hi	CONNECT BROWN MOTOR LEAD TO TERMINAL Lo
MED Lo	CONNECT YELLOW MOTOR LEAD TO TERMINAL Lo
LOW	CONNECT RED MOTOR LEAD TO TERMINAL Lo

BEST COPY AVAILABLE

PICTORIAL DIAGRAM



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UNIT 26.0

HEAT PUMPS

This unit on Heat Pumps is designed to introduce the secondary student to heat pump fundamentals, especially as heat pumps differ from basic cooling systems. Basic refrigeration principles will not to be duplicated in this unit.

All refrigeration systems might be considered heat pumps since they move heat from one place to another. There, however, are four major differences between the heat pump and the other refrigeration systems.

Heat Pumps have:

a. a switchover valve to reverse the flow of refrigerant in the heating function.
b. a separate expansion device for both heating and cooling modes of operation.
c. check valves to route refrigerant through the proper expansion devices when the system reverses from cooling to heating, etc.
d. a defrost system to defrost the outdoor coil when outdoor temperatures are below freezing in the heating mode because the outdoor coil functions as the evaporator.

The intent of this unit is to acknowledge that the student already has mastered ... basic refrigeration, use of the electrical instruments, use of gauges, etc., and concentrate on developing basic skills necessary in the installation, maintenance, and troubleshooting of residential heat pump systems.

References used in the development of this unit include:

1. Althouse, Andrew D. Turnquist, Carl H., and Bracciano, Alfred F., Modern Refrigeration and Air Conditioning. South Holland, IL: The Goodheart-Wilcox Company, Inc., 1982. (Chapter 23: Heat Pumps and Complete Air Conditioning Systems) pp 800-835.

2. Brumbaugh, James E. Heating, Ventilating, and Air Conditioning Library, Volume 3. Indianapolis, IN: Howard W. Sams & Co., Inc., 1982. (Chapter 12, Heat Pumps) pp 411-442.

3. Combination Heat-Cool Units. Fort Smith, AR: Rheem Air Conditioning Division of City Investinging Company, 1980.

4. Heat - Pump (ACR 166). Greenville, SC: Greenville Technical Coolege (Air Conditioning Department), ca 1980, (self-paced curriculum guide.)

5. Heat Pump. Fort Smith, AR: Rheem Air Conditioning Division of City Investing Company, 1983.

6. Refrigeration and Air Conditioning, Unit VIII: Heat Pumps. Natchitoches, LA: Louisiana Volcational Curriculum Development and Research Center, 1977.

7. Refrigeration and Heat Transfer. Tyler TX: General Electric Central Air Conditioning Department, pp 12-13 (Basic Heat Pump Operation). ca 1980.

8. Service Procedures: Cooling and Weathertron Heat Pump Systems. Tyler, TX: General Electric Central Air Conditioning Department, ca 1980.

9. The Add-on Heat Pump and Hot Water Bank as Energy Saving Systems. Tyler, TX: General Electric Central Air Conditioning Department, ca 1980.

10. Weathertron Heat Pumps: Defrost Control Systems. Louisville, KY: General Electric Air Conditioning Business Division, ca 1980.

MINIMUM SUGGESTED TERMINOLOGY

Cooling Cycle

Heating Cycle

Defrost Cycle

Compressor

Overload

Capacitor

Condenser

Evaporator

Contactor

Blower

Relay

Rpreesure Controls

Refrigerant Coils

Reversing Valve

Check Valve

Muffler

Accumulator

Meterming Device

Changeover Relay

Air Flow

Refrigerant Charge

C.O.P.

Performance Factor

TXV

Defrost Control

HVAC
HEAT PUMPS
SUGGESTED INSTRUCTION TIMES

HVAC UNIT/TASK		SUGGESTED HOURS
Unit 26.0	HEAT PUMPS	
26.01	Identify Components of Heat Pump	
26.02	Check Reversing Valve	
26.03	Check Solenoid Coil and Pilot Valve	
26.04	Diagnose and Resolve SOV Problems	
26.05	Test Check Valves	
26.06	Check Temperature Differential Defrost Control	
26.07	Check Time-Temperature Defrost Control	
26.08	Check Pressure Differential Defrost Control	
26.09	Determine Supplementary Heat Requirements	
26.10	Install Indoor Thermostat	
26.11	Determine Temperature Rise and Drop Across Coils	
26.12	Determine Operating Pressures	
26.13	Charge a Heat Pump	
26.14	Inspect Strip Heaters	
26.15	Install a Heat Pump	
26.16	Locate Trouble in Heat Pump	

UNIT/TASK	DESCRIPTION
Unit 26.0	HEAT PUMPS
26.01	(IDENTIFY COMPONENTS OF HEAT PUMP) Given a heat pump necessary hand tools, and orientation to the heat pump system and components; inspect a given heat pump and correctly identify and list the nine major components. State the difference between a heat pump and a conventional cooling/ refrigeration system.
26.02	(CHECK REVERSING VALVE) Given a heat pump, gauge manifold assembly, service valve wrench, mechanic's hand tools, two thermometers (or electric thermometer w/2 probes), and other necessary materials; check a reversing valve by: a. Pump-down method using gauges b. measuring temperature using thermomete
26.03	(CHECK SOLENOID COIL AND PILOT VALVE) Given heat pump, VOM, mechanic's tools, and necessary materials and information; check solenoid coil and pilot valve for proper operation.
26.04	(DIAGNOSE AND RESOLVE SOV PROBLEMS) Given a heat pump, mechanic's tools, test equipment as required and other necessary materials; diagnos and resolve SOV problems and replace SOV as needed.
26.05	(TEST CHECK VALVES) Given check valves (in or out of systems), hacksaw as necessary, mechanic tools, magnet as required, other materials needed and malfunctioning symptoms; diagnose a probable problem with check valve, conduct magn test and replace check valve if necessary.
26.06	(CHECK TEMPERATURE DIFFERENTIAL DEFROST CONTROL Given a heat pump with temperature differential defrost control, mechanic's tools, two thermometers, and other materials needed; check ooeration and calibrate temperature differentia defrost control.

26.07 (CHECK TIME-TEMPERATURE DEFROST CONTROL) Given heat pump with time-temperature defrost control, mechanic's tools, jumpers, material to close off circulation, and other necessary items; check and adjust a time-temperature defrost control and compare and contrast time-temperature control with other types.

26.08 (CHECK PRESSURE DIFFERENTIAL DEFROST CONTROL) Given a heat pump with pressure differential defrost control, mechanic's tools, material to close-off air supply to coils, and other item needed; field check the performance of a pressur differential defrost control and adjust the differential defrost control.

26.09 (DETERMINE SUPPLEMENTARY HEAT REQUIREMENTS) Given performance graph (chart) for heat pump, instructions on its use, and other materials required; determine the amount of supplemental heat required using charts and grapsh, and plot balance point of system using graph.

26.10 (INSTALL INDOOR THERMOSTAT) Given indoor thermostat (4-bulb or emergency heat type), split system heat pump, mechanic's hand tools, thermostat wire, and other materials needed; properly install indoor thermostat on heat pump following manufacturers' diagrams.

(Recommended alternate of additonal training:) Draw a schematic of an operating split system heat pump by tracing the existing wiring. The schematic must be accurate, correct symbols appropriately sized must be used, and the drawing must be neat and easily interpreted by the instructor or another mechanic.

26.11 (DETERMINE TEMPERATURE RISE AND DROP ACROSS COILS) Given a heat pump, thermometers, and other materials needed; determine temperature rise and drop across the coils. The temperatur rise will be 2-30 degrees on heating and the temperature drop will be between 12-15 degrees.

26.12 (DETERMINE OPERATING PRESSURES) Given an air-to-air heat pump, gauge and manifold set, press chart, and other necessary materials, determine the high and low side pressures. The high side temperature will be 30-35 degrees above ambient and pressures will be read from pressure chart. Low side pressure will correspond to a coil temperature of 40 degrees.

26.13 (CHARGE A HEAT PUMP) Given a heat pump, gauges or manifold set, refrigerant, pressure chart, tools, and other materials needed; charge the system so that it delivers cool air on cooling and warm air on heating and so the pressure corresponds to the outdoor ambient and evaporator design coil temperature.

26.14 (INSPECT STRIP HEATERS) Given a heat pump, VOM, clamp-on ammeters, tools, and other materials needed, inspect the strip heaters. They will be correctly wired, pull the correct current, and heat the air as designed.

26.15 (INSTALL A HEAT PUMP) Given a heat pump unit, mechanic's tools and equipment, spiril level, leak detector, gauge manifold, sling psychrometer velocimeter, measuring tape, wiping cloth, and other materials as needed; install the heat pump at a predetermined location. The installation must be in accordance with local electrical code and manufacturer's recommendatio

26.16 (LOCATE TROUBLE IN HEAT PUMP) Given a residenti heat pump system with a trouble report and one or more typical symptoms, manufacturer's information (literature or schematic) on the system, electrical diagram/schematic, mechanic's tools and equipment as need, VOM, clamp-on ammeter, gauge manifold set, thermometers, vacuum pump, leak detector, refrigerant, servic materials such as rags and oil; locate the trouble,repair it, and restore the heat pump to the correct operating temperatures.

UNIT 26.0 HEAT PUMP

TASK 26.01 IDENTIFY COMPONENTS OF HEAT PUMP

PERFORMANCE OBJECTIVE:

Given a heat pump, necessary hand tools, and orientation to the heat pump system and components; inspect a given heat pump and correctly identify and list the nine major components. State the differen~e between a heat pump and a conventional cooling/ refrigeration system.

PERFORMANCE ACTIONS:

26.0101 Using hand tools, remove panels, etc., to see basic heat pump components.

26.0102 List (identify) major components (nine) of the heat pump system.

26.0103 State the purpose of each component identified (above.)

26.0104 List Components of a conventional cooling/ refrigeration system.

26.0105 Compare/contrast the two system:
- a. Note components in heat pump system not typic to refrigeration/cooling system.
- b. Components different include:
  - (1) switchover valve-to reverse flow of refrigerant in heating function.
  - (2) separate expanison device for both heatin and cooling modes.
  - (3) check valves to route refrigerant through proper expanison device when system reverses from cooling to heating, etc.
  - (4) defrost system - in heating mode, defrost the outdoor coil (evaporator) when temper tures are below freezing.

PERFORMANCE STANDARDS:

-Identify components of a given (or a typical) heat pump (minimum of nine major components) and state the basic difference between a heat pump and a typical cooling/ refrigeration system. Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 26.0 HEAT PUMP

TASK 26.01 IDENTIFY COMPONENTS OF HEAT PUMP (Con't)

RELATED TECHNICAL INFORMATION:

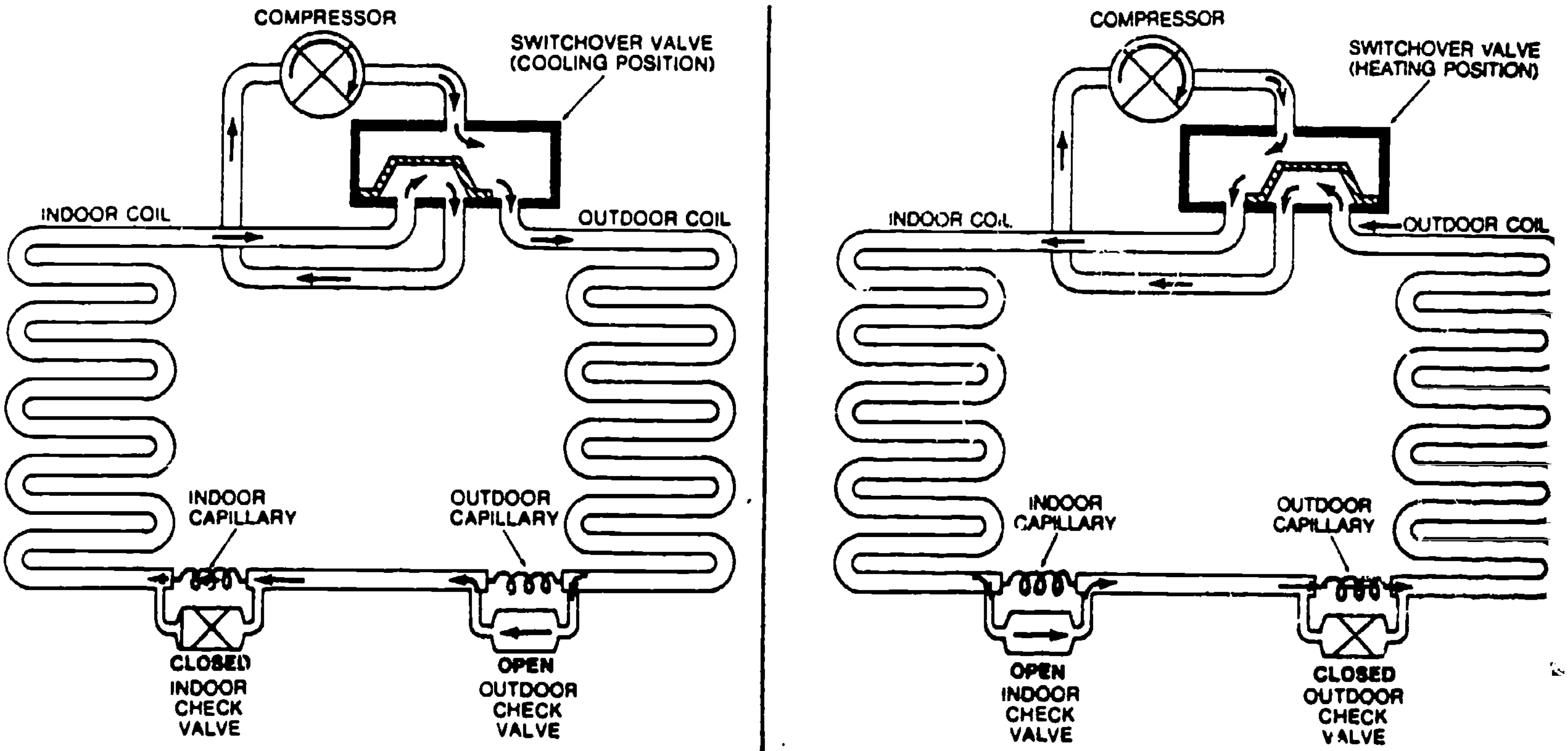
-Identify basic components of typical refrigeration/cooling system
-Identify three broad categories of heat pumps:
  a. air-to-water (water-to-air) (economical, stable, efficient)
  b. air-to-ground (earth-to-air) (least reliability)
  c. air-to-air (primary emphasis in heat pump training)
  d. solar energy-to-air (experimental)
  e. waste heat to air (experimental)
-Identify:
  A split systems
  b. self-contained systems
-Describe basic concept of heat pump (reverse flow of refrigerant.)
-Locate metering devices on split-system heat pump
-Locate suction-line filter drier on heat pump
-Identify electrical controls that differ from typical refrigeration/cooling system: changeover relay, defrost relay, and defrost control (for heating-cooling-defrosting funct
-Identify why two check valves are required in the heat pump
-Explain why the coils in a heat pump generally are labeled indoor and outdoor rather than condenser and evaporator.
-Identify safety considerations: Electrical source off, etc.

TASK EXPANSION (BASIC THEORY):

Draw (or complete) a mechanical diagram of the cooling cycle and heating cycle of a typical heat pump showing the coorect positon of the reversing valve and indicating the flow of refrigerant.

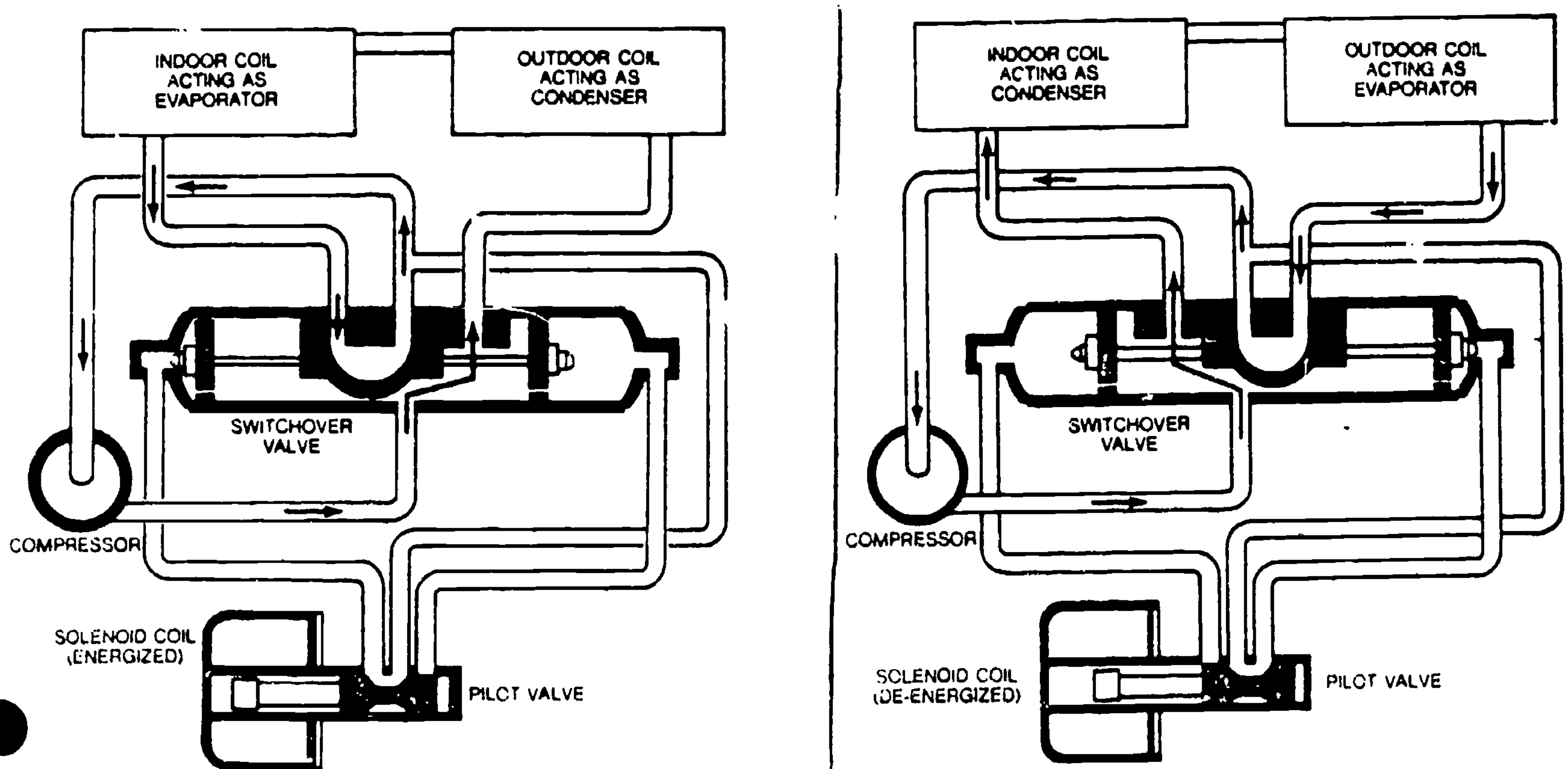
<u>ADDENDUM PAGE ACCOMPANIES THIS TASK:</u> See Basic Heat Pump Circuit

BASIC HEAT PUMP CIRCUIT



COOLING MODE

HEATING MODE



COOLING CYCLE

HEATING CYCLE

UNIT 26.0 HEAT PUMPS

TASK 26 02 CHECK REVERSING VALVE

PERFORMANCE OBJECTIVE:

Given a heat pump, gauge manifold assembly, service valve wrench, mechanic's hand tools, two thermometers (or electric thermometer w/2 probes), and other necessary materials; check a reversing valv by:

a. pump-down method using gauges
b. measuring temperature using thermometers

PERFORMANCE ACTIONS:

(By Pump-Down Method)

26.0201A Connect suction gauge to suction service port.

26.0202A Set thermostat for "heating."

26.0203A Close liquid line valve.

26.0204A Operate compressor: If no leaks in valve, compressor will pump down to 10-15 inches Hg. vacuum and hold when compressor is stopped.

26.0205A Repeat same check with thermostat set for "cooling."

26.0206A Record readings.

(By Temperature Method)

26.0201B Set thermostat for "cooling."

26.0202B Attach thermometers (degree difference on heating cooling.)

26.0203B Read temperature on each thermometer and if temperature difference is greater than 15 degrees the valve seats are leaking and the valve should be replaced.

26.0204B Set thermostat on "heating."

26.0205B Attach thermometer to same points (above, step 2.

26.0206 If temperature difference is greater than 15 degrees, valve seats are leaking and valve should be replaced.

26.0207 Record readings.

PERFORMANCE STANDARDS:

-Check reversing valves by (a) pump-down method using gauges and (b) measuring temperatures using thermometers.
-Valve will reverse refrigerant flow when heating is desired.
-Procedures of checking valves and performance must be acceptable to instructor. Safety procedures must be observed.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Apply "field hints" to servicing SOV's:
  a. Check shifting of valve at higher pressure before assuming a valve inoperative.
  b. Compressor valves hould be checked before condensing a reversing valve.
-Identify location of reversing valve.
-Describe the function of reserving valves.
-Explain how a reversing valve operates in a heat pump: (i.e., mail valve body containing a slide and piston, and a three-way pilot valve actuated by a solenoid.)
-Identify: Some manufacturer's energize solenoid for heating while others de-energize it.
-Draw a diagram showing the SOV in heating positon and cooling position.
-Explain purpose of bleed ports.
-Describe how to determine the suction and discharge ports on a reversing valve.
-Identify:
  a. mechanical check valve
  b. double expansion valve
  c. ball check valve
-Explain why the mechanical check valve is preferred on dual expansion systems.
-Identify what type system utilizes only one check valve.
-Identify safety considerations.

UNIT 26.0 HEAT PUMP

TASK 26.03 CHECK SOLENOID COIL AND PILOT VALVE

PERFORMANCE OBJECTIVE:

Given heat pump, VOM, mechanic's tools, and necessary materials and information; check solenoid coil and pilot valve for proper operation.

PERFORMANCE ACTIONS:

TASK EXPANSION (SERVICING):
(Following descriptions are for SOV de-energized during heat cycle.)

A. Check Solenoid Coil and Pilot Valve:

26.0301 Remove retaining nut/clip from solenoid core.

26.0302 Observe use/position of "space" if used between coil and valve.

26.0303 Disable compressor and outdoor fan (remove one line from motor starter relay coil.)

26.0304 Apply 24 VAC to solenoid coil.

26.0305 Slowly slide solenoid back and forth along pilot valve core. If magnetic resistance is felt, coil is good.

26.0306 If no pull felt, check for 24 VAC at coil. If 24 VAC us present; disconnect power and check coil for continuity (w/ohmmeter.)

26.0307 Replace open coil (if found.)

26.0308 If coil is good, definite clicking is heard when coil is moved along core. If coil is good and no clicking heard, pilot valve is defective. Visually inspect pilot core for defects (dents, etc.). Repair or replace as necessary.

PERFORMANCE STANDARDS:

-Check solenoid coil and pilot valve on heat pump for proper operation. Properly use VOM and preocedures for checking solenoid coil and pilot valve. Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

What is a Solenoid Valve?

The solenoid valve is an electronically operated device. It is used to control the flow of gases in a positive, fully-closed or fully-open mode. The valve is commonly used to replace a manual valve or where remote control is desirable. Solenoid valves are operated by a variety of electrical switches. Among them are automatic temperature, pressure and time switches or manual switches.

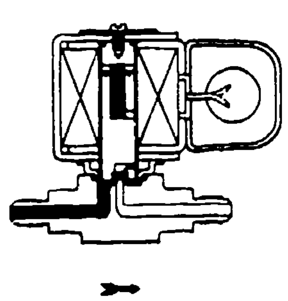
When energized, the solencid coil provides a strong magnetic force which pulls a steel plunger up into the plunger tube. This opens the valve orifice (pilot or main), permitting the flow of liquids or gases.

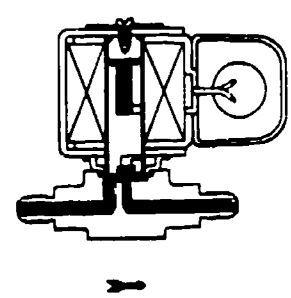
Two-Way Solenoid Valves

Two way valves control flow in one direction. They may be direct operated or pilot operated, normally closed or normally open.

Direct Operated Solenoid Valves

Are used in systems requiring low flow capacities or in applications with low pressure differentials across the valve orifice. The sealing surface that opens and closes the main valve orifice is connected to the solenoid plunger. The valve operates from zero pressure differential to maximum rated pressure differential (MOPD) regardless of line pressure. Pressure drop across the valve is not required to hold the valve open.

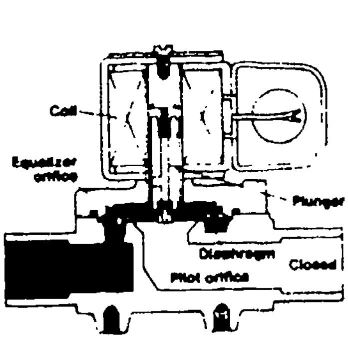


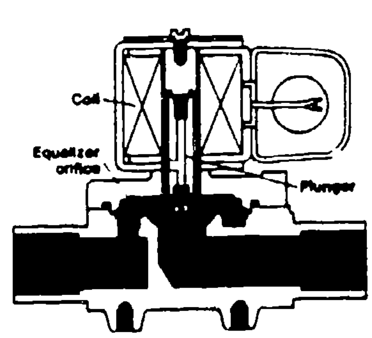


Pilot Operated Valves (Normally Closed)

Open when electrical current is applied. They are the most widely used solenoid valves. The pilot orifice is much larger than the equalizer orifice. When the coil is energized, the plunger lifts off the pilot orifice. The pressure above the diaphragm is reduced to the outlet pressure of the valve. The resulting pressure differential across the diaphragm creates a force which lifts the diaphragm off the main port, opening the valve.

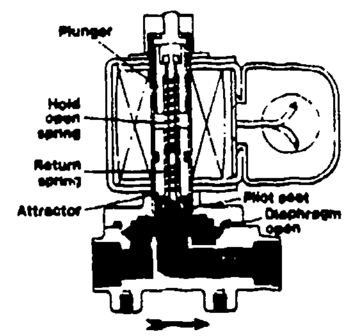
When the coil is de-energized, the pilot orifice is closed. The inlet pressure through the equalizer orifice equalizes the pressure above and below the diaphragm. The diaphragm resets, closing the valve.

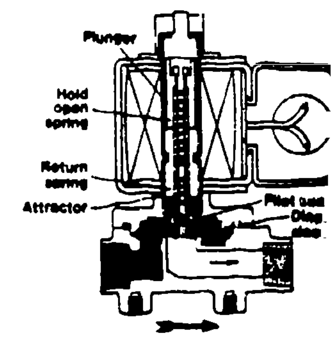




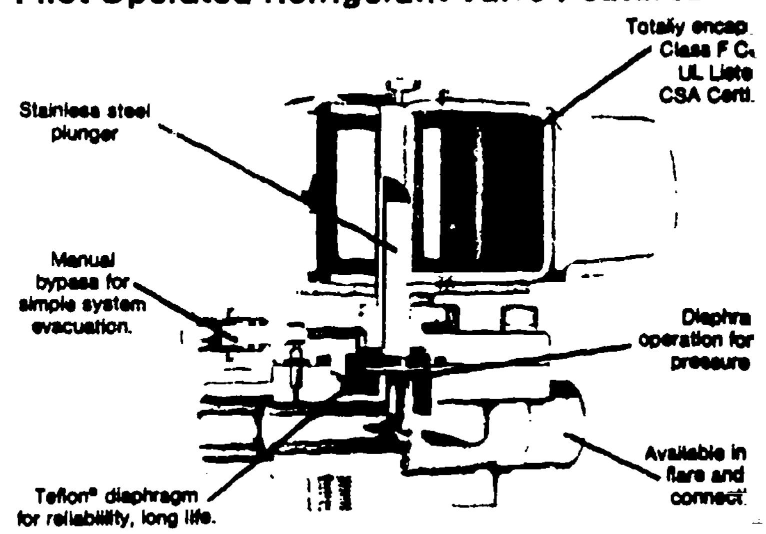
Pilot Operated Valves (Normally Open)

Close when electrical current is applied. They are used applications in which the valve remains open most of the or where it is required to open in case of an electrical malf tion. Operation is the reverse of the normally closed valv





Pilot Operated Refrigerant Valve Features



Three-Way Solenoid Valves

Three way valves are designed primarily for hot gas de from the suction side of the evaporator coil in modern multiplex systems.

MOPD (Maximum Opening Pressure Differen

The MOPD between the inlet and outlet pressure of the must not be exceeded or the valve will not open. Convers the valve is applied to a system when minimum operati pressure differential is not achieved, the valve will not fully. These values are listed in the specifications for each of valve.

Mix and Match Valves and Coils

As a convenience for our customers, the Mix and Match sy utilizes a common coil size for all refrigerant valves and an for all general purpose valves. Coil assemblies and valve assemblies are ordered separately and packaged indivic Valve body assemblies may be ordered with any coil asse

The advantages – stocking is simplified, coil changing e ated, and maximum stock flexibility gained at lower inve cost.

Electrical Connections

Electrical data for the valve will be found on the coil la Verify that all system voltages and frequencies correspo this information. Electrical wiring must conform to the Na Electrical Code and local electrical codes.

UNIT 26.0 HEAT PUMPS

TASK 26.04 DIAGNOSE AND RESOLVE SOV PROBLEMS

PERFORMANCE OBJECTIVE:

Given a heat pump, mechanic's tools, test equipment as required, and other necessary materials; diagnose and resolve SOV problems and replace SOV as needed.

PERFORMANCE ACTIONS:

26.0401 Diagnose and Resolve Problems:
(a) SOV Stuck in Cooling Position
(b) SOV Stuck in Heating Position
(c) SOV Stuck Midway or Leaking High to Low Sid

26.0402 Replace SOV:
(a) Bleed refrigerant
(b) Unbraze outer connections from SOV to outdoor and indoor coils
(c) Remove roto lock couplings from compressor discharge and suction
(d) Note valve position (pilot assembly toweard or away from you) (important for electrial connections)
(e) Remove SOV assembly
(f) Mark suction and discharge tubes for corre direction orientation
(g) Unbraze suction and discharge tubes.
(h) Install suction and discharge tubes in replacement valve. Be sure tubes point in same direction as old valve.
(i) Pack SOV with heat sink material. Braze tubes in place (not exceeding 275 degrees on SOV.)
(j) Return assembly to unit: Tighten suction roto lock first: Tighten discharge roto lock second
(k) Install and braze remaining suction tubes.
(l) Clean up after repair

PERFORMANCE STANDARDS:

-Diagnose and resolve SOV problems and replace SOV as necessary so systems functions as designed.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 26.0 HEAT PUMP

TASK 26.05 TEST CHECK VALVES

PERFORMANCE OBJECTIVE:

Given check valves (in or out of systems), hacksaw as necessary, mechanic's tools, magnet as required, other materials needed and malfunctioning symptoms; diagnose a probable problem with check valve, conduct magnet test and replace check valve if necessary.

PERFORMANCE ACTIONS:

26.0501 Diagnose probable problem based on symptoms:

a. Outdoor Check Valve(s) Stuck Closed-Cooling Mode
   (1) Suction pressure low, head pressure low
   (2) Compressor hot, may trip internal overload protector.
   (3) "If indoor unit equipped with thermostatic expansion valve, defective therm element on valve can cause same symptoms."
   (4) Equipment should operate at normal pressures in heating mode.

b. Indoor Check Valve(s) Stuck Open-Cooling
   (1) Suction pressure high, head pressure low. May be near equal pressures.
   (2) Compressor will be cool or cold.
   (3) "Check for normal pressures in heating mode." Equipment should be operating at normal pressures.

c. Outdoor Check Valve(s) Stuck Open-Heating Mode
   (1) Suction pressure high, head pressure lo
       May be near equal pressures.
   (2) Compressor will be cool or cold.
   (3) Equipment should operate at normal pressures in cooling mode.

d. Indoor Check Valves(s) Stuck Closed-Heating Mode
   (1) Suction pressure low, head pressure lo
   (2) Compressor hot: May trip internal overload.
   (3) "If outdoor unit equipped with thermostatic expansion valve, defective thermal element on valve will cause same symptoms."
   (4) Equipment should operate at normal pressure in cooling.

PERFORMANCE ACTIONS: (Con't)

e. Indoor Check Valve Leaking - Cooling Mode
   (1) Slightly high suction pressure, slightly low head pressure.
   (2) Compressor normal or cool temperature, depending on leak rate.
   (3) Equipment should operate at normal pressure in heating.

f. Outdoor Check Valve Leaking - Heating Mode
   (1) Slightly high suction pressure, slightly low head pressure.
   (2) Compressor at normal or cool temperature, depending on leak.
   (3) Equipment should operate at normal pressures in coooling mode

26.0502 Check Valve - Magnet Test (Ball Valve)

a. Stop equipment and allow head and suction pressures to equalize. (pressures must equalize for test.)
b. Slide <u>strong</u> magnet back and forth along valv body.
c. If ball valve is stuck, no sound will be hear If ball is free, distinct clicking will be heard.
d. Clicking indicates good valve.

26.0503 Replace Defective Check Valve

a. Pinch off check valve body with standard pinch off tool.
b. Recheck operating pressures to confirm diagnosis.
c. Use care in installing replacement check valv Do not bend or deform valve body.
d. Do not overheat check valve when brazing. Do not apply excessive brazing material.
e. Test unit operation.

PERFORMANCE STANDARDS:

-Diagnosis problem with check valve from symptoms, test check valve, and replace defective check valve as necessary.
-Valve should operate as designed.
-Performance must be acceptable to instructor.

SUGGESTED INSTRUCTION TIME: Hours

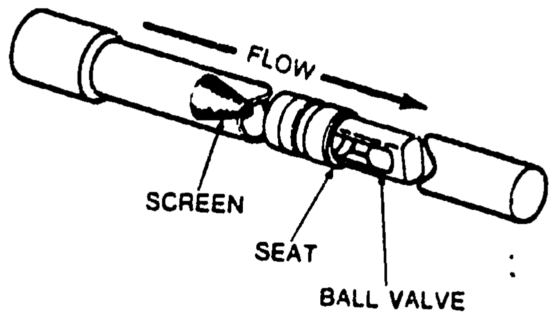
RELATED TECHNICAL INFORMATION:

-Distinguish method of interpreting valve malfuntion symptoms:

a. Cooling cycle - Stuck Closed - Outdoor:
   (1) Low suction and high superheat on indoor coil
b. Heating Cycle Stuck Closed-Indoor:
   (1) Low suction and high superheat on outdoor coil
c. Cooling Cycle - Stuck Open - Indoor:
   (1) High Stuction pressure, low superheat and
   (2) flooding back to compressor
d. Heating Cycle Stuck Open - Outdoor:
   (1) High suction and low superheat
   (2) Liquid flooding back to compressor

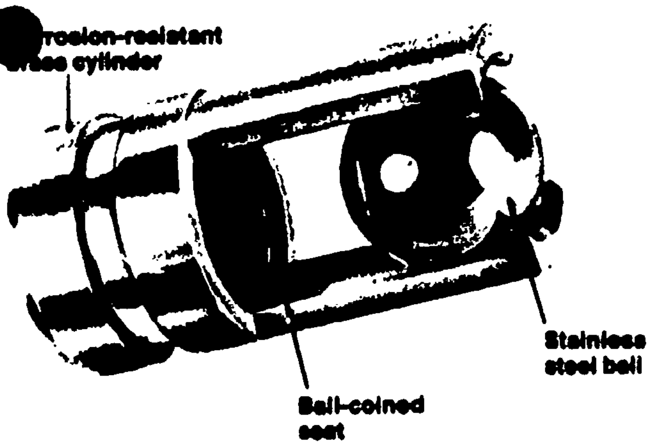
-Explain what determines the type of check valves used on heat pumps.

ADDENDUM PAGE ACCOMPANIES THIS TASK:



CHECK VALVE

Mechaniwatt Ball Check Valves



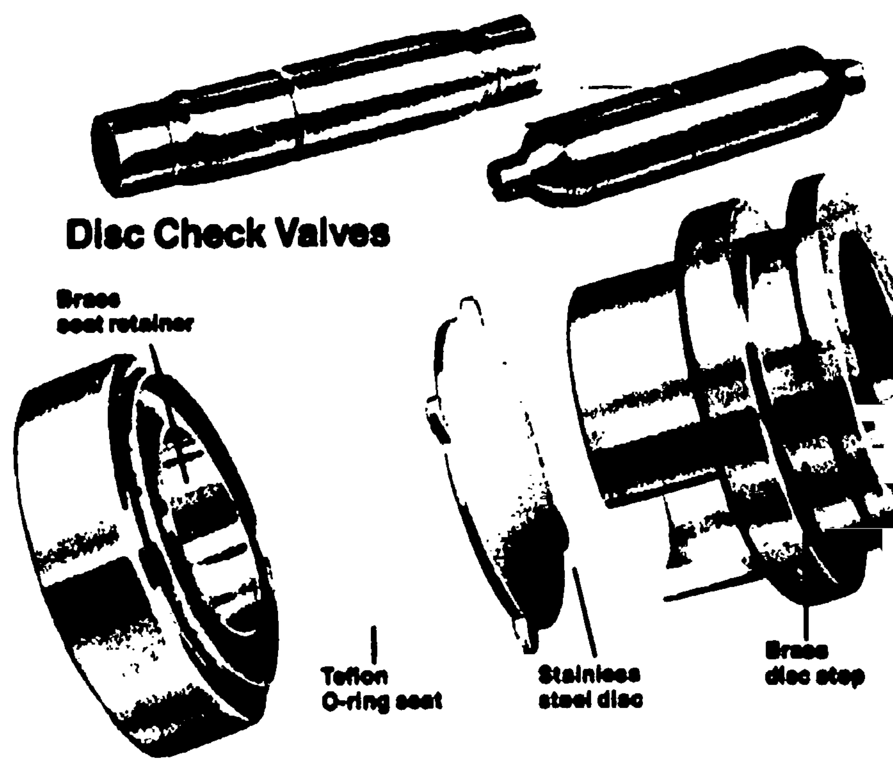
- Straight flow-through design.
- Metal to metal seating—stainless steel to brass.
- Corrosion resistant construction (stainless steel, brass, copper).
- Leak rate—Dry: 750 cc/min.
- U.L. recognized for 500 psig design pressure. (File No. SA3604)
- Small body diameter.
- One piece body construction eliminates leaks.

The Mechaniwatt check valve is a ball type design with a metal to metal seat. The straight through flow around the ball yields high flow capacities for small diameter valve bodies.

The ball coins its own seat which allows for slight differences in ball diameter.

The all metal design allows for higher installation and operating temperatures.

Disc Check Valves



- Straight flow-through design.
- Soft seating—ground stainless steel disc to teflon.
- Quiet operation.
- Corrosion resistant construction (stainless steel, teflon, brass, copper).
- Leak rate—Dry: 200 cc/min.
- UL recognized for 500 psig design pressure. (File No. SA3604)
- One piece body construction eliminates leaks....

The disc type check valve is a metal to teflon seat design with straight through flow. Both sides of the light stainless steel disc are ground flat to a 13 RMS finish assuring excellent seating characteristics. The soft teflon seat provides low initial seat leakage rates, and through continued use, gains more positive seating. The seat yields quieter operation by dampening seating noise impact.

UNIT 26.0 HEAT PUMP

TASK 26.06 CHECK TEMPERATURE DIFFERENTIAL DEFROST CONTROL

PERFORMANCE OBJECTIVE:

Given a heat pump with temperature differential defrost control, mechanic's tools, two thermometers, and other materials needed; check operation and calibrate temperature differential defrost control.

PERFORMANCE ACTIONS:

26.0601 Start unit: place in heating cycle.

26.0602 Stop airflow over outdoor coil by stopping fan or blocking coil.

26.0603 All time for coil to frost up.

26.0604
a. If defrost occurs, control is OK.
b. If defrost controls does not frost up, continue test/service procedures.

26.0605 If defrost did not initiate, remove all wires from terminals of defrost control. If reversing valve then switches, problem is in defrost control.

26.0606 Adjust or recalibrate defrost control.

26.0607 With outdoor airflow over coil stopped, insert thermometer into outdoor finned surface in the immediate area of the sensing bulb.

26.0608 Place second thermometer in discharge air stream of outdoor coil. Ambient air temperature on sens bulb of defrost control.)

26.0609 Check readings against reference:

Discharge Air Stream	Initiation Defrost Cycle	Termination Defrost Cycl
40 F	25 F +/-3	80 F +/-3
30 F	18 F +/-3	70 F "
10 F	o F +/-2	45 F "

26.0610 If termperature spread does not agree with above chart, recalibrate defrost cycle. (Initiation or termination of defrost cycle can be delayed by adjusting screw located on front and near bottom of defrost control.)

UNIT 26.0 HEAT PUMP

TASK 26.06 CHECK TEMPERATURE DIFFERENTIAL DEFROST CONTROL

PERFORMANCE ACTIONS: (Con't)

26.0611 a. Accelerate: Turn adjusting screw clockwise.
b. Terminate: Turn counterclockwise.

26.0612 Turn adjusting screw until control inititates defrost cycle at temperature that correpsonds with discharge air temperature as indicated in chart.

(Instrucgor to clarify provide hints/procedures for adjustment.)

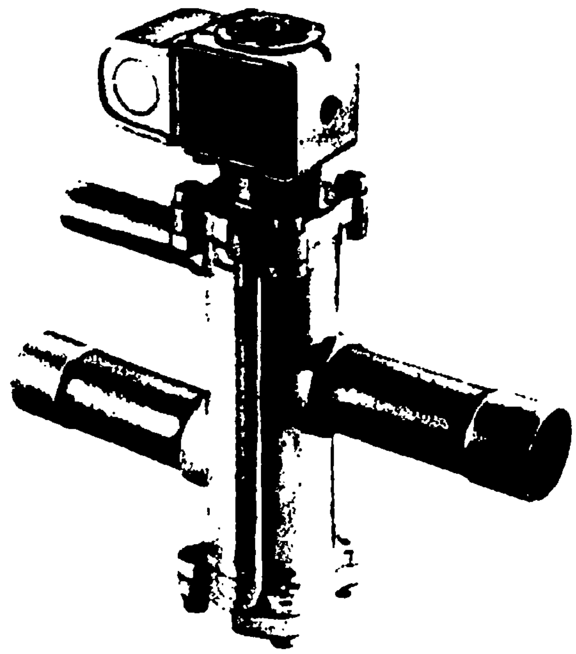
26.1203 Of defrost control does not respond to adjustment replace control.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Explain why the defrost cycle is necessary.
-Describe the types of defrost controls used on a heat pump:
  a. Ranco Timed Defrost Control (timed)
  b. Robershaw Defrost Control (air pressure/temperature)
  c. Dwyer Defrost Sensing Switch (air sensing switch)
  d. others
-Explain why the outdoor coil ices during low ambient conditions.
-Explain why it is necessary to stop the fan (outside) during defrost.
-Describe how often defrost takes place
-Explain why airflow over the outdoor coil must be stopped to check the control.
-Describe how to accelerate defrost initiation.

3-Way Diverting Valves for hot gas defrost



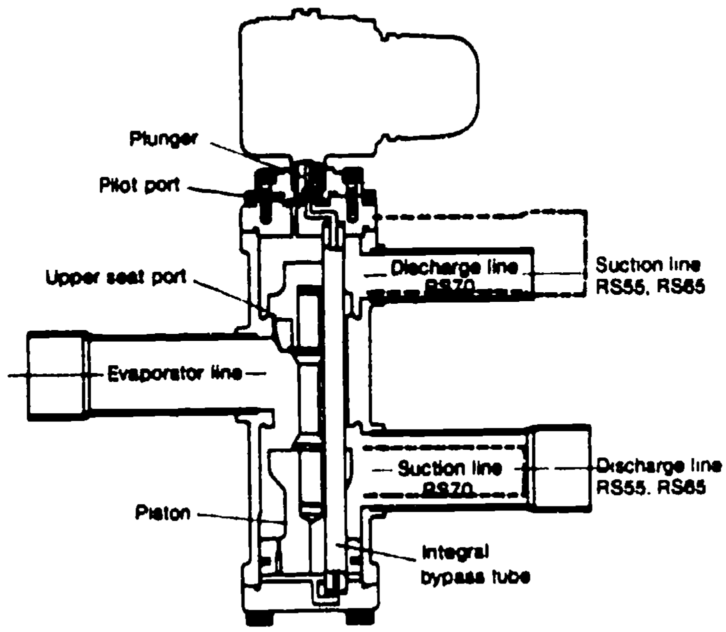
Application

Designed for hot gas defrost from the suction side of evaporator coil, these valves are commonly used wit modern multiplex systems. Using a standard coil assen their rugged design and top quality construction assure life and reliable operation.

Operation

When de-energized, the plunger closes the pilot port allowing pressures to equalize across the piston. Disc pressure holds the upper port seat closed. Flow is fro evaporator to the suction line.

When energized, discharge pressure flows to the bott the piston, creating a pressure imbalance sufficient to the piston, closing the suction line to the evaporator opening the discharge line to the evaporator. High pre gas then flows from the discharge line to the evaporator, raising the pressure and temperature in evaporator and defrosting the coil.



UNIT 26.0 HEAT PUMP

TASK 26.07 CHECK TIME-TEMPERATURE DEFROST CONTROL

PERFORMANCE OBJECTIVE:

Given heat pump with time-temperature defrost control, mechanic's tools, jumpers, material to close off circulation, and other necessary items; check and adjust a time-temperature defrost control and compare and contrast time-temperature control with other types.

PERFORMANCE ACTIONS:

26.0701 Operate system on heating cycle until defrosting is required. (Stop airflow over/thru outdoor coi using appropriaate material.)

26.0702 If defrost is <u>not</u> initiated, jump normally open controls on clock timer (typically 3 & 4.)

26.0703 If reversing valve switches, assume that clock is defective (check to see if clock is running.)

26.0704 If reversing valve does not switch, leave jumper on normally open contacts and apply jumper across defrost thermostat terminals.

26.0705 If reversing valve switches, defrost overload is defective and must be replaced. (Thermostat mus be below 25 degrees F before it can be assumed faulty.)

26.0706 If reversing valve does not switch with addition jumper connected, low voltage condition may exis or one of following controls may be defective:

a. Defrost relay
b. Reversing Valve
c. Reversing Valve Solenoid

26.0707 If 90 minute time cycle allows outdoor coil to become heavily coated with frost, reduce to 30 minutes.

26.0708 Remove screws on back plate and remove cover.

26.0709 Loosen lock nut or allen holding top cam and remove cam.

UNIT 26.0 HEAT PUMP

TASK 26.07 CHECK TIME-TEMPERATURE DEFROST CONTROL

PERFORMANCE ACTIONS: (Con't)

26.0710 Remove bottom cam and replace top cam locking it so it is centered on switch blades.

26.0711 Replace cover and screws.

PERFORMANCE STANDARDS:

-Check time-temperature defrost control and compare and contrast time-temperature control with other defrost controls.
-Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe what happens if the defrost timer motor fails.
-Explain why more frequent defrosting is necessary.
-Describe how often the time-temperature defrost system defrosts?

UNIT 26.0 HEAT PUMP

TASK 26.08 CHECK PRESSURE DIFFERENTIAL DEFROST CONTROL

PERFORMANCE OBJECTIVE:

Given heat pump with pressure defferential defrost control, mechanic's tools, material to close-off air supply to coils, and other items needed; field check the performance of a pressure defferential defrost control and adjust the differential defrost control.

PERFORMANCE ACTIONS:

26.0801 Check pressure tubes to ensure they are free of restrictions.

26.0802 Check that defrost sensing bulb and coil return bend are clean and secure.

26.0803 Start system and place it in heating mode.

26.0804 Cover outdoor coil (at least 50%.)

26.0805 All unit pressures and temperatures to stabilize.

26.0806 Gradually block off remainder of coil (90-95%.)

26.0807 Defrost cycle should initiate: If cycle does not initiate proceed with check procedures.

26.0808 Stop unit if above step in procedures does not result in defrost cycle initiating.

26.0809 If defrost initiation adjustment is necessary, adjust according to manufacturer's recommendation (Turn temperature termination setting screw counterclockwise to setting at least 23 F above temperature of bulb. Remember control is designed so defrost can be initiated only when coil is at least 23 F below termination setting.

26.0810 Re-start unit.

26.0811 If unit goes into defrost cycle, screw initiatio setting at least two full turns clockwise.

26.0812 Bring unit out of defrost cycle by rotating term nation setting clockwise until cycle terminates.

26.0813 Return termination setting to at least 23 F above bulb termperature.

UNIT 26.0	HEAT PUMP
TASK 26.08	CHECK PRESSURE DIFFERENTIAL DEFROST CONTROL

PERFORMANCE ACTIONS: (Con't)

26.0814 With outdoor coil completely free of ice cover, 90-95% of outdoor coil.

26.0815 Gradually, turn initiation adjustment screw counterclockwise until unit goes into defrost cycle.

PERFORMANCE STANDARDS:

-Check pressure differential defrost control and adjust the differential defrost control as necessary so the unit defrost as intended by the manufacturer.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe the switching mechanism in a differential temperature defrost control.
-Identify where the sensing bulb of a differential temperature defrost control typically is located.
-Describe where the air pressure tubes are located.

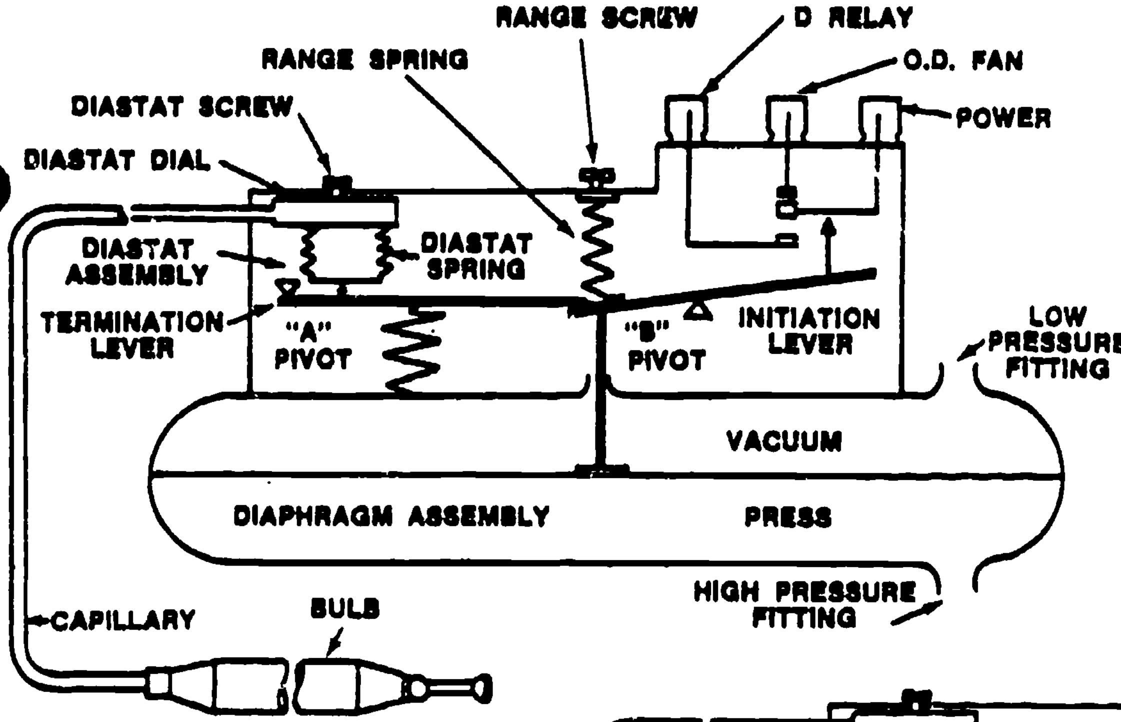


FIGURE 1

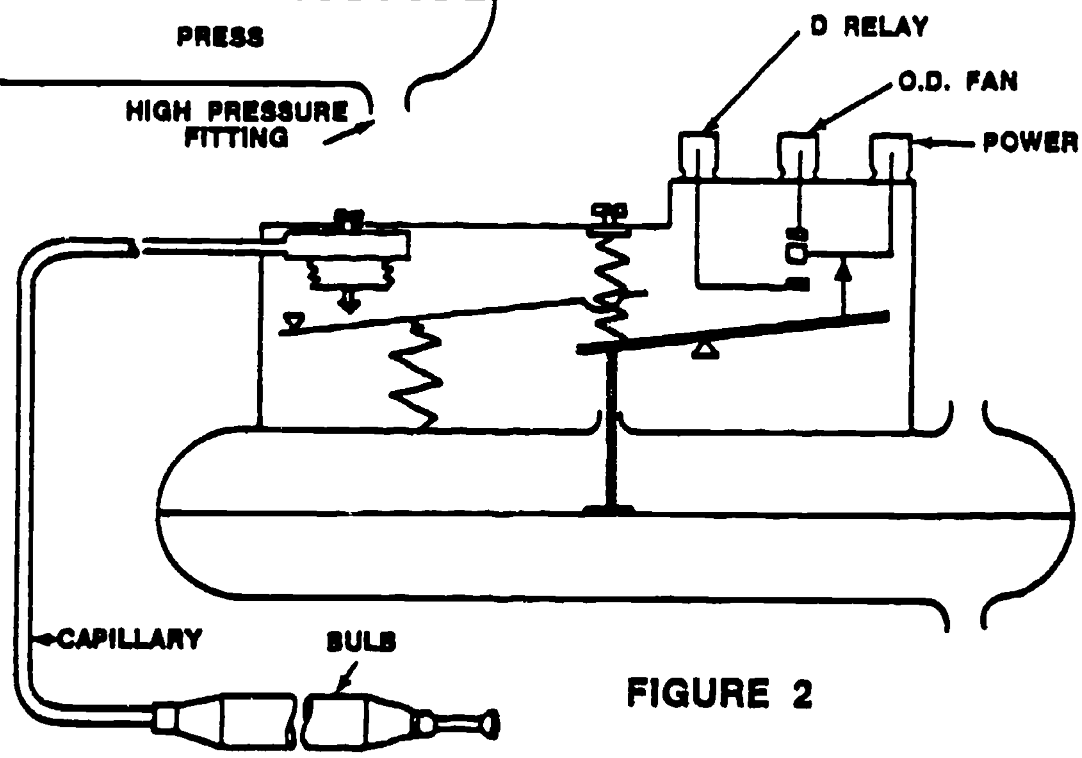


FIGURE 2

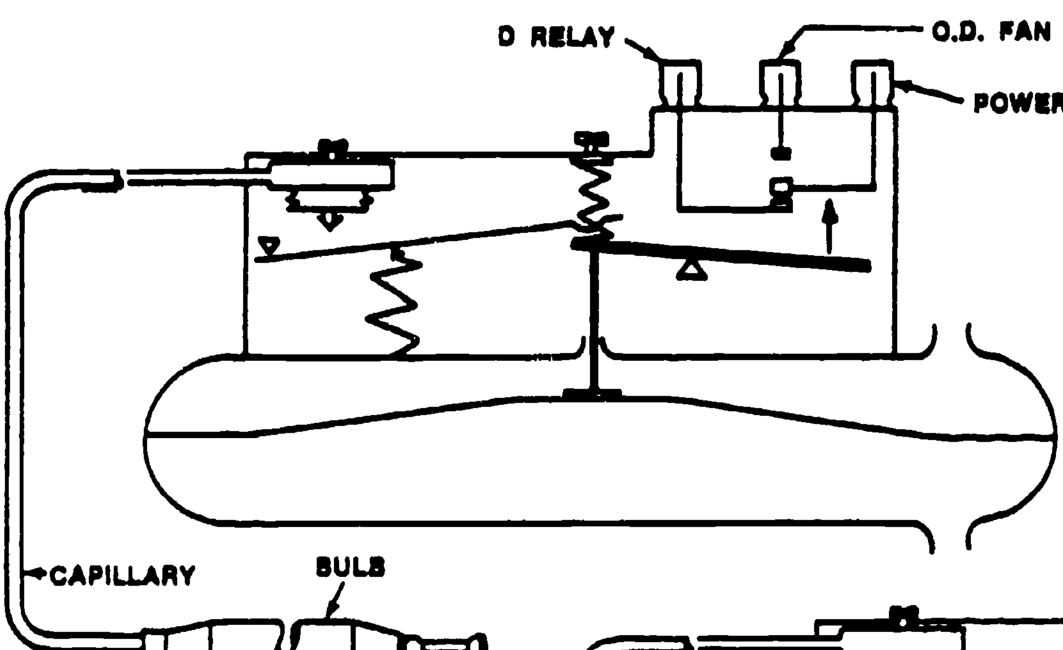


FIGURE 3

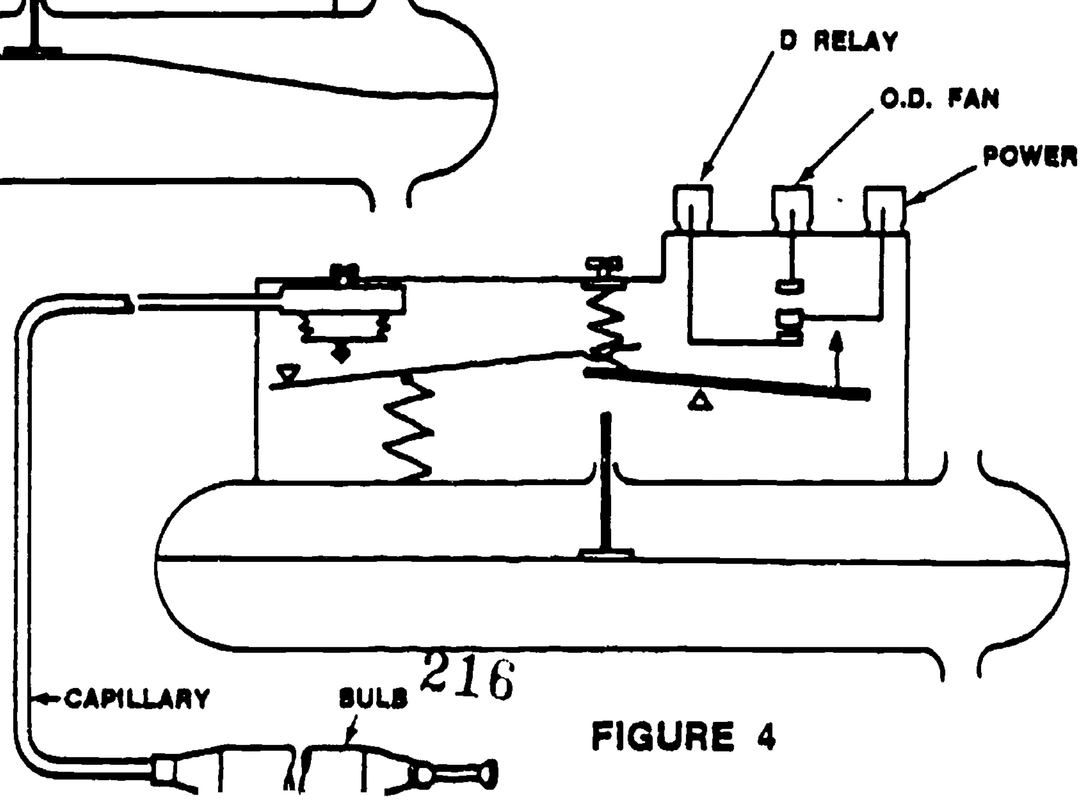
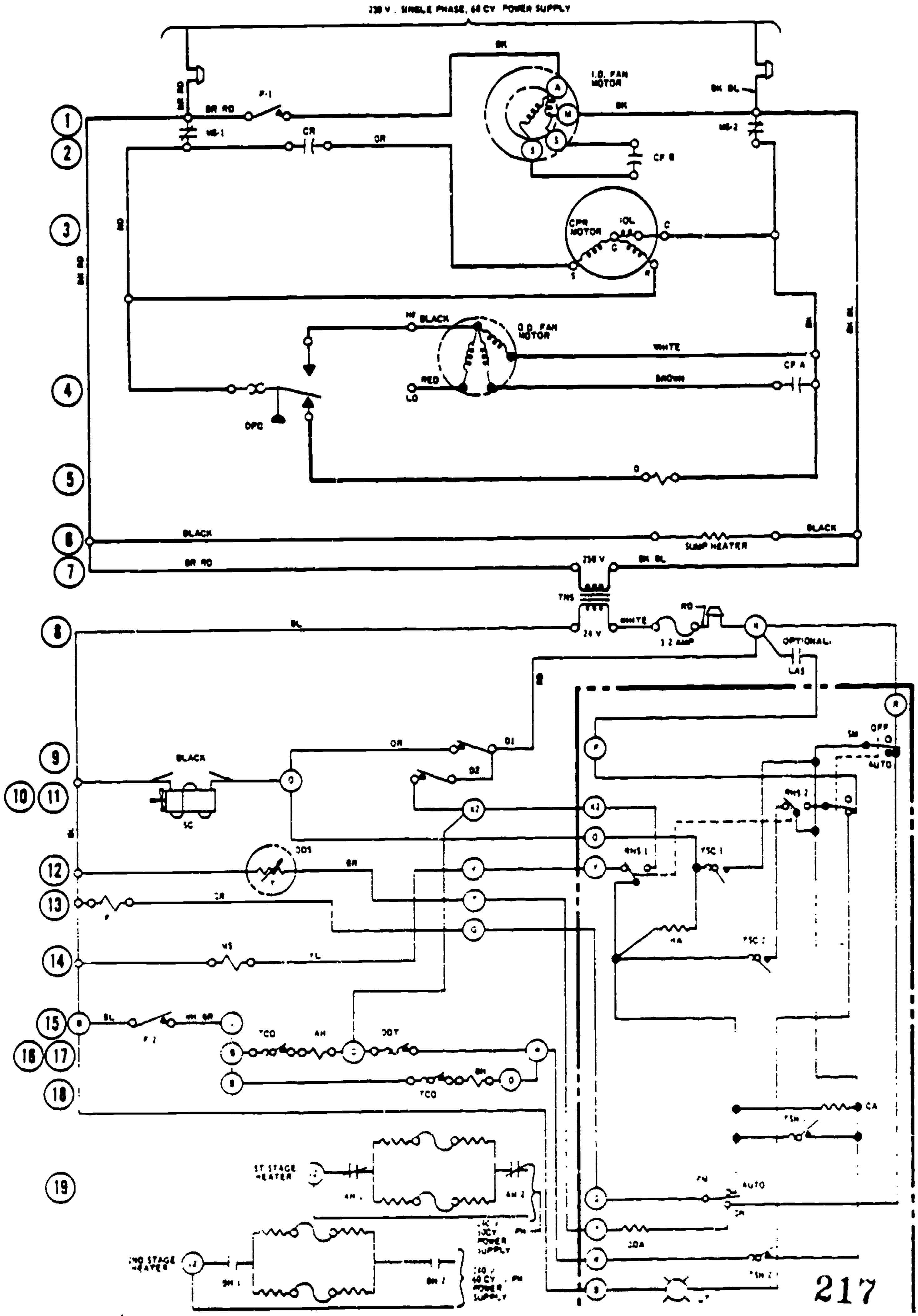


FIGURE 4

TYPICAL WEATHERTRON HEAT PUMP SCHEMATIC DIAGRAM

ROBERTSHAW SYSTEM



UNIT 26.0 HEAT PUMP

TASK 26.09 DETERMINE SUPPLEMENTARY HEAT REQUIREMENTS

PERFORMANCE OBJECTIVE:

Given performance graph (chart) for heat pump, instructions on its use, and other materials required; determine the amount of supplemental heat required using charts and graphs and plot balance point of system using graph.

PERFORMANCE ACTIONS:

"Use procedures recommended for chart/ graph issued."

26.0901 Draw vertical line upward from outdoor winter design temperature.

26.0902 Draw horizontal line from calculated heat loss line intersecting the vertical outdoor winter design line previously drawn.

26.0903 Mark point of intersection.

26.0904 Draw heat loss line from 65 F outdoors passing through intersection of design temperature and the calculated heat loss point.
(Instructor or student: Explain why 65 F is used: It is point where neither heating or cooling is required.)

26.0905 Plot point where heat loss line intersects heating capacity curve of heat pump. Intersect poi is the "balance point."

26.0906 From balance point, draw vertical line downward to determine balance point temperature.

26.0907 Shade area between three proints just determine Shaded area determines supplemental heat requirments in Btu's. Amount of supplemental heat required is the difference between total heat los and heat pump capacity at design temperature.

26.0908 Change Btu's to KW (Btu's/3,413=Kw.)

PERFORMANCE STANDARDS:

- Determine supplementary heat requirements of a given heat pump using performance graph/chart for heat pump.
- Correct procedures and calculations are important.
- Performance must meet instructor's standards.

UNIT 26.0 HEAT PUMP

TASK 26.09 DETERMINE SUPPLEMENTARY HEAT REQUIREMENTS (Con't)

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECNICAL INFORMATION:

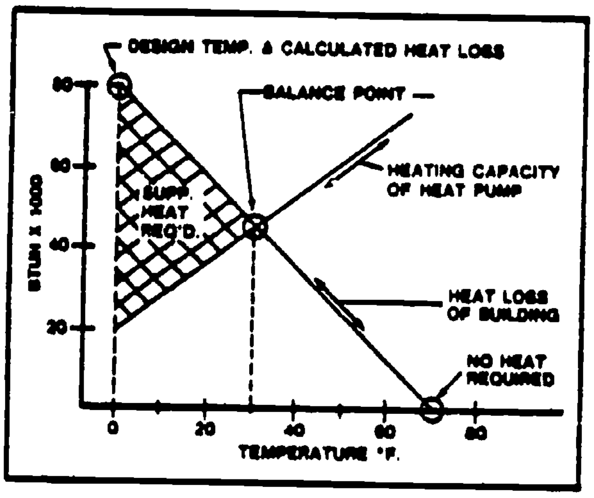
-Define "balance point"
-Explain how the supplemental heat required is determined
-Identify how many Btu's are in 1 watt
-Explain why it is desirable to install at least one heat strip even in areas where design point indicates no need for them.
-Explain why outdoor thermostats are used.

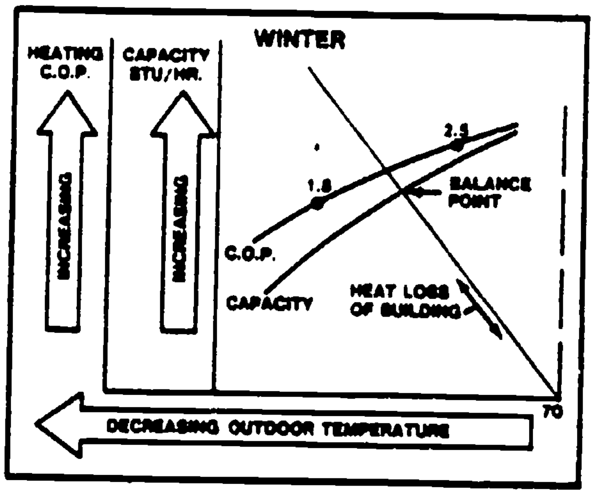
ADDENDUM PAGE ACCOMPANIES THIS TASK: see accompanying chart.

TASK EXPANSION:

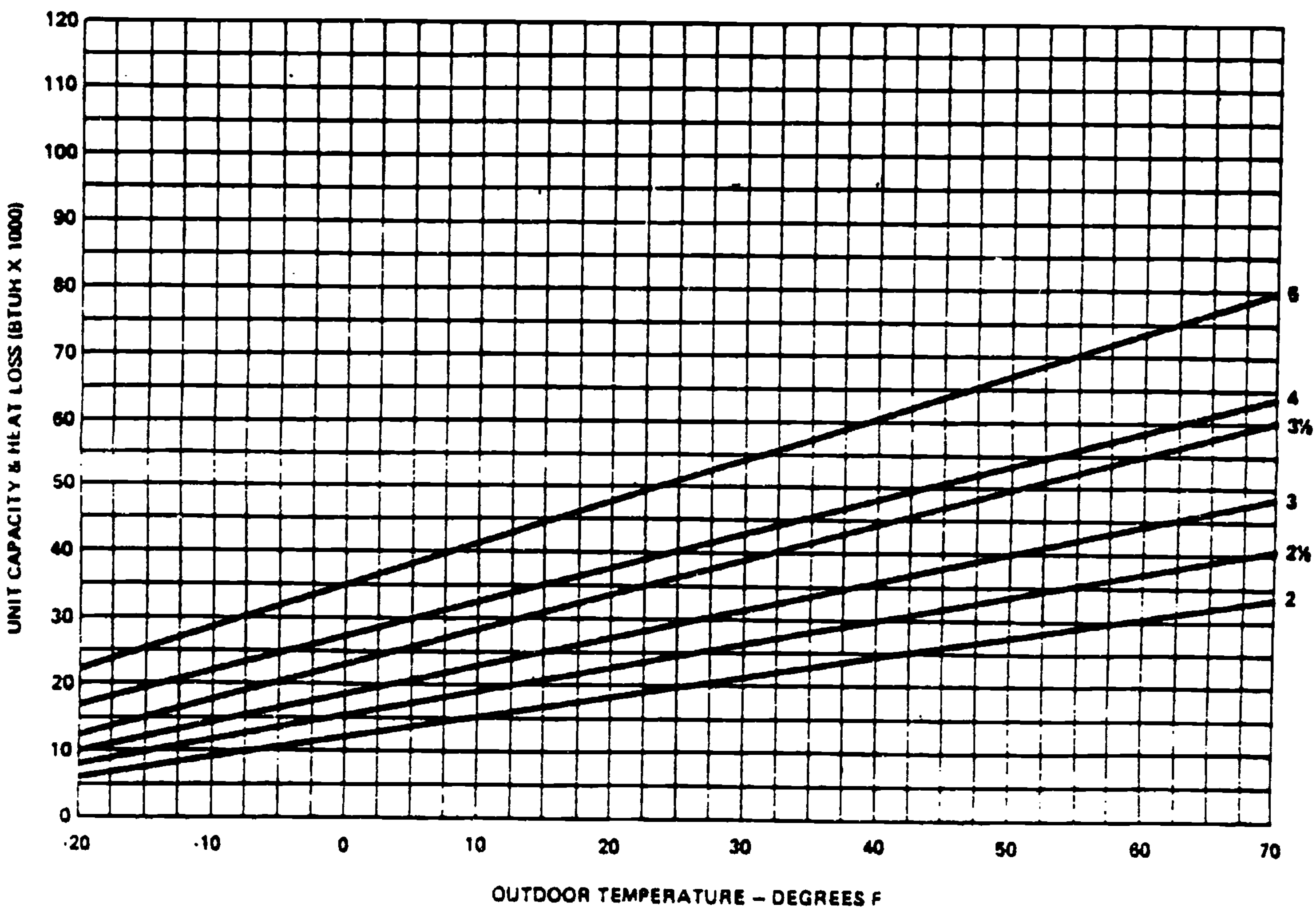
"Given performance graph for heat pump, calculate set point of outdoor thermostats using performance graph."

1. Transpose previously graphed information to new graph paper.
2. Project vertical line upward from balance point. (Instructor explain.)
3. From end point of this line draw line parallel with heat pump heating curve to intersect the heat loss line.
4. From this point, repeat vertical and parallel lines: Continue until all available stages are plotted.
5. Make projections from vertical staging lines downard to outdoor temperature line.
6. Set outdoor thermostats 3° above points located.
7. Check work.





INTEGRATED HEATING CAPACITY CURVES
FOR SPLIT SYSTEM HEAT PUMPS



UNIT 26.0 HEAT PUMP

TASK 26.10 INSTALL INDOOR THERMOSTAT

PERFORMANCE OBJECTIVE:

Given indoor thermostat (4-bulb or emergency heat type), split system heat pump, mechanic's hand tools, thermostat wire, and other materials needed; properly install indoor thermostat on heat pump following manufacturers' diagrams.

(Recommended alternate of additional training:)
Draw a schematic of an operating split system heat pump by tracing the existing wiring. The schematic must be accurate, correct symbols appropriately sized must be used, and the drawing must be neat and easily interpreted by the instructor or another mechanic.

PERFORMANCE ACTIONS:

26.1001 a. Study diagram with thermostat.
b. Study diagram with heat pump.

26.1002 Ensure that thermostat is correct component for system design.

26.1003 Install sub-base and level it.

26.1004 Wire thermostat to unit. (Install wire, etc., as necessary.)

26.1005 Check wiring, especially connections to proper terminals.

26.1006 Start unit: Check installation in all modes.

26.1007 Stop unit.

26.1008 Check wiring, installation.

26.1009 (Alternate/additional action) Draw schematic of installation and leave it with instruction boosks, etc., concerning installation.

PERFORMANCE STANDARDS:

-Install indoor thermostat on given heat pump. Circuit must be according to diagram provided and must be electrically mechanically secure and safe and the unit must operate as intended. The thermostat unit must be level and performance must meet instructor's standards.

UNIT 26.0 HEAT PUMP

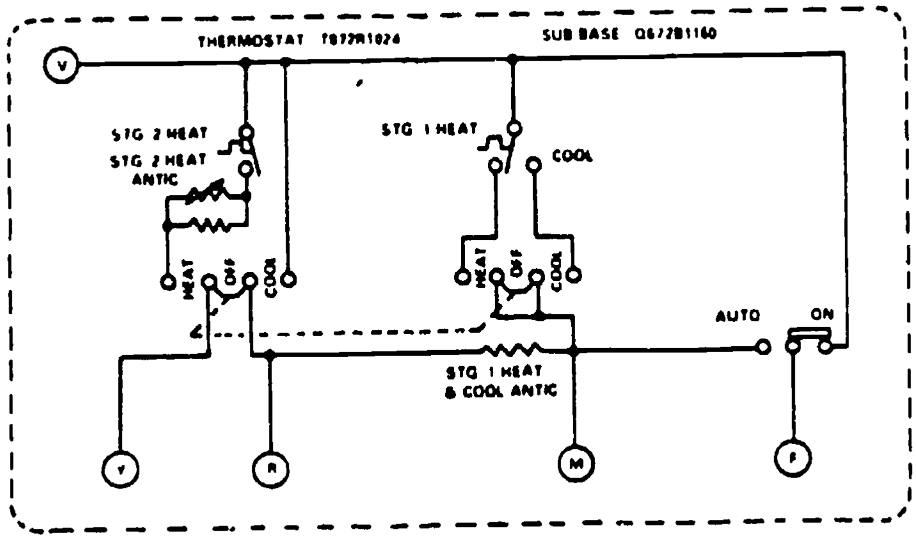
TASK 26.10 INSTALL INDOOR THERMOSTAT (Con't)

SUGGESTED INSTRUCTION TIME: Hours

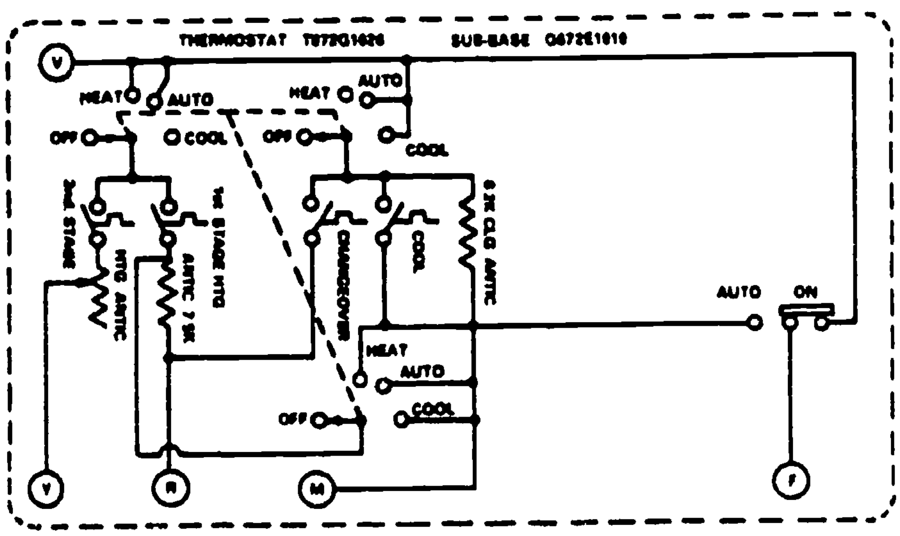
RELATED TECNICAL INFORMATION:

-Recognize and state difference between two-bulb and four-bulb thermostat.
-Explain the advantages of emergency heat thermostat.
-Interpret (read) schematic diagram of
  a. Indoor thermostat
  b. Heat pump
-Describe the sequencing of heat pump thermostats.
-Describe the "Emergency Heat Thermostat."
-Describe/demonstrate how to wire the Emergency Heat Thermostat.

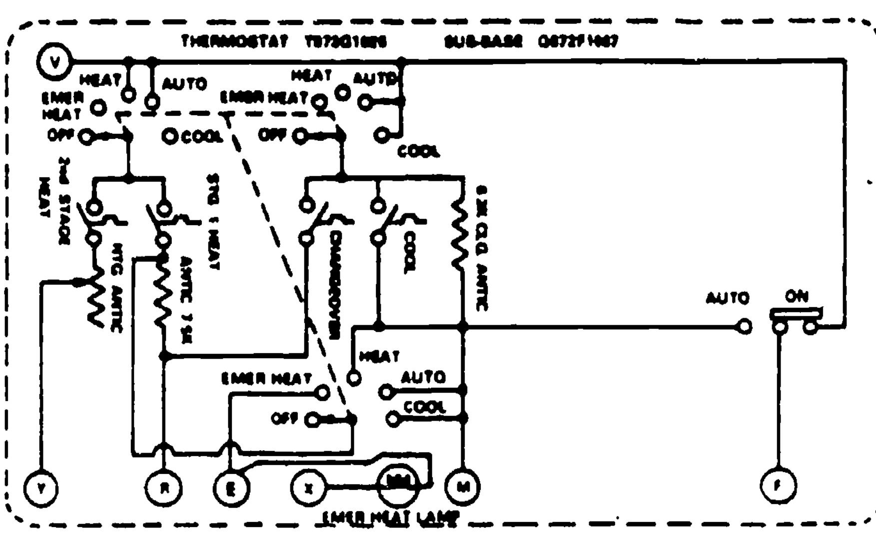
ADDENDUM PAGE ACCOMPANIES THIS TASK: See thermostat schematics.



TWO-BULB THERMOSTAT



FOUR-BULB THERMOSTAT DIAGRAM



Emergency Heat Thermostat

UNIT 26.0 HEAT PUMP

TASK 26.11 DETERMINE TEMPERATURE RISE AND DROP ACROSS COILS

PERFORMANCE OBJECTIVE:

Given a heat pump, thermometers, and other materials needed; determine temperature rise and drop across the coils. The temperature rise will be 20-30 degrees on heating and the temperature drop will be between 12-15 degrees.

PERFORMANCE ACTIONS:

(See related tasks already mastered.)

PERFORMANCE STANDARDS:

-Determine temperature rise and drop across coils. Temperature rise should be between 20-30 degrees F and temperature drop should be between 12-15 degrees.

SUGGESTED INSTRUCTION TIME: N/A: "Similar competency already mastered."

RELATED TECHNICAL INFORMATION:

-Measure temperature with thermometer
-Identify where temperature measurements are taken to determine temperature rise and drop across coils.
-Explain why correct rise and drop is important
-Identify safety considerations

UNIT 26.0 ELECTRIC HEATING

TASK 26.12 DETERMINE OPERATING PRESSURES

PERFORMANCE OBJECTIVE:

Given an air-to-air heat pump, gauge and manifold set, pressure chart, and other necessary materials, determine the high and low side pressures. The high side temperature will be 30-35 degrees above ambient and pressures will be read from pressure chart. Low side pressure will correspond to a coil temperature of 40 degrees.

PERFORMANCE ACTIONS:

(See related tasks already mastered.)

PERFORMANCE STANDARDS:

- Determine operating (high and low side) pressures for a given air to air heat pump. High side temperature will be 30-35 degrees above ambient and pressures will be read from pressure chart. Low side pressure will corrrespond to a coil temperature of 40 degrees.
- Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: N/A: "Similar competency already mastered."

RELATED TECHNICAL INFORMATION:

- Demonstrate how to use the gauge and manifold set
- Describe how to read the pressure chart
- Identify and explain purpose of service valves
- Define ambient temperature
- Identify safety considerations

UNIT 26.0 HEAT PUMP

TASK 26.13 CHARGE A HEAT PUMP

PERFORMANCE OBJECTIVE:

Given a heat pump, gauges or manifold set, refrigerant, pressure chart, tools, and other materials needed; charge the system so that it delviers cool air on cooling and warm air on heating and so the pressure corresponds to the outdoor ambient and evaporator design coil temperature.

PERFORMANCE ACTIONS:

(See related tasks in refrigeration, etc.)

PERFORMANCE STANDARDS:

-Charge a heat pump so that it delivers cool air on cooling and warm air on heating and so the preesure corresponds to the outdoor ambient and evaporator design coil temperatures.

SUGGESTED INSTRUCTION TIME: N/A: "Similar competency already mastered."

RELATED TECHNICAL INFORMATION:

-Demonstrate how to use gauges in charging a heat pump
-Explain functions of service valves on typical heat pump
-Identify typcial types of refrigerants
-Explain how to read/use temperature pressure charts
-Identify all sealed system components
-Identify safety considerations

UNIT 26.0 ELECTRIC HEATING

TASK 26.14 INSPECT STRIP HEATERS

PERFORMANCE OBJECTIVE:

Given a heat pump, VOM, clamp-on ammeters, tools, and other materials needed, inspect the strip heaters. They will be correctly wired, pull the correct current, and heat the air as designed.

PERFORMANCE ACTIONS:

(See related tasks already mastered.)

PERFORMANCE STANDARDS:

-Inspect strip heaters on a given heat pump. The strips must be correctly wired pull the correct current, and heat the air as designed.
-Performance must be to the instructor's standards.

SUGGESTED INSTRUCTION TIME: N/A: "Similar competency already mastered."

RELATED TECHNICAL INFORMATION:

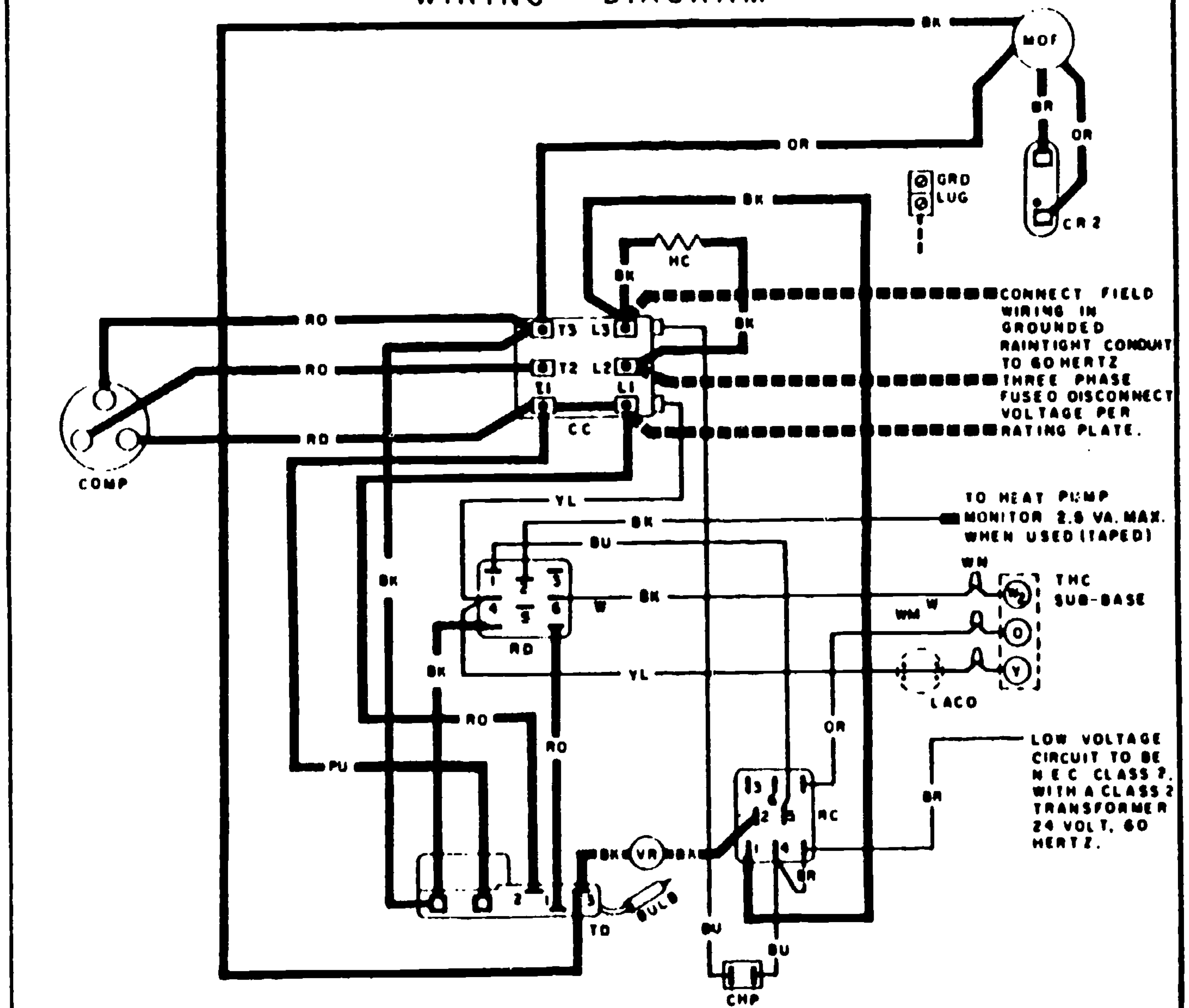
-Demonstrate how to measure voltage with the VOM
-Demonstrate how to measure amperate with the clamp-onammeter
-Locate strip heaters on given heat pumps
-Explain purpose and types of strip heaters
-Identify safety considerations

EXPANDED TRAINING:

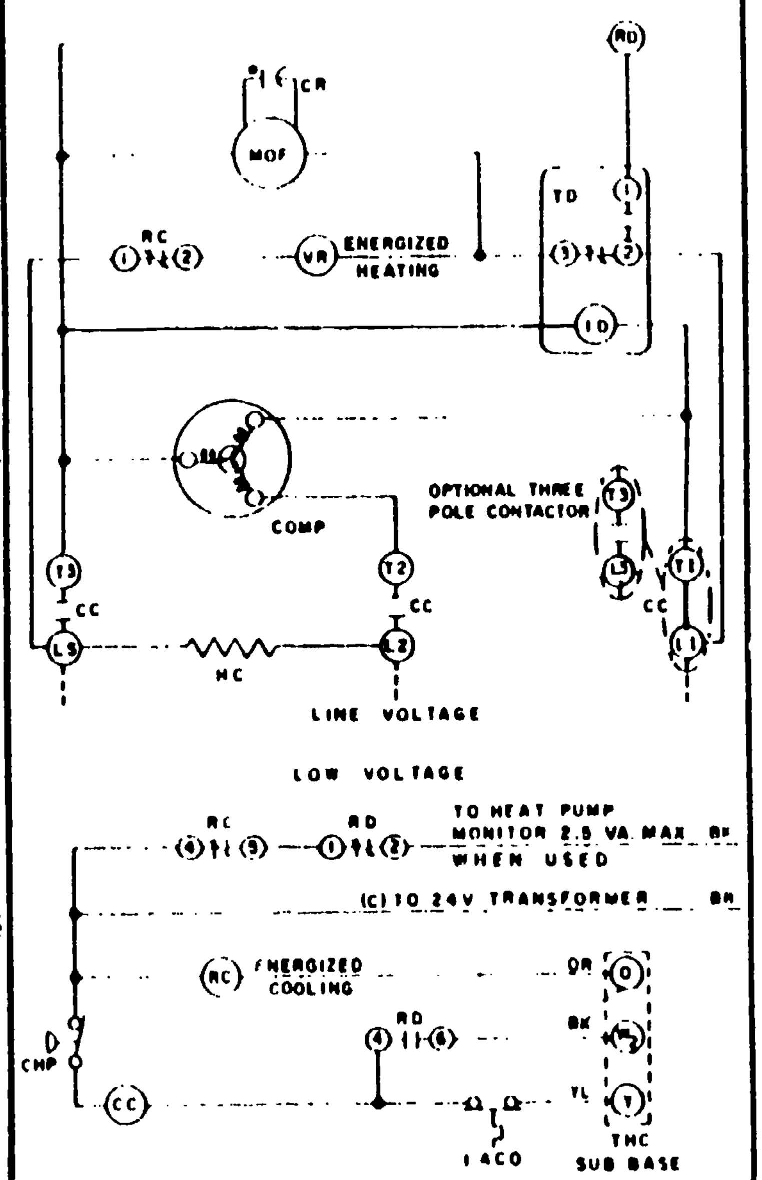
Interpret electrical schematic (circuit) of heat pump with level of accuracy/competency expected of entry level service trainee.

ADDENDUM PAGES ACCOMPANIES THIS TASK: (See accompanying three pages (1-Ø, 3-Ø, & 460v 3-Ø)

WIRING DIAGRAM



SCHEMATIC DIAGRAM



NOTES:
1 CONNECTORS SUITABLE FOR USE WITH COPPER CONDUCTORS ONLY
2 MOTOR-COMPRESSOR THERMALLY PROTECTED.

COMPONENT CODE

CC	CONTACTOR
CHP	CONTROL, HIGH PRESSURE
COMP	COMPRESSOR
CR	CAPACITOR, RUN
HC	HEATER, CRANKCASE
LACO	LOW AMBIENT CUT OUT
MOF	MOTOR, OUTDOOR FAN
RC	RELAY, CHANGEOVER
RD	RELAY, DEFROST
TD	TIMER, DEFROST
THC	THERMOSTAT, HEAT-COOL
VR	VALVE, REVERSING
WN	WIRE NUT
WM	WIRE MARKER.

WIRING

1 LINE VOLTAGE
- FACTORY STANDARD
- OPTIONAL COMPONENT

2 LOW VOLTAGE
- FACTORY STANDARD
- OPTIONAL COMPONENT

3. FIELD INSTALLED POWER
4 FIELD INSTALLED CONTROL

NOTE 1. REPLACEMENT WIRE MUST BE THE SAME SIZE AND TYPE OF INSULATION AS ORIGINAL.
2. WARNING - CABINET MUST BE PERMANENTLY GROUNDED AND CONFORM TO NEC & LOCAL CODES

WIRE COLOR CODE

BK -- BLACK	PU -- PURPLE
BU -- BLUE	RD -- RED
BR -- BROWN	WH -- WHITE
GR -- GREEN	YL -- YELLOW
OR -- ORANGE	

WIRING DIAGRAM
REMOTE HEAT PUMP
THREE PHASE WITH CRANKCASE HEATER

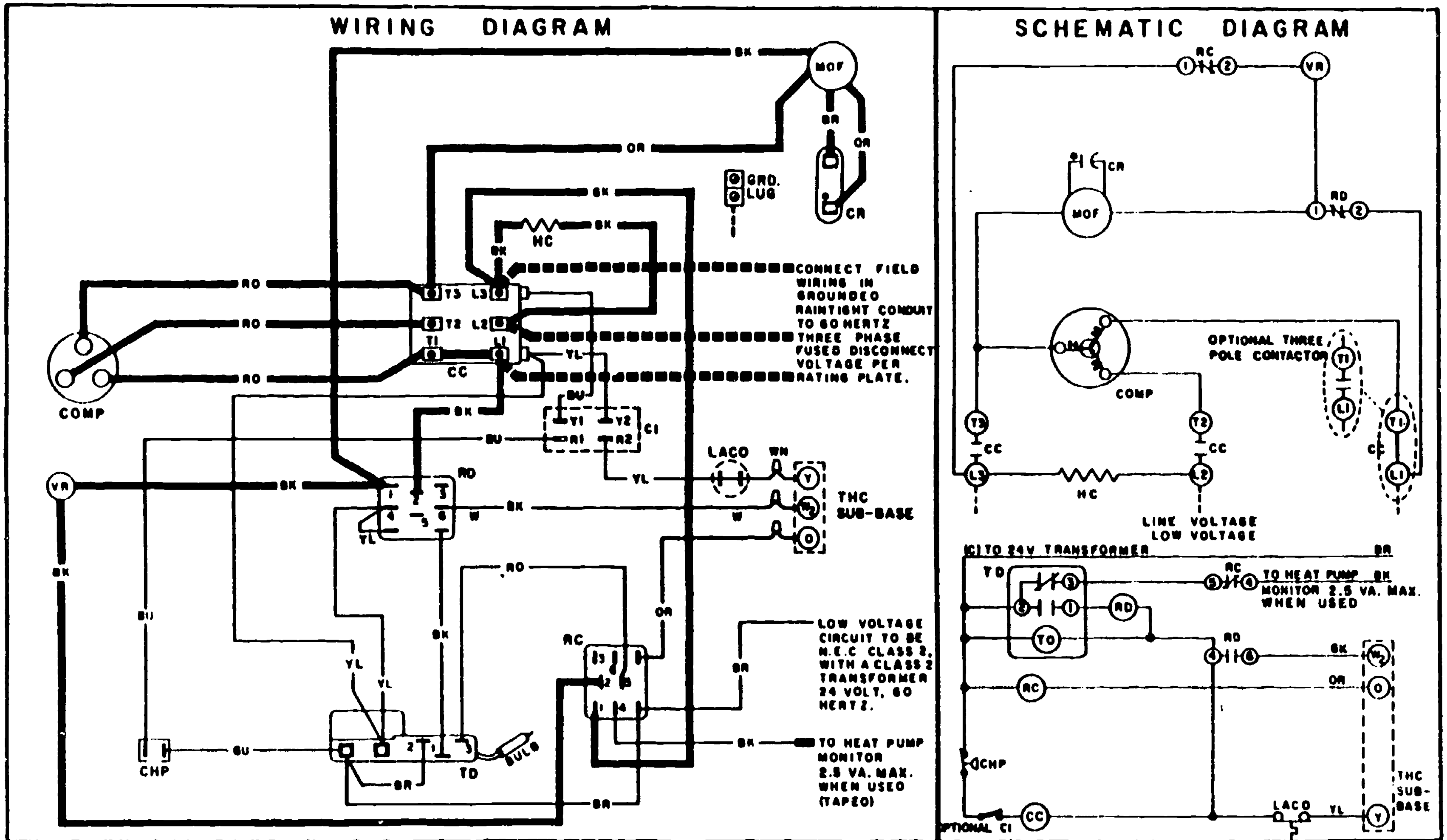
DR. BY	APP. BY	DATE	DWG. NO.	
R.D.H.		8-25-75	90-20499-01	07

90-20499-01 07

214

ADDENDUM TO TASK 26.14

BEST COPY AVAILABLE



90-20520-01

NOTES:
1. CONNECTORS SUITABLE FOR USE WITH COPPER CONDUCTORS ONLY
2. MOTOR-COMPRESSOR THERMALLY PROTECTED UNDER PRIMARY SINGLE PHASING CONDITIONS.

COMPONENT CODE

CC	CONTACTOR
CHP	CONTROL, HIGH PRESSURE
COMP	COMPRESSOR
CR	CAPACITOR, RUN
HC	HEATER, CRANKCASE
LACO	LOW AMBIENT CUT OUT
MOF	MOTOR, OUTDOOR FAN
RC	RELAY, CHANGEOVER
RD	RELAY, DEFROST
CI	COMPRESSOR, INTERLOCK
TD	TIMER, DEFROST
THC	THERMOSTAT, HEAT-COOL
VR	VALVE, REVERSING
WN	WIRE NUT
WM	WIRE MARKER

WIRING
1. LINE VOLTAGE
 - FACTORY STANDARD
 - OPTIONAL COMPONENT
2. LOW VOLTAGE
 - FACTORY STANDARD
 - OPTIONAL COMPONENT
3. FIELD INSTALLED POWER
4. FIELD INSTALLED CONTROL

NOTE 1. REPLACEMENT WIRE MUST BE THE SAME SIZE AND TYPE OF INSULATION AS ORIGINAL.
2. WARNING-CABINET MUST BE PERMANENTLY GROUNDED AND CONFORM TO N E C & LOCAL CODES

WIRE COLOR CODE

BK _ _ BLACK	PU _ _ PURPLE
BU _ _ BLUE	RD _ _ RED
BR _ _ BROWN	WH _ _ WHITE
GR _ _ GREEN	YL _ _ YELLOW
OR _ _ ORANGE	

WIRING DIAGRAM
REMOTE HEAT PUMP
THREE PHASE, 460 VOLT
WITH CRANKCASE HEATER

DR BY	APP BY	DATE	DWG NO	
R.D.M.		1-14-77	90-20520-01	04

UNIT 26.0 HEAT PUMP

TASK 26.15 INSTALL A HEAT PUMP

PERFORMANCE OBJECTIVE:

Given a heat pump unit, mechanic's tools and equipment, spirit level, leak detector, gauge manifold, sling psychrometer, velocimeter, measuring tape, wiping cloth, and other materials as needed; install the heat pump at a predetermined location. The installation must be in accordance with local electrical code and manufacturer's recommendations.

PERFORMANCE ACTIONS:

26.1501 Install heat pump according to:
 a. Manufacturer's instructions, recommendations
 b. Specifications
 c. Local electrical code, etc.

26.1502 Install gauge manifold.

26.1503 Operate system.

26.1504
 a. Determine air conditions, both volume and properties.
 b. Measure air openings and air velocities.
 c. Determine db and wb values on inlet and outlet of both evaporator and condenser: Record measurements.
 d. Reverse cycle and determine new conditions after the unit has stabilized: Record data.

26.1505 After unit tests out, clean up after installation.

PERFORMANCE STANDARDS:

-Install heat pump according to manufacturer's instructions, specificiations, and local electrical code.
-Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-National Electric Code
-Locating heat pump components: Inside, Outside
-Tubing, piping
-Duct work
-Adjustment of system

ADDENDUM PAGE ACCOMPANIES THIS TASK!

System, Make__________ Model______________ Serial No.____________ Type__________ EER__________

First Cycle (Heating Cycle):

Condenser-Air Velocity, In__________________________ Grille Size__________ Air Volume__________

Out__________________________ Grille Size__________ Air Volume__________

db Temp. In__________________________ db Temp. Out__________________________

wb Temp. In__________________________ wb Temp. Out__________ Heat Loss__________

th In__________________________ th Out__________________________

Evaporator

Air Velocity, In__________________________ Grille Size__________ Air Volume__________

Air Velocity, Out__________________________ Grille Size__________ Air Volume__________

db Temp. In__________________________ db Temp. Out__________________________

wb Temp. In__________________________ wb Temp. Out__________ Heat Gain__________

th In__________________________ th Out__________________________

Second Cycle-Reverse the Refrigerant Flow (Cooling Cycle):

Condenser-Air Velocity, In__________________________ Grille Size__________ Air Volume In__________

Air Velocity, Out__________________________ Grille Size__________ Air Volume Out__________

db Temp. In__________________________ db Temp. Out__________________________

wb Temp. In__________________________ wb Temp. Out__________ Heat Loss__________

th In__________________________ th Out__________________________

Evaporator

Air Velocity, In__________________________ Grille Size__________ Air Volume In__________

Air Velocity, Out__________________________ Grille Size__________ Air Volume Out__________

db Temp. In__________________________ db Temp. Out__________________________

wb Temp. In__________________________ wb Temp. Out__________ Heat Gain__________

th In__________________________ th Out__________________________

UNIT 26.0 HEAT PUMP

TASK 26.16 LOCATE TROUBLE IN HEAT PUMP

PERFORMANCE OBJECTIVE:

Given a residential heat pump system with a trouble report and one or more typical symptoms, manufacturer's information (literature or schematic) on the system, electrical diagram/schematic, mechanic's tools and equipment as need, VOM, clamp-on ammeter, gauge manifold set, thermometers, vacuum pump, leak detector, refrigerant, service materials such as rags and oil; locate the trouble, repair it, and restore the heat pump to the correct operating temperatures.

PERFORMANCE ACTIONS:

26.1601 Interpret trouble report, symptoms:

a. No heat:
   (1) Heat pump an auxiliary heat fail to heat.
b. Not enough heat:
   (1) Auxiliary heat malfunctioning.
c. Too much heat:
   (1) Auxiliary heat cycles too long.
   (2) Auxiliary heat runs continously.
   (3) Heat pump runs continously.
d. No cooling:
   (1) Heat pump fails to cool.
e. Not enough cooling:
   (1) Heat pump malfunctioning.
f. Too much cooling:
   (1) Heat pump runs continously.
g. Noise:
   (1) Mechanical noise.
   (2) Air noise.
h. Odor:
   (1) Filters dirty.
   (2) Wires burning.
i. Cost of operation:
   (1) Refrigerant charge.
   (2) Cycling time.

26.1602 Diagnose (list, identify) probable cause(s).

26.1603 Review specifications, instruction book, diagrams, etc., on system.

26.1604 Troubleshoot system:

a. Test external circuit:
b. Check thermostat (power,etc.)
c. Check compressor motor
d. Check electric heaters

UNIT 26.0 HEAT PUMP

TASK 26.16 LOCATE TROUBLE IN HEAT PUMP

PERFORMANCE ACTIONS: (Con't)

e. Check solenoid valve
f. Check four-way valve
g. Check for temperature difference across coils and airflow through coils

26.1605 Install gauges: Check pressures: Test for leaks.

26.1606 Run unit for about 20 minutes: Check reversing valve and TEC operations: Check outdoor and indoor coils, fans, motors, and temperatures.

26.1607 Check reversing valve to see if it is acting slowly or not at all.

26.1608 Repair what is necessary by pumping all refrigerant into liquid receiver: Replace all defective parts and reassemble unit: Evacuate system, charge it, and test it for leaks.

26.1608 Return system to normal (design) operation.

PERFORMANCE STANDARDS:

-Locate trouble in heat pump, repair it, and restore system to correct operating temperatures.
-Performance must be to instructor's standards. System must be to specifications.

SUGGESTED INSTRUCTION TIME: N/A: (Competencies in actions should be mastered: However, student may need experience to apply competencies to problem solving.)

RELATED TECHNICAL INFORMATION:

-Technique of listing to customer's complaint.
-Describe typical procedure for initiating troubleshoot of heat pump: Describe steps in troubleshooting.
-Use electrical test equipment: VOM, clamp-on ammeter.
-Use gauges, etc.
-Make list (or identify) of troubleshooting "probable causes" to help diagnose problem.
-(See unit on customer relations for cross-training.)

SEE ADDENDUM PAGES ACCOMPANYING THIS TASK:

COLLECT DATA ON HEAT PUMP SYSTEM:

DATA:.

	At the Beginning	After 15 Minutes	After Repair
Low-Side Pressure			
High-Side Pressure			
Suction Line Temp., Approx.			
Liquid Line Temp., Approx.			
Evaporator Air Temperature			
Noise: Compressor			
Motor			

EER ______________________

Remarks:

REFRIGERATION AND AIR CONDITIONING

PS CHECK SHEET — HEAT PUMP — COOLING

Dealer Name ______
Address ______
Homeowner's Name ______
Address ______
Date ______ Man ______ Time In ______ Time Out ______
Equipment Make and Model ______
Comments by Homeowner ______

AT THERMOSTAT

- [ ] Record thermostat set point. ______
- [ ] Check thermostat for faulty wiring and level.
- [ ] Turn thermostat to "lowest" cooling setting.

INDOOR UNIT

- [ ] Check supply voltage and record. Time ___ Voltage ______
- [ ] Clean or change filters.
- [ ] Clean out blower wheel and blower compartment.
- [ ] Check amperage on motor and record. ______

BELT DRIVE BLOWERS

- [ ] Check all wiring in blower compartment for loose connections or bad insulation
- [ ] Remove blower belt and check for wear.
- [ ] Check motor bearings.
- [ ] Check pulley and drive alignment.
- [ ] Check pulley and drive set screws for tightness.
- [ ] Check motor bracket for tightness.
- [ ] Check blower for free operation.
- [ ] Lubricate blower and motor bearings.
- [ ] Put belt back on blower and drive pulleys. Check belt tension slippage.

DIRECT DRIVE BLOWERS

- [ ] Check all wiring in blower cabinet for loose connections and bad insulation.
- [ ] Check motor bearings.
- [ ] Check for free blower operation
- [ ] Check blower set screws for tightness.
- [ ] Lubricate motor bearings, unless they are sealed.

INDOOR COIL

- [ ] Check and clean indoor coil.
- [ ] Check and clean condensate drain.
- [ ] Check static pressure. Entering ___ Leaving ______
- [ ] Check temperature difference over coil.
- [ ] Check for proper voltage at transformer.

OUTDOOR UNIT

- [ ] Check and clean outdoor coil.
- [ ] Oil outdoor coil fan motor.
- [ ] Check voltage on both load and line side of contactor with compressor running. Load ___ Line ______
- [ ] Check all wiring for loose connections.
- [ ] Check all wiring for damaged insulation.
- [ ] Gauge refrigeration system and check operating pressures. ______ ______
- [ ] Check refrigerant charge.
- [ ] Check reversing valve operation.
- [ ] Check amperage draw on outdoor fan motor. Nameplate ___ Actual ______
- [ ] Check amperage draw on compressor. ______
- [ ] Visually inspect connecting tubing and coils for evidence of oil leak.
- [ ] Return thermostat to original set point.

SUPPLEMENTAL ELECTRIC HEAT

- [ ] Turn off unit disconnect
- [ ] Check all electrical wiring for loose connections and damaged insulation
- [ ] Turn on unit disconnect
- [ ] Check supply voltage and record. Time ___ Voltage ______
- [ ] Check amp draw as each heating element comes on
- [ ] Check total amp draw and record ______
- [ ] Check humidifier

BE SURE TO LEAVE ALL AREAS NEAT AND CLEAN

NOTE: A PS cooling check on heat pump should be made only when outdoor air temperature is 70 F or above

REFRIGERATION AND AIR CONDITIONING

PS CHECK SHEET — HEAT PUMP — HEATING

Dealer Name ______________________________
Address ______________________________
Homeowner's Name ______________________________
Address ______________________________
Date ____________ Man ____________ Time In ____________ Time Out ____________
Equipment Make and Model ______________________________
Comments by Homeowner ______________________________

AT THERMOSTAT

- ☐ Record thermostat set point. ________
- ☐ Check thermostat for faulty wiring and level.
- ☐ Turn thermostat to highest heating setting.

INDOOR UNIT

- ☐ Check supply voltage and record.
  Time____Voltage ______
- ☐ Clean or change filters.
- ☐ Clean out blower wheel and blower compartment.
- ☐ Check motor amperage and record. ________

BELT DRIVE BLOWERS

- ☐ Check all wiring in blower compartment for loose connections or bad insulation.
- ☐ Remove blower belt and check for wear.
- ☐ Check pulley and drive alignment.
- ☐ Check pulley and drive set screws for tightness.
- ☐ Check motor bracket for tightness.
- ☐ Check blower for free operation.
- ☐ Lubricate blower and motor bearings.
- ☐ Put belt back on blower and drive pulleys. Check belt tension slippage.

DIRECT DRIVE BLOWERS

- ☐ Check all wiring in blower cabinet for loose connections and bad insulation.
- ☐ Check motor bearings.
- ☐ Check for free blower operation
- ☐ Check blower set screws for tightness.
- ☐ Lubricate motor bearings, unless they are sealed.

INDOOR COIL

- ☐ Check and clean indoor coil.
- ☐ Check and clean condensate drain.
- ☐ Check static pressure. Entering____Leaving____
- ☐ Check for proper voltage at transformer.

OUTDOOR UNIT

- ☐ Turn off outdoor unit disconnect.
- ☐ Check and clean outdoor coil.
- ☐ Oil outdoor coil fan motor.
- ☐ Check voltage on both load and line side of contactor with compressor running. Load____Line ______
- ☐ Check all wiring for loose connections.
- ☐ Check all wiring for damaged insulation.
- ☐ Turn on outdoor unit disconnect.
- ☐ Check reversing valve operation.
- ☐ Check amperage draw on outdoor fan motor.
  Nameplate____Actual ________
- ☐ Check amperage draw on compressor. ________
- ☐ Visually inspect connecting tubing and coils for evidence of oil leak.
- ☐ Return thermostat to original set point.

SUPPLEMENTAL ELECTRIC HEAT

- ☐ Turn off unit disconnect.
- ☐ Check all electrical wiring for loose connections and damaged insulation.
- ☐ Turn on unit disconnect.
- ☐ Check supply voltage and record.
  Time____Voltage ______
- ☐ Check amp draw as each heating element comes on.
- ☐ Check total amp draw and record. ________
- ☐ Check humidifier.

BE SURE TO LEAVE ALL AREAS NEAT AND CLEAN

NOTE: A PS heating check on heat pump should be made only when the outdoor air temperature is below 55°F.

UNIT 27.0

GAS HEATING

The purpose of this unit on Gas Heating is to provide the secondary graduate with the fundamental knowledge and skills necessary for entry level employment as a gas appliance serviceman or "gas burner mechanic" (D.O.T. 637.261-018.)

Training will prepare the graduate to inspect and clean, locate malfunctions in, make repairs to, and adjust gas-fueled heating systems. Related training may include servicing cooking stoves, clothes dryers, hot water heaters, and outdoor lights and grills that use gas fuel.

During training, the student will continue working with hand and speciality tools such as acetylene torches, volt-ohm-meters, and manometers.

Related tasks such as troubleshooting thermostat controls and electrical devices are covered in other units of this articulated, instruction guide.

NOTE: Some tasks described in this unit apply to the unit on Oil Heating. Tasks may be identified as Gas and Oil Heating.

References used in the development of this unit include:

Residential Heating and Cooling Services and Procedures, Phase II(S), Dallas, TX: Lennox Industries, Inc., Educational Department, 1980.

YC Gas-Electric Models, Tyler, TX: General Electric, Central Air Conditioning Department.

Refrigeration and Air Conditioning, Unit 7A (Forced Air-Heating in Central Units), Natchitoches, LA: Cocational Curriculum Development and Research Center, 1976.

Brumbaugh, James E., Heating, Ventilating, and Air Conditioning Library, Vol. 2, Indianapolis, IN: Howard W. Sams & Co., Inc., (Audel), 1982.

HVAC
GAS HEATING
SUGGESTED INSTRUCTION TIMES

HVAC UNIT/TASK		SUGGESTED HOURS
Unit 27.0	GAS HEATING	
27.01	Light and Adjust Pilots	
27.02	Check Temperature Rise Across Furnace	
27.03	Determine Gas Pressure of Furnace	
27.04	Troubleshoot and Replace Fan Limit Control	
27.05	Remove and Replace Gas Valve	
27.06	Remove and Replace Transformer	
27.07	Remove and Replace Room Thermostat	
27.08	Remove and Replace Blower and Motor	
27.09	Align Flue and Mount Draft Diverters	
27.10	Align Gas Burners	
27.11	Wire Gas Heating System as Required	
27.12	Adjust Gas Pressure Regulator	
27.13	Adjust Primary Air Flow on Burner	
27.14	Identify Trouble Symptom	
27.15	Compute Cubic Feet Per Hour Requirements for Furnace	

HVAC
TASK LISTINGS

UNIT/TASK	DESCRIPTION
Unit 27.0	GAS HEATING
27.01	(LIGHT AND ADJUST PILOTS) Given basic tools, equipment, and materials needed; light and adjust pilots. Pilot must stay lit when bypass is released and must be adjusted to a soft blue flame.
27.02	(CHECK TEMPERATURE RISE ACROSS FURNACE) Given a gas furnace, thermometers and the necessary tools, measure the temperature rise across the furnace. The temperature rise will be plus or minus 10 percent of 50 degrees.
27.03	(DETERMINE GAS PRESSURE OF FURNACE) Given a gas furnace*, U tube manometer, and necessary fittings, soap solutions, manufacturer's specifications, and necessary tools and materials; measure the gas manifold pressure. The pressure should be between 3.5 and 4 inches of water column on L.P. gas.
27.04	(TROUBLESHOOT AND REPLACE FAN-LIMIT CONTROL) Given a furnace with a fan-limit control, the necessary tools and materials, troubleshoot and replace the fan-limit control. The fan-limit control will turn the fan off and on and the limit will be adjusted so the heat exhanger temperature does not exceed 200 degrees.
27.05	(REMOVE AND REPLACE GAS VALVE) Given a gas furnace, and the required tools and materials; remove and replace a gas valve. The valve must open when voltage is applied, close when voltage is removed, and the pilot must remain lit. The joints will be leakproof and the electrical connections must be tight and secure.
27.06	(REMOVE AND REPLACE TRANSFORMER) Given a gas furnace, necessary tools and materials, and a replacement transformer; remove and replace the transformer so it isfirmly in place, the wires securely connected, and so the unit will work as designed.

27.07 (REMOVE AND REPLACE ROOM THERMOSTAT) Given a gas heating system with a wall thermostat, remove and replace the wall thermostat. The wall thermostat will be level mounted securely, wire color codes will be followed, and the thermostat should control the furnace to within 2 degrees of the desired setting.

27.08 (REMOVE AND REPLACE BLOWER AND MOTOR) Given a gas heating system, remove and replace the blower and motor. The blower and motor will be tight and secure, the belt will be adjusted to allow a movement of one inch in the center.

27.09 (ALIGN FLUE AND MOUNT DRAFT DIVERTERS) Given a gas heating system and tools, sheet metal screws applicable fire codes, and other required materiasl; mount a draft diverter and align the flue. The flue must be plum, level, and fastended to the draft diverter. The system must draw according to the applicable fire code specifications.

27.10 (ALIGN GAS BURNERS) Given a gas heating system, tools, and equipment, align the gas burners. the burner must be aligned 90 degrees to manifold with spud directly in the center of the primary air opening.

27.11 (WIRE GAS HEATING SYSTEM AS REQUIRED) Given a gas heating system, electrical schematic or diagram of system, necessary wire and connectors, electrical fittings; wire the system as instructed/ required. Wires must be of the proper type, and must be color coded according to the schematic or practice of the industry (local codes.) Connectors must be properly/securely installed. Electrical connections must be secure and the system must operate as designed.

27.12 (ADJUST GAS PRESSURE REGULATOR) Given a residential air conditioning heating system with a gas pressure regulator, manometer, soap solution, manufacturer's specifications, basic tool kit and equipment; adjust the gas pressure regulator to specifications and so that it is leakproof.

27.13 (ADJUST PRIMARY AIR FLOW ON BURNER) Given a gas heating system and basic tool kit, adjust the primary air flow on the burner. The flame will be soft blue and will not lift from the burner.

27.14 (IDENTIFY TROUBLE SYMPTOM) Given a gas heating system, a customer complaint or trouble report about the system's functioning, and the necessary specifications and tools, identify the primary trouble(s) with the system.

27.15 (COMPUTE CUBIC FEET PER HOUR REQUIREMENTS FOR FURNACE) Given a gas furnace, manufacturer's specifications, and other materials/references needed; compute cubic feet per hour gas requirements without error.

MINIMUM SUGGESTED TERMINOLOGY

Air Shutter	Mechanism located at main burner throat for adjusting primary air supply.
Atmospheric Burner	Utilizes normal air pressure surround furnace to supply combustion air.
Bimetal	Copper and nickel allôw which expands as temperature is increased causing bimetal to bend or warp.
Bonnet	Air collection chamber.
Burner Manifold	Services as a distribution header for the main burner. Contains the burner orifices.
Burner Orifice	Introduces correct amount of gas into the burner throat inducing a mixture of primary air.
Calibration	Relationship of dial setting and the cut-in temperature of thermostat.
Control Set Point	Temperature at which dial is set.
Cut-In-Point	Temperature at which thermostat calls for heating.
Cut-Out-Point	Temperature at which thermostat stops calling for heating.
Cycle Rate	Number of items per hour that the heating equipment is cycled on at half load conditions: 5-7 cycles per hour is recommended for fired heating equipment.
Draft Diverter	Bleeds room air into flue system to stabilize secondary air through the combustion chamber and heat exchanger.
Droop	Indoor temperature control condition where room remains below thermostat setting. Occurs in cold weather and is caused by heat anticipator since it provides false heat source for thermostat.
Gas-Pressure Regulator	Device for adjusting gas line pressure specified by appliance manufacturer.
Gas Valve	Electrically operated valve that controls the flow of gas.

Heat Anticipator	Bias heaters that shuts off thermostat before room reaches thermostat setting.
Heat Exchanger	Removes heat from combustion gases and transfers to conditioned space.
Main Burner	Blends gas and air into a burnable mixture for a complete combustion within the combustion chamber.
Manifold Pressure	Operating pressure within the burner manifold. Measured in inches H_2O: Normally 3.5 inches for natural gas and 11.0 inches for LP gas.
Manual or Mechanical	Difference in degrees-F between cut-in and cut-out terperature with NO electrical load connected to thermostat.
Operating Differential	Difference in degrees-F between cut-in and cut-out temperature when thermostat actually is operating equipment. (Less than mechanical differential.)
Orifice Inserts	Plugs with small, precisly drilled holes that meter precise amounts of gas to individual burners.
Pilot Burner	Provides ignition for the main burners.
Pilot Orifice	Delivers correct amout of gas to the pilot burner.
Pilot Runner (Crossover Ingniter)	Small opening in gas burner which diverts a small amount of gas to the fincity of the pilot flame to assist in a quick, even lighting of all burners in a gas furnace.
Pilot Safety Control	Electric switch which prevents a gas valve from opening unless a pilot light is present.
Power Burner	(or induced or forced burner) Utilizes fan or blower to force air inot combustion chamber.
Primary Air	Combustion air that enters the burner throat to mix with gas inside burner.
Primary Shutter	Adjustable opening on gas burner which meters the amout of air to mix with gas in order to produce a proper flame.

Range	Minimum to maximum temperature scale show on dial.
Secondary Air	Combustion air surrounding burner flame. Drawn in by flue draft on atmospheric burner.
Solenoid Valve	Electrical device normally closed, that controls the flow of gas.
Thermocouple	Safety device on gas furnace to cut off the gas supply in the event of loss of flame in the pilot light.

UNIT 27.0	GAS HEATING
TASK 27.01	LIGHT AND ADJUST PILOTS

PERFORMANCE OBJECTIVE:

Given basic tools, equipment, and materials needed; light and adjust pilot. Pilot must stay lit when bypass is released and must be adjusted to a soft blue flame.

PERFORMANCE ACTIONS:

27.0101 Turn on gas.

27.0102 Depress gas safety bypass.

27.0103 Put lighted match to pilot assembly.

27.0104 When pilot lights, hold bypass open for 60 seconds.

27.0105 Relaese bypass

27.0106 Adjust pilot ot a soft blue flame.

PERFORMANCE STANDARDS:

-Light and adjust pilot that will stay lit when bypass is released and that is adjusted to a soft blue flame.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Heat
-Heat measurement (BTU)
-Conduction, Convection, and Radiation
-Gas furnace fundamentals:
    a. Mixing gas fuel with air for combustion
    b. Safety and comfort controls
    c. Air moving system
-Gas and combustion
-Burners: Atmospheric and Power burners
-Heat Exchangers
-Identify different gases:
    a. Manufactured
    b. Natural
    c. Mixed
    d. LP
-Manifold Pressure
-Standing pilot: Aerated and Non-aerated

UNIT 27.0 GAS HEATING

TASK 27.02 CHECK TEMPERATURE RISE ACROSS FURNACE

PERFORMANCE OBJECTIVE:

Given a gas furnace, thermometers and the necessary tools, measure the temperature rise across the furnace. The temperature rise will be plus or minus 10 percent of 50 degrees.

PERFORMANCE ACTIONS:

27.0201	Drill 5/16 inch access holes in supply and return ducts.
27.0202	Insert plenum thermometer in each hole.
27.0203	Jump thermostat terminals at primary controls.
27.0 04	Turn "on" disconnect switch to start burner. Start timing the burner as soon as it fires.
27.0205	Allow furnace to run for about 10 minutes.
27.0206	Check temperature rise between warm air and return air temperatures. (Temperature rise of between 85 and 95 degrees F is satisfactory.)

PERFORMANCE STANDARDS:

-Determine the temperature rise across a given gas furnace. The temperature rise should be +/-10 percent of 50 degrees.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe how to measure temperature across a furnace.
-Describe/locate where to make temperture measurements.
-Explain what causes high and low readings.
-Identify safety considerations.

UNIT 27.0 GAS HEATING

TASK 27.03 DETERMINE GAS PRESSURE OF FURNACE

PERFORMANCE OBJECTIVES:

Given a gas furnace*, U tube manometer, and necessary fittings, soap solutions, manufacturer's specifications, and necessary tools and materials; measure the gas manifold pressure. The pressure should be between 3.5 and 4 inches of water column on natural gas or between 10 and 11 inches of water column on L.P. Gas.

PERFORMANCE ACTIONS:

27.0301 Review manufacturer's specifications/instructions.

27.0302 Assemble tools, materials, etc.

27.0303 Gain access to the furnace.

27.0304 Attach manometer.

27.0305 Measure gas pressure.

27.0306 Set gas pressure to manufacturer's specifications.

27.0307 Remove manometer.

27.0308 Leak test.

PERFORMANCE STANDARDS:

-Determine gas pressure of furnace using U tube manometer or other suitable instrucment. The pressure should be between 3.5 and 5 inches of water column on natural gas or between 10 and 11 inches of water column on L.P Gas.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Explain purpose for checking gas pressure
-Locate pressure taps on given furnace
-Describe/demonstrate the use of the U tube manometer
-Describe/demonstrate how to adjust pressure regulator
-Identify safety consideration

*Or residential air conditioning/heating system using gas.

UNIT 27.0 GAS HEATING

TASK 27.04 TROUBLESHOOT AND REPLACE FAN-LIMIT CONTROL

PERFORMANCE OBJECTIVE:

Given a furnace with a fan-limit control, the necessary tools and materials, troubleshoot and replace the fan-limit control. The fan-limit control will turn the fan off and on and the limit will be adjusted so the heat exchanger temperature does not exceed 200 degrees.

PERFORMANCE ACTIONS:

27.0401 Drill access holes in supply and return ducts.

27.0402 Insert a plenum thermometer in each hole.

27.0403 Remove blower belt or disconnect blower motor power.

27.0404 Jump thermostat terminals at primary control.

27.0405 Turn "on" disconnect switch to start burner. Start timing burner as soon as it fires.

27.0406 The burner should operate for about 5-6 minutes before the limit control contacts open and turn it off.
NOTE: Do not allow the return air to exceed 200 degrees or the supply air to exceed 250 degrees. Turn off the disconnect switch if either reaches its temperature limit.

27.0407 Replace limit switch if either thermometer reaches its limit without the burner cutting out on limit.

27.0408 Mechanically secure the replacement limit switch in position.

27.0409 Electrical connection must be secure with proper color coding/connections.

PERFORMANCE STANDARDS:

-Trobuleshoot and replace a fan-limit control on a given furnce. The fan-limit control must turn the fan off and on and the limit will be adjusted so the heat exchanger temperature does not exceed 200 degrees.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe the purpose of the fan-limit control.
-Identify where the fan-limit control is located.
-Describe what the possible results of improperly adjusted or bad controls.
-Identify safety consideration.

UNIT 27.0 GAS HEATING

TASK 27.05 REMOVE AND REPLACE GAS VALVE

PERFORMANCE OBJECTIVE:

Given a gas furnace, and the required tools and materials; remove and replace a gas valve. The valve must open when voltage is applied, close when voltage is removed, and the pilot must remain lit. The joints will be leak-proof and the electrical connections must be tight and secure.

PERFORMANCE ACTIONS:

27.0501 Determine if system is using (a) direct operated valve or (b) combination valve.

27.0502 Determine if main valve is defective: Verify that pilot safety is holding and that there is power to main valve and that valve does not open.

27.0503 Turn off gas supply and disconnect.

27.0504 Replace valve following mechanical safety procedures outlined by training (instructor), manufacturer's specifications, and practices of the industry.

27.0505 Check replaced valve for leaks.

27.0506 Place valve and system back into operation.

27.0507 Light pilot.

27.0508 Fire off furnace.

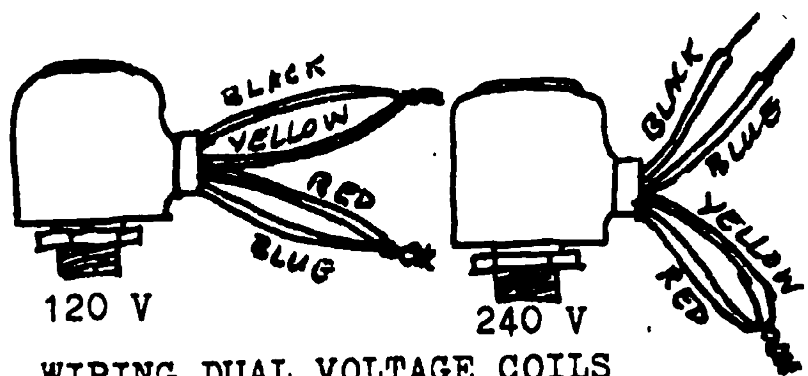
PERORMANCE STANDARDS:

-Remove and replace gas valve on a given gas furnace. The valve must remain open when voltage is applied, close when voltage is removed, and the pilot must remain lit. The joints must be leakproof and the electrical connections must be tight and secure.

SUGGESTED INSTRUCTION TIME:

RELATED TECHNICAL INFORMATION:

-Describe the purpose of the gas valve.
-If required, identify typesof gas valves.
-Describe how to make or demonstrate making electrical connections.
-Identify safety considerations.



WIRING DUAL VOLTAGE COILS

(Blue wire was formally green.)

UNIT 27.0 GAS AND OIL HEATING

TASK 27.06 REMOVE AND REPLACE TRANSFORMER

PERFORMANCE OBJECTIVE:

Given a gas furnace, necessary tools and materials, and a replacement transformer; remove and replace the transformer. The transformer will be firmly in place, the wires securely connected, and the unit must work as designed.

PERFORMANCE ACTIONS:

27.0601	Test primary circuit with VOM.
27.0602	Check secondary circuit with VOM.
27.0603	Determine if the transformer is defective*
27.0604	Replace defective transformer with part of similar specifications.
27.0605	Mount replacement transformer securely in position.
27.0606	Make secure electrical connections follow color coding in schematic and using proper connectors.
27.0607	Test transformer for proper operation (20-26 volts on secondary.)

PERFORMANCE STANDARDS:

-Remove and replace a transformer in a given gas furnace. The transformer will be mounted firmly in place, the wi~es securely connected, and the unit mist work as c .gned.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe the purpose of the transformer
-Locate the transformer
-Identify the primary and secondary windings of the transformer
-Make the electrical connections
Identify safety considerations
-Use of VOM as test instrument (voltmeter function.)

* If VOM indicates power at secondary terminals, proceed with check for faulty relay.

UNIT 27.0 GAS AND OIL HEATING

TASK 27.07 REMOVE AND REPLACE ROOM THERMOSTAT

PERFORMANCE OBJECTIVE:

Given a gas heating system with a wall thermostat, remove and replace the wall thermostat. The wall thermostat will be level, mounted securely, wire color codes will be followed, and the thermostat should control the furnace to within 2 degrees of the desired setting.

PERFORMANCE ACTIONS:

27.0701 Determine that thermostat is defective.

27.0702 Obtain replacement thermostat (manufacturer's specifications.)

27.0703 Remove thermostat cover (disconnecting voltage supply to thermostat, if applicable.)

27.0704 Note circuit (wire) connections to thermostat. (if schematic is not available, make drawing of terminal connections, noting color coding of wiring.)

27.0705 Remove connections and thermostat from base.

27.0706 Remove old base, if applicable.

27.0707 Install replacement thermostat according to manufacturer's instructions, securely connecting wiring to proper terminals.

27.0708 Check thermostat operation.

27.0709 Replace thermostat cover. (Record any boservations such as actual temperature readings that differ from thermostat settings that may help owner or other servicemen.)

PERFORMANCE STANDARDS:

-Remove and replace room wall thermostat. The wall thermostat will be level and mounted securely. Wire color codes will be followed and the thermostat will control the furance to within 2 degrees of the desired setting.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Identify types of wall thermostats to the instructor's standards.
-Determine the location of wall thermostats.
-Describe the procedures for leveling and mounting a wall thermostat.
-Describe how a wall thermostat is constructed.
-Describe how a wall thermostat operates.
-Identify safety considerations.

UNIT 27.0 GAS AND OIL HEATING

TASK 27.08 REMOVE AND REPLACE BLOWER AND MOTOR

PERFORMANCE OBJECTIVE:

Given a gas heating system, remove and replace the blower and motor. The blower and motor will be firmly in place, the electrical connections will be tight and secure, the belt will be adjusted to allow a movement of one inch in the center.

PERFORMANCE ACTIONS:

27.0801 Check blower and motor for proper operation.

27.0802 Check for blower noise, balance (due to debris (lint) collection, etc.), lubrication, and wear.

27.0803 Check blower drive belt, if so equipped.

27.0804 Check motor for operation and for line voltage if no operation observed.

27.0805 If required, obtain replacement blower or motor.

27.0806 Remove faulty non-operative blower or motor. Disconnect power if applicable.

27.0807 Replace blower or motor as applicable.

27.0808 Make electrical connections to motor following schematic diagram and manufacturer's specifications.

27.0809 Connect blower to motor drive (direct, belt, etc.) If belt drive is used, properly adjust belt and pulleys.

27.0810 Check operation of replacement parts.

PERFORMANCE STANDARDS:

-Remove and replace blower and motor. The blower and motor will be firmly in place, the electrical connections will be tight and secure, the belt will be adjusted to allow a movement of one inch in the center (if applicable.)

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe procedure for adjusting tension on a belt drive.
-Identify electrical connections to a blower motor.
-Describe typical types of motors.
-Describe typical sizes of motors.
-Identify electrical wiring color codes.
-Identify types of wire connectors.
-Describe/demonstrate procedure for splicing wire (if applicable.)
-Describe procedure for checking motor mountins.
-Identify safety considrations.
-Checking motors for worn or damaged bearings.

TASK EXPANSION: Align Blower Motor

RELATED PERFORMANCE OBJECTIVE:

Align the motor of a given heating system. Electrical and mechanical connections must be secure. If equipped with pulleys, they must be in alignment.

ENABLING ACTIONS:

EA-1	Loosen mount.
EA-2	Adjust position of direct drive motor to provide clearance for fan blades.
EA-3	Inspect belt and pulley for wear, if applicable.
EA-4	Position motor so belt runs straight, if applicable.
EA-5	Tighten motor.
EA-6	Tighten electrical connections.
EA-7	Set speed.
EA-8	Secure all mechanical connections.

STANDARDS:

Align the motor of a given heating system.

UNIT 27.0 GAS HEATING

TASK 27.09 ALIGN FLUE AND MOUNT DRAFT DIVERTERS

PERFORMANCE OBJECTIVE:

Given a gas heating system and tools, sheet metal screws, applicable fire codes, and other required materials; mount a draft diverter and align the flue. The flue must be plum, level, and fastened to the draft diverter. The system must draw according to the applicable fire code specifications.

PERFORMANCE ACTIONS:

27.0901 Set draft diverter on top of furnace.

27.0902 Align flue with draft diverter.

27.0903 Plum and level.

27.0904 Fasten flue to draft diverter.

27.0905 Check draw against applicable fire code specifications.

PERFORMANCE STANDARDS:

-Align flue and mount draft diverters so that flue is plum, level, and fastened to the draft diverter. The system must draw according to applicable fire codes.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

UNIT 27.0 GAS HEATING

TASK 27.10 ALIGN GAS BURNERS

PERFORMANCE OBJECTIVE:

Given a gas heating system, tools and equipment, align the gas burners. The burners must be aligned 90 degrees to manifold with spud directly in the center of the primary air opening.

PERFORMANCE ACTIONS:

27.1001	Remove manifold
27.1002	Remove burners from heat exchanger.
27.1003	Clean burner darts.
27.1004	Replace burners in heat exhanger.
27.1005	Replace manifold.
27.1006	Align burners 90 degrees to manifold.
27.1007	Secure all fasteners.
27.1008	Adjust primary air flow on burner.

PERFORMANCE STANDARDS:

-Align gas burners 90 degrees to manifold with spud directly in center of primary air opening.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

UNIT 27.0 GAS HEATING

TASK 27.11 WIRE GAS HEATING SYSTEM AS REQUIRED

PERFORMANCE OBJECTIVE:

Given a gas heating system, electrical schematic or diagram of system, necessary wire and connectors, electrical fittings wire the system as instructed/required. Wires must be of the proper current handling size, proper type, and must be color coded according to the schematic or practice of the industry (local codes.) Connectors must be properly/securely installed. Electrical connections must be secure and the system must operate as designed.

PERFORMANCE ACTIONS:

27.1101 Determine curcuits to be inspected or checked.

27.1102 Check questionable wiring for wear, damage, and possible hidden defects. Use VOM as applicable.

27.1103 Make drawing of circutis to be replaced if schematic is not clear.

27.1104 Obtain replacement wire with proper color coding. and of proper size and type.

27.1105 Disconnect power from circuit.

27.1106 Remove old wire.

27.1107 Install replacement wire.

27.1108 Check circuit wiring against schematic. Check connections.

27.1109 Connect power, check circuit operation.

PERFORMANCE STANDARDS:

-Electrically wire a complete gas heating system using wire of the correct size, type and color. Connections must be secure and the system must operate as designed.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 27.0 GAS HEATING

TASK 27.11 WIRE GAS HEATING SYSTEM AS REQUIRED (Con't)

RELATED TECHNICAL INFORMATION:

-Read and interpret system electrical schematics.
-Identify electrical terminals.
-Demomstrate the proper method of making electrical connections.
-Identify types of wire suitable for wiring given systems/circuits.
-Calculate the size of wire required for a given circuits/loads.
-Describe/outline the operating sequence of a gas furnace.
-Identify safety considerations.
-Identify typical symptoms of electrical wire wear, breakdown, and damage.

UNIT 27.0 GAS HEATING

TASK 27.12 ADJUST GAS PRESSURE REGULATOR

PERFORMANCE OBJECTIVE:

Given a residential air conditioning heating system with a gas pressure regulator, manometer, soap solution, manufacturer's specifications, basic tool kit and equipment; adjust the gas pressure regulator to specifications and so that it is leakproof.

PERFORMANCE ACTIONS:

27.1201 Attach manometer.

27.1202 Measu. : gas pressure.

27.1203 Set gas pressure to manufacturer's specifications.

27.1204 Remove manometer.

27.1205 Leak test.

PERFORMANCE STANDARDS:

-Adjust gas pressure regulator on a given system to manufacturer's specifications and so there is no leak.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

UNIT 27.0 GAS HEATING

TASK 27.13 ADJUST PRIMARY AIR FLOW ON BURNER

PERFORMANCE OBJECTIVE:

Given a gas heating system and basic tool kit, adjust the primary air flow on the burner. The flame will be soft blue and will not lift from the burner.

PERFORMANCE ACTIONS:

27.1301 Light gas burner.

27.1302 Completely close air shutter.

27.1303 Open shutter until all yellow tips are gone andflame is soft blue.

27.1304 Lock shutter in position with locking screw.

PERFORMANCE STANDARDS:

-Adjust primary air flow on burner so the flame is soft blue and does not lift from the burner.

SUGGEST INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

UNIT 27.0 GAS HEATING

TASK 27.14 IDENTIFY TROUBLE SYMPTOM

PERFORMANCE OBJECTIVE:

Given a gas heating system, a customer complaint or trouble report about the system's functioning and the necessary specifications and tools, identify the primary trouble(s).

PERFORMANCE ACTIONS:

27.1401
a. Review service call/report.
b. Talk to customer.
c. Observe operation of furnace.

27.1402 Narrow the area of the trouble to:
a. No heat: Burner fails to start.
b. Not enough heat: Burner cycles too often or runs continously.
c. Too much heat: Burner cycles too long or runs continously.
d. Noise: Combustion, mechanical, or air noise.
e. Odor
f. Cost of operation.

27.1403 Follow toubleshooting chart/steps to test and service/repair system.*

PERFORMANCE STANDARDS:

-Identify trouble of customer's complaint through talking with customer, observing the system, conducting tests, and using standard troubleshooting procedures.

SUGGESTED INSTRUCTION TIME: 1-3 Hours (depends on trouble encoutered)

RELATED TECHNICAL INFORMATION:

-Opeation of gas furnaces.
-Operation of thermostat, fan, etc.
-Use of tools and test instruments.

* See Trouble Shooting Charts for Gas Furnaces In:

<u>Residential Heating and Cooling (Service and Procedures)</u>, Dallas, TX: Lennox Industries Inc., 1980, pp.37-54. (This publication is available through the Articulation Program Library. Other troubleshoot charts may be substituted).

UNIT 27.0 GAS HEATING

TASK 27.15 COMPUTE CUBIC FEET PER HOUR REQUIREMENTS FOR FURNACE

PERFORMANCE OBJECTIVE:

Given a gas furnace, manufacturer's specifications, and other materials/references needed; compute cubic feet per hour gas requirements without error.

PERFORMANCE ACTIONS:

27.1501 Determine BTU rating of furnace.

27.1502 Determine heat released (BTU) per cubic foot of gas:
a. Natural gas = 1000 to 1100.
b. Manufactured gas = 500-600.
c. Liquid petroleum (LP) = 2500 to 3200.

27.1503 Compute specific gas requirements for type of gas used.

PERFORMANCE STANDARDS:

-Compute cubic feet per hour requirements for given gas furnace.

SUGGESTED INSTRUCTION TIME: Hours

INSPECT GAS-FIRED WARM AIR HEATING SYSTEM

WORKSHEET

Inspect a gas-fired warm air heating system and complete this worksheet:

FURNACE:
Make__________ Model_______ Type______ Capacity______ Serial#______

FAN:
Make____________ Type_______________ Size______________

FAN MOTOR:
Make__________ Model_______ Type______ Hp_________ Size_________

Voltage________ Hertz_______ Phase_________ Current_____________

Belts: Make__________ No#____________ Length_________ Width______

Filter: Make__________ Size___________ Type___________ Condition_______

Bonnet Temp.__________________________ Stack Temp.______________________

ROOM TEMPERATURE

Room	High	Low	Velocity	Grille Size
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Unit 28.0

OIL HEATING

This unit of instruction is designed to provide the secondary student with the fundamental knowledge and skills necessary to enter employment as an "oil burner mechanic" trainee (D.O.T. 862.281-018.)

The oil burner mechanic is responsible for maintaining oil fuelded heating systems as well as servicing and adjusting oil burners. Typcial job task include checking the thermostat, burner nozzels, controls, and other parts to locate problems. Other tasks include adjusting and replacing parts, replacing oil and air filters, and cleaning accumulated debris, soot, and ash from the system.

There is similarity in training between some task in the Oil Heating unit and the tasks in the Gas Heating unit. Oil Heating tasks that are very similar to Gas Heating tasks are not duplicated in this unit.

References used in the development of this unit include:

Residential Heating and Cooling Services and Procedures, Phase II(S). Dallas,TX, Lennox Industries, Inc. Educational Department, 1980.

Oil Furnace, Rheem Mini Manual. Fort Smith, AR: Rheem Air Conditioning Division, 1980.

Field, Edwin M., Oil Burners. Indianapolis, IN: Theodore Audel & Co., 1977.

The Professional Serviceman's Guide to Oil Heat Savings. Elyria, OH: R.W. Beckett Corporation, 1979.

HVAC
OIL HEATING
SUGGESTED INSTRUTION TIMES

HVAC UNIT/TASK		SUGGESTD HOURS
Unit 28.0	OIL HEATING	
28.01	Clean or Replace Furnace Filter	
28.02	Adjust Oil Burner	
28.03	Troubleshooting Oil Heater	

HVAC
TASK LISTINGS

UNIT/TASK	DESCRIPTION
Unit 28.0	OIL HEATING
28.01	(CLEAN OR REPLACE FURNACE FILTER) Given an oil furnace, tools, equipment, and materials, clean or replace the furnace filters. The filter must be clean and dry and must not restrict air flow.
28.02	(ADJUST OIL BURNER) Given a residential oil furnace, necessary instruction, oil burner, mechanic's tools, and equipment, and manufacturer's specifications; adjust the oil burner to specifications or so that it operates efficiently.
28.03	(TROUBLESHOOTING OIL HEATER) Given a residential oil furnace, necessary instructions, oil burner mechanic tools and equipment, manufacturer's specifications and "troubleshooting chart"; troubleshoot the oil heater to remove source of complaint and return the heater to the manufacturer's specifications or efficient service.

UNIT 28.0 OIL HEATING

TASK 28.01 CLEAN OR REPLACE FURNACE FILTER

PERFORMANCE OBJECTIVE:

Given an oil furnace, tools, equipment, and materials, clean or replace the furnace filters. The filter must be clean and dry and must not restrict air flow.

PERFORMANCE ACTIONS:

28.0101 Locate furnace filter(s).

28.0102 Identify replacement type, if replacement is required.

28.0103 Remove old filter.

28.0104 Replace or clean furnace filter according to manufacturer's recommendations.

28.0105 Replace filter.

PERFORMANCE STANDARDS:

-Clean or replace furnace filter so that it is clean and dry and does not restrict air flow.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Identify typical types of material that collect in the furnace filter.
-Identify general procedures for cleaning a filter.

TASK EXPANSION:

-Clean or replace fuel line filter.

UNIT 28.0 OIL HEATING

TASK 28.02 ADJUST OIL BURNER

PERFORMANCE OBJECTIVE:

Given a residential oil furnace, necessary instructions oil burner mechanic's tools and equipment, and manufacturer's specifications; adjust the oil burner to specifications or so that it operates efficiently.

PERFORMANCE ACTIONS:

28.0201 Take preparation steps:

a. Calibrate and check operation of measuring equipment according to manufacturer's recommendations.
b. Prepare heating unit for testing. (e.g., Drill 1/4 inch holes in flue between heating plant and barometric draft regulator about 2 flue pipe diameters from elbow and one flue pipe diameter from draft regulator. Drill 1/4 inch hole in fire door or inspection cover to speed up testing and reduce instrument handling. NOTE: Actions will be determined locally according to procedures and equipment.) (See step 2 below.)
c. Clean and seal heating plant: Burner blast tube fan housing, and blower wheel are clear of dirt and lint; seal air leaks to combustion chambers.
d. Inspect nozzle. (Recommend annual replacement.)
e. Adjust electrodes to manufacturer's specification.
f. Operate burner, adjusting air setting for proper flame, for about 10 minutes or until operation has stabilized.
g. Check burner pressure: Bleed air from pump and nozzle piping and check pump pressure and adjust to 100 psi or manufacturer's specifications as required.

28.0202 Adjust Combustion:

a. Set overfire draft to specifications of .02 inches water column.

Alternate: Adjust draft regulator for breech draft reading of .04-.06 inches as sampling hole.

See step 1-b above. Seal hole in fire door. Seal flue sampling hole if desired.

UNIT 28.0 OIL HEATING

TASK 28.02 ADJUST OIL BURNER

PERFORMANCE ACTIONS: (Con't)

28.0202
b. After about 5-10 minutes of operation, take smoke reading in flue to identify unburned fuel-poor combustion.
c. Develop smoke-CO_2 Curve.
d. Adjust air setting.

28.0203 Check Combustion Performance.

28.0204 Perform Final Checks:
a. Measure stack temperature.
b. Check ignition for prompt ignition on starting.
c. Check for prompt pump cutoff. Purge air from line as necessary. Replace pump or solenoid as necessary.
d. Perform annual cleanup.

PERFORMANCE STANDARDS:

-Adjust a given residential oil burner so that it operates according to manufacturer's specifications and so that the burner is properly adjusted to conform to the recommendations of the National Assoication of OIL Heat Service Managers or the U.S. Environmental Protection Agencies's "Guidelines for Residential Oil Burner Adjustments." Adequate fresh air must be available to support combustion. The burner must be efficient, the ignition must start promptly and the pump must cutoff promptly.
-Performance process and product must meet the instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:
-Orientation to oil burner mechanic test instruments.
-Orientation to principles of oil furnace.

ADDENDUM ACCOMPANIES THIS TASK DESCRIPTION.

NAME: ______________________ DATE: ______________

OIL BURNER ADJUSTMENT WORKSHEET

FURNACE:

Manufacturer: ______________________ Model: __________

Nameplate Rating: BTU Input: __________ BTU Output: ________

Sq. Feet Radiation: ______________________ Age: __________

Type: () Gravity () Forced () Hot Water () Steam () Warm Air

Coal Converted? () YES () NO

Adequate air supply for combustion? () YES () NO

Adequate return air? () YES () NO

OIL BURNER:

Manufacurer: ______________________ Model: __________

Type: () Flame Retention () Conventional () Low Pressure
() Rotary () Shell Head () Other __________

COMBUSTION TEST:

Efficiency (%) __________
POOR FAIR GOOD EXCELLENT
60 70 80 90

Smoke __________
ACCEPTABLE UNACCEPTABLE
0 2 4 6

CO_2 (%) __________
POOR FAIR GOOD EXCELLENT
6 8 10 12 14

OR

O_2 (%) __________
EXCELLENT GOOD FAIR POOR
2 4 6 8 10 12

Room Temp. __________ Stack Temperature __________

Net Stack Temp. (°F) __________
EXCELLENT GOOD FAIR POOR
300 400 500 600 700 800

Overfire Draft __________ " H_2O

BREECH DRAFT __________ " H_2O

UNIT 28.0 OIL HEATING

TASK 28.03 TROUBLESHOOTING OIL HEATER

PERFORMANCE OBJECTIVE:

Given a residential oil furnace, necessary instructions, oil burner mechanic tools and equipment, manufacturer specifications, and"troubleshooting chart"; troubleshoot the oil heater to remove source of complaint and return the heater to the manufacturer's specifications or efficient service.

PERFORMANCE ACTIONS:

28.0301 Identify customer's complaint:

a. No Heat:
   (1) Burner fails to start.
   (2) Burner starts but fails to ignite.
   (3) Burner starts and fires, locks out on safety while firing.
   (4) Burner starts and fires but then loses flame.
b. Not Enough Heat:
   (1) Burner cycles too short.
   (2) Burner runs continously.
c. Too Much Heat:
   (1) Burner cycles too long.
   (2) Burner runs continously.
d. Noise:
   (1) Combustion noise.
   (2) Mechanical noise.
   (3) Air noise.
e. Odor.
f. Cost of Operation.

28.0302 Use "troubleshooting charts" to eliminate complaint.

PERFORMANCE STANDARDS:

-Troubleshoot oil heater problems using "troubleshoot charts" provided by the instructor. Complaint must be correctly identified and problem must be located with 100% accuracy.
-Performance and product must be to instructor's standares.
-"Troubleshooting chart" must be accurately used.

SUGGESTED INSTRUCTION TIMES: Hours

RELATED TECHNICAL INFORMATION:

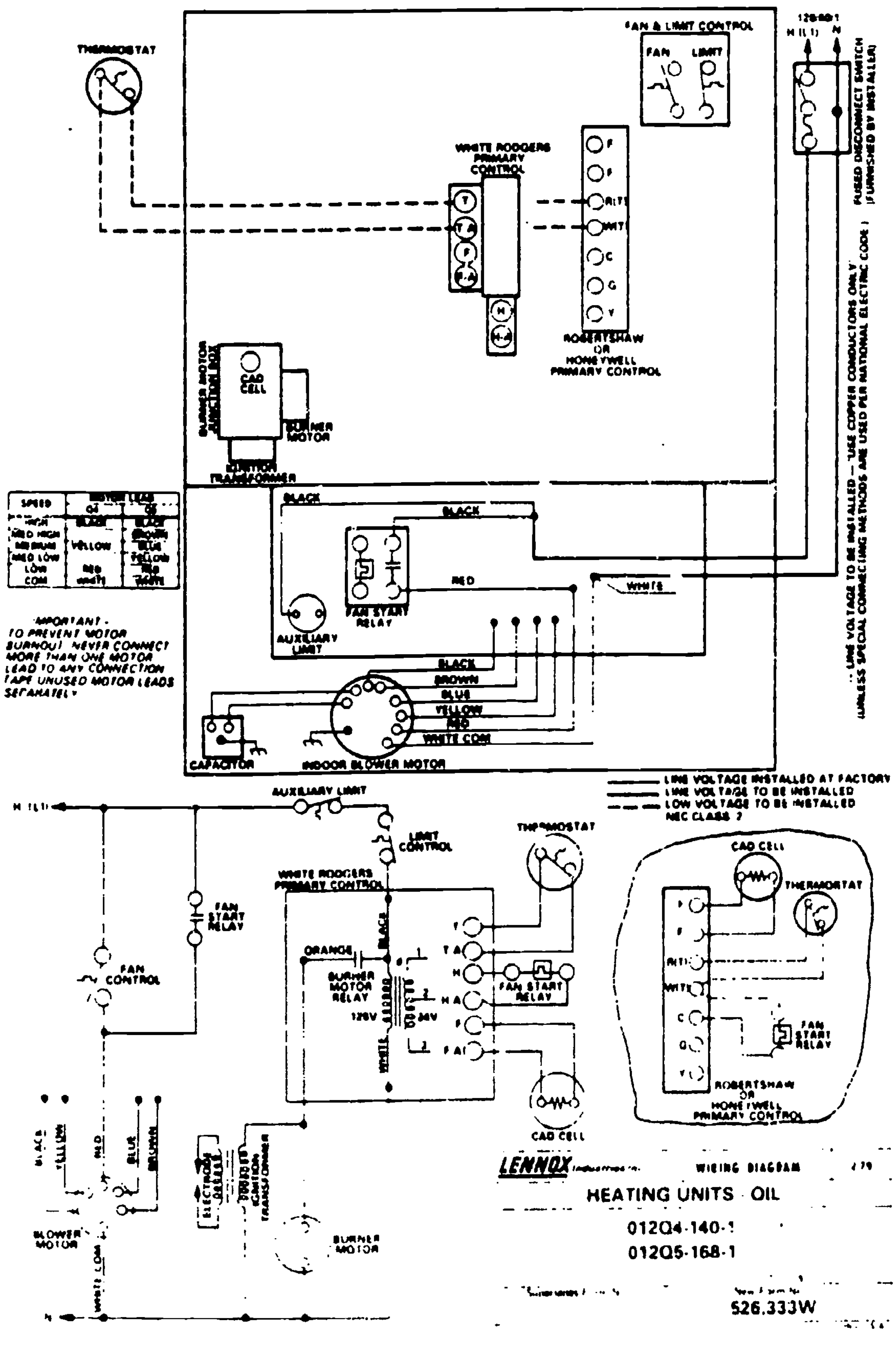
ADDITIONAL TASKS - NOT DESCRIBED:

Tasks concerning oil controls are omitted from this unit since heating systems controls already are described in electric resistance and gas heating units. Types of oil controls which are found in systems include:

- -Thermostat
- -Limit controls
- -Primary control
  - -Cadmium Cell Primary Control
  - -Oil valves
  - -Time delay controls
  - -Circulator or fan control
  - -Auxiliary contorls

See units on Electrical Resistance Heating and Gas Heating for related training.

TYPICAL OIL SCHEMATIC



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UNIT 29.0

HYDRONICS

The purpose of hydronics instruction is to introduce the secondary Air Conditioning-Refrigeration-Heating student to the science of heating with water.

Primarily, this unit will be for orientation rather than skill development. Emphasis will be on introducing the student to the terminology and basic types of hydronic systems. Students will be introduced to the advantages and disadvantages of hydronic systems and to common hydronic system designs.

Skill development will concentrate on basic system checks or measurements and basic adjustments.

References used in the development of this unit include:

Brumbaugh, James E., Heating, Ventilating, and Air Conditioning Library, Volume 1, Indianapolis, IN: Howard W. Sams & Co., Inc. (Audel), 1982, Chapter 7- Hot-Water Heating Systems, Chapter 6 - Steam Heating Systems, Chapter 15 - Boilers and Boiler Fittings, Chapter 16 - Boiler and Furnace Conversions.

Brumbaugh, James E., Heating, Ventilating, and Air Conditioning Library, Volume 2, Indianapolis, IN: Howard W. Sams & Co., Inc. (Audel) 1982, Chapter 8 - Pipes, Pipe Fittings, and Piping Details, Chapter 9 - Valves and Valve Installation, Chapter 10 - Steam and Hot Water Line Controls.

Brumbaugh, James E., Heating, Ventilating, and Air Conditioning Library, Volume 3, Indianapolis, IN: Howard W. Sams & Co. Inc. (Audel) 1982, Chapter 1 - Radiant Heating and Chapter 2 - Radiators, Convectors, and Unit Heaters.

This unit is a preliminary descripiton and may require revision after initial field trial testing. Training emphasis is orientation.

HVAC
HYDRONICS
SUGGESTED INSTRUCTION TIMES

HVAC UNIT/TASK		SUGGESTED HOURS
Unit 29.0	HYDRONICS	
29.01	Adjust Low Water Switch	
29.02	Check Water Temperature of a Boiler	
29.03	Orientation to Testing Circulating Pump	

HVAC
TASK LISTINGS

UNIT/TASK	DESCRIPTION
Unit 29.0	HYDRONICS
29.01	(ADJUST LOW WATER SWITCH) Given a hydronics heating system, test a low water switch. The low water switch will prevent operation of the system when a low water condition exists.
29.02	(CHECK WATER TEMPERATURE OF A BOILER) Given a hydronic heating system, thermometer, tools, and other materials necessary, describe how to test the temperature of a boiler. The temperature measured will be within limits set by the manufacturer's design. (Alternate: Check water temperature of a boiler with thermometer (installed.)
29.03	(ORIENTATION TO TESTING CIRCULATING PUMP) Given an orientation to a hydronic heating system observe how to test the circulating pump. The pump should deliver the specified GPM according to design.

MINIMUM SUGGESTED TERMINOLOGY

Hot Water or Steam Coils	Transfer heat from water to air blown through coil
Head	Pressure exerted by column of water measured in height of water column
Forced Circulation System	System requiring pump pressure for circulation
Psi (PSI)	Pounds per square inch of pressure
Chilled Water	Water cooled before circulating through coils for cooling purposes
Gpm (GPM)	Flow rate in gallson per minute
Centrifugal Pump	Pump in which fluid is moved by an impellor
Hydronics	Science of heating with water
Design Water Temperature Drop	Difference in temperature between supply and return water temperature at boiler design output

UNIT 29.0 HYDRONICS

TASK 29.01 ADJUST LOW WATER SWITCH

PERFORMANCE OBJECTIVE:

Given a hydronic heating system, test a low water switch. The low water switch will prevent operation of the system when a low water condition exists.

PERFORMANCE ACTIONS: (Instructor to identify actions.)

29.0101 Describe purpose of low water switch.

29.0102 Identify types of low water switches.

29.0103 Locate switches in a system or where switches should/could be located.

29.0104 Describe how to test a switch.

29.0105 Identify safety considerations.

PERFORMANCE STANDARDS:

-Adjust low water switch on a hydronic heating system so the system will not operate when a low water condition exists.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 29.0 HYDRONICS

TASK 29.02 (Orientation) CHECK WATER TEMPERATURE OF A BOILER

PERFORMANCE OBJECTIVE:

Given a hydronic heating system, thermometer, tools, and other materials necessary, describe how to test the temperature of a boiler. The temperature measured will be withing limits set by the manufacturer's design. (Alternate: Check water temperature of a boiler with thermometer installed.)

PERFORMANCE ACTIONS: (Instructor to identify actions.)

29.0201 Demonstrate or describe procedure for using thermometer.

29.0202 Identify the proper place(s) to take temperature readings.

29.0203 Explain importance of maintaining constant temperature in a boiler.

29.0204 Identify safety considerations.

PERFORMANCE STANDARDS:

-Describe how to test water temperature of a boiler of a hydronic heating system. The temperature measured will be within limits set by the manufacturer's design.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 29.0 HYDRONICS

TASK 29.03 (Orientation) ORIENTATION TO TESTING CIRCULATING PUMP

PERFORMANCE OBJECTIVE:

Given an orientation to a hydronic heating system, observe how to test the circulating pump. The pump should deliver the specified GPM according to design.

PERFORMANCE ACTIONS: (Instructor to identify actions.)

29.0301 Locate the circulating pump(s).

29.0302 Identify types of pumps.

29.0303 Determine the proper sizes of pumps.

29.0304 Describe the purpose of pumps.

29.0305 Explain how to test a pump.

29.0306 Identify safety considerations.

PERFORMANCE STANDARDS:

-Describe how to test the circulating pump of a hydronics heating system so that the pump delivers the specified GMP according to design.

SUGGESTED INSTRUCTION TIME: Hours

RELATED ORIENTATION TOPICS IN HYDRONICS

These items might be identified during field visits to hydronic systems.

Boilers: Common types:
- -Residential
- -Commercial

Filing a hydronics system (boiler)

Fittings and Accessories: Indicating and controlling devices:
- -Pressure relief valves
- -water gauges
- -Water columns
- -Steam gauge
- -Steam gauge pugtails
- -Pressure controllers
- -Low-water cutoffs
- -Vacuum relief valves
- -Steam boiler injectors
- -Try cocks
- -Fusible plugs
- -Blow-off valve
- -Steam Loop
- -Combination gauges: Pressure, thermometer, and altimeter
- -Aquastats
- -Combination valves (dual controls)

Purging Air from system
Cleaning boilers
Troubleshooting boilers
Water chillers
Galvanized, copper, and brass pipe
Pipe fittings
Welding pipe
Insulating pipe
Handling drips from pipe
Valves
Radiators and convectors

NAME: ______________________________ DATE: ______________

HYDRONIC HEATING SYSTEM WORKSHEET

Inspect a hydronic heating system and complete this worksheet.

FURNACE:

MAKE: __________ MODEL: __________ SERIAL #: __________ TYPE: __________

CAPACITY: __________

PUMP:

MAKE: __________ MODEL: __________ SERIAL #: __________ TYPE: __________

CAPACITY: __________

PUMP MOTOR:

MAKE: __________ MODEL: __________ SERIAL #: __________ TYPE: __________

CAPACITY: __________

CONTORL THERMOSTAT: MAKE: __________ TYPE: __________

LIMIT CONTROL: MAKE: __________ TYPE: __________

PUMP SIZES: FEED: ____________________ RETURN: ______________

STACK TEMPERATURE: ______________ FLAME COLOR: ______________

FURNACE WATER TEMP.: ______________ FEED WATER TEMP.: __________

RETURN WATER TEMP.: ______________ WATER LEVEL: ______________

NOTES:

UNIT 30.0

SOLAR HEATING SYSTEMS

This unit introduces the secondary student to the language and fundamentals of practical solar heating systems.

Upon completing this unit, the secondary graduate should be prepared to:

- -identify the basic types of solar heating systems
- -use basic terminology associated with solar heating systems
- -identify the basic expectations of performance of different types of systems
- -solve simple problems concerning "rules of thumb" for collector tilt and collector orientation, and
- -identify basic components of a typical flat plate solor collector

Ideally, the student will be introduced to the function of all components in both air and hydronic solar assisted heating systems using flat plate collectors. Students will be given an orientation to elementary installation practices of solar assisted heating systems.

The intent of this unit is to provide an orientation to solar heating systems. Skill development will be limited and students who desire further information about solar assisted heating systems should seriously consider additional career preparation at Greenville Techical College.

Currently, thr:e of the four secondary career centers have a solar heating display.

HVAC
SOLAR HEATING SYSTEMS
SUGGESTED INSTRUCTION TIMES

HVAC UNIT/TASK		SUGGESTED HOURS
Unit 30.0	SOLAR HEATING SYSTEMS	
30.01	Identify Basic Types of Solar Heating Systems	
30.02	Identify Basic "Rules of Thumb: for Adjusting Solar Installations	
30.03	Identify Basic Components of a Typical Flat Plate Collector	

HVAC
TASK LISTINGS

HVAC UNIT/TASK	DESCRIPTION
30.0	SOLAR HEATING SYSTEMS
30.01	(IDENTIFY BASIC TYPES OF SOLAR HEATING SYSTEMS) Given instruction and orientation (field trip) to solar heating systems (demonstration), identify: a. Difference between air and liquid. b. Difference between active and passive systems. Describe the systems that are of practice valve. Performance must be acceptable to the instructor.
30.02	(IDENTIFY BASIC "RULES OF THUMB" FOR ADJUSTING SOLAR INSTALLATIONS) Given instruction and orientation (including field trip to solar installation site), identify the "rules of thumb" for: a. Collector tilt b. Collector orientation Performance must be to instructor's standards.
30.03	(IDENTIFY BASIC COMPONENTS OF A TYPICAL FLAT PLATE COLLECTOR) Given instruction and orientation to the basic components of a typical flat plate collector of a solar heating system, identify the basic components of a typical flat plate collector.

MINIMUM SUGGESTED TERMINOLOGY

Absorptivity	Ratio of solar energy absorbed by a surface compared to total amount of solar energy striking the surface.
Greenhouse Effect	Tendency of some transparent materials, such as glass, to both transmit and block radiation, resulting in both direct and indirect heat gain.
Heat Transfer	Transfer of heat from one substance or region to another.
Sensible Heat	Heat that can be physically felt or 'sensed' or absorbed by a liquid or solid mass.
Termal Mass	Potential heat storage capacity of a given substance or system.
Insolation	Total solar energy received at any given point on the earth's surface.
Diffuse Radiation	Portion of sun's radiation diffused or scattered by atmospheric particles, clouds, and pollutants.
Direct Radiation	Radiation not reflected, absorbed,or diffused that passes more or less directly to the earth.
BTU (Btu)	British thermal unit: Amount of heat required to raise temperature of one pound of water one degree Fahrenheit.
Aggressive Water	Highly mineralized local water with high levels of dissolved sulfates and chlorides and high PH values.
Thermo-Syphon	Circulation of water between a tank and a collector maintained by natural convection currents set up when water is heated.
Heat Exchanger	Device that absorbes heat and then releases it to complete heat transfer process.
Loop	Pipe configuration designed to complete a liquid flow from one given point to another with interconnections among components in a system.

Sensor	Device (e.g., thermostat) to detect changes to control on/off functions at predetermined range limits.
One-Way Check Valve	Valve which permits flow in one direction only and prevents flow back to source.
Auxiliary Storage	Standby or backup storage facility that permits storage of hot water that exceeds capacity of prime or system storage facility.
Auxiliary Heat	Standby or backup gas or electric heating system programmed to automatically maintain heating load requirements when the solar system fails to meet the required load demands.
Corrosion	Eating away or wearing away of metals, especially metals in contact with chemicals.
Closed System	Solar system into which no air penetrates or from which no air can be expelled.
Open System	Solar system into which air can penetrate or from which air can be expelled for draindown or to create a syphon effect.
PH	Degree of acidity or alkalinity of a solution, 7 being neutral.

These are representative terms that the student might encounter in solar heating systems. Additional terms may be encountered in passive solar and other solar concepts.

UNIT 30.0 SOLAR HEATING - FUNDAMENTALS

TASK 30.01 IDENTIFY BASIC TYPES OF SOLAR HEATING SYSTEMS

PERFORMANCE OBJECTIVE:

Given instruction and oreintation (field trip) to solar heating systems (demonstration), identify:

a. Difference between air and liquid systems and
b. Difference betweenactive and passive systems.

Describe the systems that are of practical value. Performance must be acceptable to the instructor.

PERFORMANCE ACTIONS: (Actions to be clarified by instructor)

PERFORMANCE STANDARDS:

-Upon completing this task or unit, the student should be able to identify the basic types of solar heating systems and describe the major differences between the systems.
-Performance must be acceptable to the instructor.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATICN:

-Identify:
a. Active System - Uses external mechanical power to move or store solar heat.
b. Passive System - Does not use external mechanical power to move or store solar heat.
c. Hybrid System - Combines both active and passive systems.

-Describe solar altitude - angle of sun's position in sky with respect ot earth.
-Describe solar aximuth - Position of sun with respect to compass directions.

UNIT 30.0 SOLAR HEATING-FUNDAMENTALS

TASK 30.02 IDENTIFY BASIC "RULES OF THUMB" FOR ADJUSTING SOLAR INSTALLATIONS

PERFORMANCE OBJECTIVE:

Given instruction and orientation (including field trip to solar installation site), identify the "rules of thumb" for:

a. Collector tilt
b. Collector orientation

Performance must be to instructor's standards.

PERFORMANCE ACTIONS:

30.0201 Identify "rules of thumb" for collector tilt:

a. Winter - Tilt collector at angle equal to latitude + 15 degrees.
b. Summer - Tilt collector at angle equal to latitude - 15 degrees.
c. Average for Year - Title to angle approximately equal to latitude.

30.0202 Identify "rules of thumb" for collector orientation:

a. Winter - south-facing
b. Summer - South- or southeast receives more radiation than south-facing.

PERFORMANCE STANDARDS:

-Identify the "rules of thumb" for solar collector tilt and collector orientation.
-Performance must be to instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

UNIT 30.0 SOLAR HEATING -FUNDAMENTALS

TASK 30.03 IDENTIFY BASIC COMPONENTS OF A TYPICAL FLAT PLATE COLLECTOR

PERFORMANCE OBJECTIVE:

Given instruction and oreintation to the basic components of a typical flat plate collector of a solar heating system, identify the basic components of a typical flat plate collector.

PERFORMANCE ACTIONS:

30.0301 Identify:
- a. Inlet
- b. Insulation
- c. Glazing Cover
- d. Copper tubes
- e. Copper absorber plate
- f. Thermal break between collector framing and absorber
- g. Outlet

30.0302 Identify other components as required by instructor.

PERFORMANCE STANDARDS:

-Identify basic components of a typical flat plate collector to the standards of the instructor.

SUGGESTED INSTRUCTION TIME: Hours

RELATED TECHNICAL INFORMATION:

-Describe the general design and construction of typical flat palte collector
-Describe how the "greenhouse effect" make the flat plate collector absorb heat
-Describe factors which influence the efficiency of flat plate collectors

RECOMMENDATIONS FOR ADDITIONAL TRAINING IN RESIDENTIAL SOLAR SYSTEMS

The following references are recommended for additional training in residential solar systems.

Fulkerson, Dan, Residential Solar Systems. Stillwater, OK: Mid-America Vocational Cirriculm Consortium, Inc. 1982 (Instructor's and Student's manuals available.).

Solar Heating Mechanics (V-TECS Catalog). Pittsburgh, PA: Associated Educational Consultants, Inc. (Pennsylvania Department of Education), 1980.

Additional Topica: (Topics from above reference sources)

Characteristics of thermo-syphon domestic hot water system (DHW)
Characteristics of pumped circulation DHW system with heat exchanger
Characteristics of pumped circulation DHW system with freeze control
Characteristics of pumped circulation DHW system with draindown
Arrangements for DHW storage tanks
Characteristics of single storage DHW tank
Characteristics of dual DHW tank
Characteristics of combined solar space and DHW system
Characteristics of water collection, water storage, water distribution space heating systems
Differences between a series configuration and a parallel configuration in water collection, water storage, water distribution space heating systems
Characteristics of water collection, water storage, heat pump districution space heating systems
Differenced between an air-to-air heat pump and a water-to-air heat pump function in a solar space heating system
Steps in operation of an air-to-air heat pump in a solar heating system
Steps in operation of water-to-air heat pump in a solar heating system
Design considerations for piping systems
Design considerations for corrosion protection
Requirements for absorber plate insulation
High temperature protection
Circulating pumps and solar system controls

UNIT 31.0

AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR

This unit, Automotive Air Conditioner Maintenance and Repair, is designed to introduce the secondary student to the basis of the automotive air conditioning system and to provide the student with the skills necessary to service and maintain an automotive air conditioner including replacing minor parts.

References used to develop this module include:

Kirkpatrick, James M., and Weaver, Micheal K, Automotive Air Conditioning and Climate Control. Indianapolis, IN: Bobbs-Merrill Company, Inc., 1983. (Excellent coverage of auto AC's with good visuals. Easy to understand. Recommended. $14.81.

Kirkpatrick, James M., and Weaver, Michael K., Automotive Air Conditioning and Climate Control-Student's Manual. Indianapolis, IN: Bobbs-Merrill Company, Inc. 1983. (Excellent activities which can be used as outcome-referenced tests, recommended.) $4.91. Available from: Bobbs-Merrill Publishers, Inc.

HVAC
AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR
SUGGESTED INSTRUCTION TIMES

HVAC UNIT/TASK		SUGGESTED HOURS
Unit 31.0	AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR	*
31.01	Check air Conditioner for Satisfactory Operation	*
31.02	Discharge Air Conditioning System	*
31.03	Pressure Test and Leak Test AC System	*
31.04	Diagnose air Conditioning System Malfunctions	*
31.05	Repair AC Electrical Circuits	*
31.06	Inspect and Recharge Air Conditioning System with Refrigerant	*
31.07	Evacuate AC System	*
31.08	Replace Drier in AC System	*
31.09	Replace Expansion Valve in AC Unit	*
31.10	Replace Condenser Assembly in Air Conditioning Unit	*
31.11	Replace POA Valve in AC Unit	*
31.12	Replace Air Conditioner Compressor	*
	TOTAL HOURS	30

*Recommended by secondary onstructors. (Individual task times may need revision after field trial testing.)

UNIT/TASK	DESCRIPTION
Unit 31.0	AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR
31.01	(CHECK AIR CONDITIONER FOR SATISFACTORY OPERATION) Given an automobile air conditioning system, manufacturer's manual and necessary tools, equipment, and materials and helper if required; check the air conditioner for satisfactory operation.
31.02	(DISCHARGE AIR CONDITIONING SYSTEM) On a given automobile air conditioning system, using the tools and equipment necessary; discharge the AC system.
32.03	(PRESSURE TEST AND LEAK TEST AC SYSTEM) Given access to necessary tools, equipment, and service manual, install a manifold gauge set on assigned air conditioning unit and compare the pressure readings to the manufacturer's specifications.
	3-B Given a leak detector, necessary tools, equipment, and service manual, test for refrigerant leaks on an assigned air conditioning unit in accordance with manufacturer's specifications.
32.04	(DIAGNOSE AIR CONDITIONING MALFUNCATIONS) Given an air condicioning system with known malfunctions a service manual, and the necessary tools and equipment; identify the malfunctions that exist in the unit, All malfunctions known by the instructor must be identified. Time limit is one hour.
32.05	(REPAIR AC ELECTRICAL CIRCUITS) Given the necessary tools and equipment, service manual, and a malfunctioning AC unit electrial system; repair the circuit according to the manufacturer's specifications.
32.06	(INSPECT AND RECHARGE AIR CONDITIONING SYSTEM WITH REFRIGERANT) Given an automobile with air conditioning system needing refrigerant system recharging, appropriate service manual, required tools and equipment; charge an evalcuated air conditioning system with refrigerant according to manufacturer's specifications. When completed, there will be no bubbles in the drier viewing window.

32.07 (EVACUATE AC SYSTEM) Given an automobile with air conditioner, appropriate tools, equipment and service manual; evacuate the air condition system in accordance with manufacturer's specifications and procedures. When completed, there will be no coolant remaining in the AC system.

32.08 (REPLACE DRIER IN AC SYSTEM) Given a service manual for an automobile with faulty AC drier; the necessary tools and equipment; replace the air conditioning receiver drier (dehydrator) on the vehicle in accordance with the manufacturer's specificiations. When completed, there will be no bubbles in the viewing glass.

32.09 (REPLACE EXTENSION VALVE IN AC UNIT) Given required tools, equipment, service manual, and an operational AC unit needing servicing; replace the expansion valve on the unit according to the manufacturer's service procedure. The replaced unit must not leak and must function properly.

32.10 (REPLACE CONDENSER ASSEMBLY IN AIR CONDITIONING UNIT) Given necessary tools, equipment, service manual, and replacement condenser assembly; replace the AC condenser assemble on a given automobile in accordance with manufacturer's specifications. When completed, there will be no leaks in the condenser, and it will not touch the radiator.

32.11 (REPLACE POA VALVE) Given a vehicle with a malfunctioning POA control valve, and access to a service manual and the necessary tools and equipment; replace the POA valve according to manufacturer's specifications.

32.12 (REPLACE AIR CONDITIONER COMPRESSOR) Given access to required tools, equipment, service manual, a replacement air conditioner compressor, and an automobile AC system with a bad compressor; replace the air conditioner compressor on a given automobile according to manufacturer's service manual.

UNIT 31.0 — AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR

task 31.01 — CHECK AIR CONDITIONER FOR SATISFACTORY OPERATION

PERFORMANCE OBJECTIVE:

Given an automobile air conditioning system, manufacturer's manual and necessay tools, equipment, and materials and helper if required; check the air conditioner for satisfactory operation.

PERFORMANCE ACTIONS:

31.0101 Operate the system to check if system is operating correctly.

31.0102 If malfunctioning is suspected, check drive belt condition and tension.

31.0103 Check compressor magnetic clutch operation.

31.0104 Check sight glass, if equipped.

31.0105 Check system lines and connections.

31.0106 Check air flow system.

31.0107 Follow manufacturer's diagnosis chart for further checks.

PERFORMANCE STANDARDS:

-On a given automotive air conditioner, follow manufacturer's diagnosis chart to determine if system is operating satisfactorily.
-Findings must agree 100 precent with instructor's diagnosis.

SUGGESTED INSTRUCTION TIME: 2 Hours

UNIT 31.0 AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR

TASK 31.02 DISCHARGE AIR CONDITIONING SYSTEM

PERFORMANCE OBJECTIVE:

On a given automobile air conditioning system, using the tools and equipment necessary; discharge the AC system.

PERFORMANCE ACTIONS:

31.0201 Check system for leaks before discharging.

31.0202 Determine if system:
- a. Equipped with hand operated service valves
- b. Equipped with Schrader valve service fittings

31.0203
- a. Discharging hand valve system:
  1. Connect gauge set.
  2. Open manifold high-pressure valve, keep low-pressure valve closed.
  3. Crack the service discharge valve allowing refrigerant to slowly escape (thru exhaust system.)*
- b. Discharging Schrader Valve Service Fittings:
  1. Connect gauge set with both valves closed.
  2. Crack manifold high-pressure gauge valve allowing refrigerant to slowly escape (thru exhaust outlet...not in service area.)*
  3. When high-pressure gauge reads less than 100 psi, crack low-pressure gauge valve until all pressure is removed.

PERFORMANCE STANDARDS:

-On a given AC system, discharge the system of refrigernat, being cafeful not to remove any oil during the process.

SUGGESTED INSTRUCTION TIME: 2 Hours

(CAUTION:* Fast discharging may draw oil from system.)

STUDENT: ______________________________
PROGRAM: ______________________________
YEAR: ____________
EVALUATOR: ____________________________

DISCHARGING THE SYSTEM CHECKLIST

______ Obtain gauge set.
______ Close both valves on the gauge set.
______ Be sure the car is not running.
______ Connect the suction gauge test hose to the suction service port on the compressor.
______ Connect the discharge gauge test hose to the discharge service port on the compressor.
______ Run the automobile engine at 1200 to 1500 rpm.
______ Turn on the air conditioner to high and let run for 15 minutes.
______ Turn off the air conditioner.
______ Turn off the automobile engine.
______ Open the discharge gauge valve a small amount. Let the refrigerant discharge into a shop towel.
______ Check the shop towel for oil traces.
______ Let refrigerant escape until the discharge pressure gauge shows zero. Open the suction valve and let out any vapor on the suction side.
______ Close both gauge valves.
______ Remove the test gauge set from the car.

UNIT 31.0 AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR

TASK 31.03 PRESSURE TEST AND LEAK TEST AC SYSTEM

PERFORMANCE OBJECTIVE:

A. Given access to necessary tools, equipment, and a service manual, install a manifold gauge set on assigned air conditioning unit and compare the pressure readings to the manufacturer's specifications.

PERFORMANCE ACTIONS:

31.0301 Consult manufacturer's service manual to obtain pressure specifications.

31.0302 Connect manifold gauge set.

31.0303 Purge air from service lines and position service valves (to cracked position.)

31.0304 With engine running at fast idle and air conditioning unit on, allow at least 5 minutes for unit to stablize.

31.0305 Record pressure readings and ambient temperatures.

31.0306 Compare readings to specifications to determine if unit is functioning properly.

B. Given a leak detector, necessary tools, equipment, and service manual; test for refrigerant leaks on an assigned air conditioning unit in accordance with manufacturer's specifications.

PERFORMANCE ACTIONS:

31.0301 Run engine at fast idle.

31.0302 Operate AC unit, allowing time for unit to stablize.

31.0303 Check sight glass to ensure ample charge exists.

31.0304 Allow AC unit to operate on high blower for about 10 minutes with windows and door open.

31.0305 Shut off AC unit and engine and allow time for pressure to equalize.

PERFORMANCE ACTIONS: (Con't)

31.0306 Using leak detector, check all components of system for refrigerant leaks.

PERFORMANCE STANDARDS:

-On a given automobile air conditioning system, pressure test and leak test the system and report findings to the instructor.
-Findings should agree with the instructor's findings.

SUGGESTED INSTRUCTION TIME: 3 Hours

LEAK TEST REPORT

Type of System

______ Factory
______ Add-On

Type of Leak Tester

______ Halide Torch
______ Electronic
______ Soapy Water

Automobile Make and Model

____

Parts Checked	Location of Leak (If Any)
______ Receiver-Drier	______________
______ Condenser	______________
______ TXV	______________
______ POA	______________
______ Liquid Line	______________
______ Discharge Line	______________
______ Suction Line	______________
______ Compressor	______________
______ Evaporator	______________
______ Other	______________

UNIT 31.0 AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR

TASK 31.04 DIAGNOSE AIR CONDITIONING SYSTEM MALFUNCTIONS

PERFORMANCE OBJECTIVE:

Given an air conditioning system with known malfunctions, a service manual, and the necessary tools and equipment; identify the malfunctions that exist in the unit. All malfunctions known by the instructor must be identified. Time limit is one hour.

PERFORMANCE ACTIONS:

31.0401 Perform visual test in accordance with manufacturer's automotive service manual.

31.0402 Install manifold gauge set on the air conditioning unit to determine pressure readings.

31.0403 Check sight glass for ample refrigerant charge.

31.0404 check electrical system with volt-ohmmeter following proper troubleshooting techniques (procedures.)

PERFORMANCE STANDARDS:

-On a given automotive AC system with known malfunctions, identify the malfunctions that exist in the unit within one hour.

SUGGESTED INSTRUCTION TIME: 2 Hours

UNIT 31.0 AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR

TASK 31.05 REPAIR AC ELECTRICAL CIRCUITS

PERFORMANCE OBJECTIVE:

Given the necessary tools and equipment, service manual, and a malfunctioning AC unit electrical system; repair the circuit according to the manufacturer's specifications.

PERFORMANCE ACTIONS:

31.0501 Perform operational check on AC system.

31.0502 Check for:
- a. Blown fuses.
- b. Disconnected or broken positive wire.
- c. Disconnected or broken ground wire.
- d. Clutch coil.
- e. Switch contacts. (optional)
- f. Blower motor for defects. (optional)

31.0503 Isolate problem and repair or replace defective item(s).

PERFORMANCE STANDARDS:

-On an instructor provided vehicle with a malfunction in the air conditioning electrical circuit, locate the problem and repair the circuit.

SUGGESTED INSTRUCTION TIME: 2 Hours (Minimum)

UNIT 31.0	AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR
TASK 31.06	INSPECT AND RECHARGE AIR CONDITIONING SYSTEM WITH REFRIGERANT

PERFORMANCE OBJECTIVE:

Given an automobile with air conditioning system needing refrigerant system recharging, appropriate service manual, requiring tools and equipment; charge an evalcuated air conditioning system with refrigerant according to the manufacturer's specifications. When completed, there will be no bubbles in the viewing window.

PERFORMANCE ACTIONS:

31.0601 Consult manufacturer's service manual for the amount of refrigerant needed.

31.0602 Install manifold gauge set on air conditioning unit and to refrigerant supply.

31.0603 Purge all air from service lines.

31.0604 Charge all air from service lines.

31.0605 Check sight glass for clear flow (no air bubbles), if equipped.

31.0606 Performance test air conditioner.

PERFORMANCE STANDARDS:

-On a given automobile air conditioning system, evacuate and recharge the refrigerant to the manufacturer's specifications.

SUGGESTED INSTRUCTION TIME: 2 Hours

RELATED TECHNICAL INFORMATION:

-Always wear protective goggles when servicing refrigeration system.
-Service the AC system in a well-ventilated area.
-Do not discharge refrigerant (R-12) directly into service area.
-Keep refrigerant from skin.
-Observe standard safety precautions in handling refrigerant.
-Allow for refrigerant expansion when refilling containers.

STUDENT: ________________________
PROGRAM: ________________________
YEAR: ________
EVALUATOR: ________________________

ADDING REFRIGERANT CHECKLIST

______ Obtain gauge set and refrigerant can.
______ Close both valves on the gauge set.
______ Be sure car is not running.
______ Connect the suction gauge test hose to the suction service port on the ccmpressor.
______ Connect the discharge gauge test hose to the discharge service port on the compressor.
______ Purge all air from the test hoses by cracking the valves slightly to blow freon through the hoses.
______ Connect the center hose on the manifold to a refrigerant can, after it has been weighed.
______ Turn the valve on the refrigerant can clockwise to puncture the seal.
______ Open the refrigerant can valve.
______ Run the automobile engine at 1200 to 1500 rpm.
______ Turn on the air conditioner to high.
______ Open the suction service valve and add refrigerant until the sight glass clears.
______ Close the suction service valve and remove the test gauge set from the car.
______ Weigh the refrigerant can. ______ ounces. How much refrigerant did you add? ______

UNIT 31.0 — AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR

TASK 31.07 — EVACUATE AC SYSTEM

PERFORMANCE OBJECTIVE:

Given an automobile with air conditioner, appropriate tools, equipment and service manual; evacuate the air condition system in accordance with manufacturer's specifications and procedures. When completed, there will be no coolant remaining in the AC system.

PERFORMANCE ACTIONS:

31.0701 Consult manufacturer's service manual for evacuation procedures.

31.0702 Close manifold gauge, set hand valve.

31.0703 Put on eye safety goggles.

31.0704 Remove service valve caps and install appropriate manifold gauge etc.

31.0705 Position hand operated type service valves to mid (cracked) position.

31.0706 Purge system of all refrigerant if gauges indicate pressure by opening low side manifold valve to center hose.

31.0707 Connect vacuum pump to center hose and allow it to work a minimum of one-half (1/2) hour.

PERFORMANCE STANDARDS:

-Evacuate/discharge AC system in given automobile following manufacturer's instructions.

SUGGESTED INSTRUCTION TIME: 2 Hours

STUDENT: ______________________________
PROGRAM: ______________________________
YEAR: __________
EVALUATOR: ____________________________

EVACUATING THE SYSTEM CHECKLIST

_______ Obtain gauge set and vacuum pump.
_______ Close both valves on the gauge set.
_______ Be sure the car is not running.
_______ Connect the suction gauge test hose to the suction service port on the compressor.
_______ Connect the discharge gauge test hose to the discharge service port on the compressor.
_______ Connect the center test hose from the test gauge set to the vacuum pump.
_______ Open both valves on the test gauge set.
_______ Start the vacuum pump and run until the evaporator shows at least 26 inches of vacuum. Let it run at this level for 30 minutes.
_______ Close both valves on the test gauge.
_______ Turn off the vacuum pump.
_______ Remove the test hose from the vacuum pump.
_______ Watch the suction gauge for loss of vacuum.
_______ If the system is tight, charge it with the correct amount of refrigerant.

UNIT 31.0 — AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR

TASK 31.08 (ORIENTATION) — REPLACE DRIER IN AC SYSTEM

PERFORMANCE OBJECTIVE:

Given a service manual for an automobile with a faulty AC drier, the necessary tools and equipment; replace the air conditioning receiver drier dehydrator) on the vehicle in accordance with the manufacturer's specifications. When completed, there will be no air bubbles in the viewing glass.

PERFORMANCE ACTIONS:

31.0801	Install manifold gauge set.
31.0802	Release refrigerant charge slowly.
31.0803	Disconnect high and low pressure coolant lines.
31.0804	Move condenser to allow access to drier.
31.0805	Replace drier.
31.0806	Reconnect system in reverse order of steps.
31.0807	Perform operational check for leaks and proper operation.

PERFORMANCE STANDARDS:

-Replace AC receiver drier (dehydrator) on given vehicle.
-Replaced unit must not leak and must perform satisfactorily.

SUGGESTED INSTRUCTON TIME: 1 Hour

UNIT 31.0 — AUTOMOTIVE AIR CONDITONER MAINTENANCE AND REPAIR

TASK 31.09 (ORIENTATION) — REPLACE EXPANSION VALVE IN AC UNIT

PERFORMANCE OBJECTIVE:

Given required tools, equipment, service manual, and an operational AC unit needing servicing; replace the expansion valve on the unit according to the manufacturer's service procedure. The replaced unit must not leak and must function properly.

PERFORMANCE ACTIONS:

31.0901 Install manifold gauge set.

31.0902 Release refrigerant charge slowly(not in service area.)

31.0903 Disconnect equalizer line and expansion valve.

31.0904 Pull out sensing tube carefully from suction line well.

31.0905 Remove rubber seal from sending tube.

31.0906 Replace expansion valve and reassemble unit in reverse steps.

31.0907 Perform operating test for leaks and proper functioning of unit.

PERFORMANCE STANDARDS:

-Replace expansion valve in AC unit provided by the instructor.
-The replaced unit must function properly with no leaks.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 31.0 AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR

TASK 31.10 (ORIENTATION) REPLACE CONDENSER ASSEMBLY IN AIR CONDITIONING UNIT

PERFORMANCE OBJECTIVE:

Given necessary tools, equipment, service manual, and replacement condenser assembly; replace the AC condenser assembly on a given automobile in accordance with manufacturer's specifications. When completed, there will be no leaks in the condenser, and it will not touch the radiator.

PERFORMANCE ACTIONS:

31.1001 Install manifold gauge set.

31.1002 Slowly release refrigerant charge.

31.1003 Remove receiver drier if attached.

31.1004 Remove condenser bolts and condenser from vehicle.

31.1005 Reverse the procedure to reinstall the condenser or a new condenser assembly.

PERFORMANCE STANDARDS:

-Replace the condenser assembly in a given automobile air conditioning system.

SUGGESTED INSTRUCTION TIEM: Hours

UNIT 31.0 AUTOMOTIVE AIR CONDITONER MAINTENANCE AND REPAIR

TASK 31.11 (ORIENTATION) REPLACE POA VALVE IN AC UNIT

PERFORMANCE OBJECTIVE:

Given a vehicle with a malfunctioning POA valve, and access to a service manual and the necessary tools and equipment; replace the POA valve according to manufacturer's specifications.

PERFORMANCE ACTIONS:

31.1101 Install manifold gauge set.

31.1102 Release refrigerant charge slowly.

31.1103 Remove POA valve.

31.1104 Reinstall POA valve.

31.1105 Recharge system with refrigerant.

31.1106 Perform operational test and check for leaks and proper functioning.

PERFORMANCE STANDARDS:

-On a given vehicle with a malfunctioning POA valve; replace the POA valve so the unit functions properly with no leaks.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 31.0 AUTOMOTIVE AIR CONDITIONER MAINTENANCE AND REPAIR

TASK 31.12 (ORIENTATION) REPLACE AIR CONDITIONER COMPRESSOR

PERFORMANCE OBJECTIVE:

Given access to required tools, equipment, service manual, a replacement air conditioner compressor, and an automobile AC system with a bad compressor; replace the air conditioner compressor on a given automobile according to manufacturer's service manual.

PERFORMANCE ACTIONS:

31.1201 Locate and follow manufacturer's procedure for replacing the AC compressor.

31.1202 Evacuate AC system.

31.1203 Remove and replace AC compressor.

31.1204 Recharge system.

31.1205 Performance test AC unit.

PERFORMANCE STANDARDS:

-Replace AC compressor on a given automobile following manufacturer's procedures and meeting instructor's standards.

SUGGESTED INSTRUCTION TIME: Hours

UNIT 32.0

ESTIMATING AND PLANNING AIR CONDITIONING, REFRIGERATION, AND HEATING JOBS

The purpose of this Estimating and Planning unit is to introduce the secondary student to the process of planning a sequence of work operations for the installation, service, or repair of an air conditioning, refrigeration, or heating system or equipment that will achieve the desired results. The plan must involve the important task necessary to complete the job and it must be organized in the proper order in which the task should be completed.

The intent of this unit is to provide the secondary student with an orientation to the task involved in estimating and planning air conditioning, refrigeration, and heating jobs. Students who desire additional knowledge or skills or who may wish to pursue careers in estimating and planning are encouraged to consider additional training at Greenville Technical College.

The intent of this unit is to provide the secondary student with an orientation to the tasks involved in estimating and planning air conditioning, refrigeration, and heating jobs. Students who desire additional knowledge or skills in estimating and planning are encouraged to consider post-secondary training at Greenville Technical College.

HVAC
ESTIMATING AND PLANNING
SUGGESTED INSTRUCTION TIMES

<u>HVAC</u> UNIT/TASK		SUGGESTED HOURS
Unit 32.0	ESTIMATING AND PLANNING	
32.01	Estimate Cost of Specific Installation, Service, or Repair	
32.02	Estimate Cost of Materials For Specific Job	
32.03	Estimate Costs of Labor Needed for a Specific Job	
32.04	Inventory Equipment, Materials, and and Supplies	
32.05	Complete a Trouble Report on Tools, Equipment, and Materials not Servicable	
32.06	Plan a Sequence of Work Operations	
32.07	Complete Written Forms and Records	

HVAC
TASK LISTINGS

UNIT/TASK	DESCRIPTION
Unit 32.0	ESTIMATING AND PLANNING
32.01	(ESTIMATE COST OF SPECIFIC INSTALLATION, SERVICE, OR REPAIR) Given information such as drawings and specifications for a new installation or description of necessary parts, materials, etc., for service or repair to a system, all forms, schedules, and current pricing information; estimate the cost of the specific job. The estimate must include the cost of materials, equipment or components, cost of labor, overhead cost, and expected profit and must be within a predetermined range (such as 10%) calculated by the instructor.
32.02	(ESTIMATE COST OF MATERIALS FOR A SPECIFIC JOB) Given drawings and specifications for new installation or list of necessary parts, materials, etc., for service or repair, the necessary materials forms and schedules; the estimate the cost of the materials for the specific job. The estimate must include all of the materials, etc., needed to complete the job and contain prives effective at the time the estimate is submitted. The estimate must be within acceptable range determined by the instructor (e.g., 5-10% of instructor's estimate.)
32.03	(ESTIMATE COSTS OF LABOR NEEDED FOR A SPECIFIC JOB) Given drawings and specifications (or description) for a specific job and a list of all the needed materials, forms, and schedules; estimate the cost of the labor for the job based on labor rates provided by the instructor. The labor rates must represent the labor unit prices effective at the time the estimate is submitted. The estimate must be within +/-5-10% of that figured by the instructor.
32.04	(INVENTORY EQUIPMENT, MATERIALS, AND SUPPLIES) Given a supply room or any area containing quantities of equipment, materials, and supplies; inventory the equipment, materials, and supplies as directed by the instructor. The inventory must be accurate when compared to the control inventory and must be completed using the appropriate forms furnished by the instructor.

32.05 (COMPLETE A TROUBLE REPORT ON TOOLS, EQUIPMENT, AND MATERIALS NOT SERVICABLE) Given an area containing equipment, tools, or materials to be maintained, the necessary forms and information, maintain a trouble report on the maintenance of the equipment. The report must be up to date and in accordance with the policy of the instructor.

32.06 (PLAN A SEQUENCE OF WORK OPERATIONS) Given a job description and designated reults; plan the sequence of work operations that will achieve the desired results. The plan must involve all the tasks necessay to complete the job and the proper order in which they should be completed.

32.07 (COMPLETE WRITTEN FORMS AND RECORDS) Given instruction, sample forms and records to complete, and sample jobs to write up; complete required forms and records to the instructor's standards.

UNIT 32.0 ESTIMATING AND PLANNING

TASK 32.01 ESTIMATE COST OF SPECIFIC INSTALLATION, SERVICE, OR REPAIR

PERFORMANCE OBJECTIVE:

Given information such as drawings and specifications for a new installation or description necessary parts, materials, etc., for service or repair to a system, all forms, schedules, and current pricing information; estimate the cost of the specific job. The estimate must include the cost of materials, equipment or components, cost of labor, overhead cost, and expected profit and must be within a predetermined range (such as 10%) calculated by the instructor.

PERFORMANCE ACTIONS:

32.0101 Review drawings and specifications or service or repair needs and estimated work.

32.0102 Draw up any or all of the following needs:
a. Branch circuit materials
b. Pad, or other support requirements
c. Piping, ducting, etc.
d. Labor schedule, etc.

32.0103 Transfer above information to estimating form:
a. Unit cost of materials
b. Material cost
c. Unit labor/hours
d. Labor cost

32.0104 Add all costs.

32.0105 Add percentage of total to cover overhead: Use percentage factor given by instructor.

32.0106 Add percentage of total to cover expected profit: Use percentage factor provided by instructor.

32.0107 Submit completed estimate to instructor.

PERFORMANCE STANDARDS:

-Estimate cost of a given specific installation, service, or repair to an air conditioning, refrigeration, or heating system using the provided forms, schedules, and current pricing information showing the cost of materials, cost of labor overhead cost, and expected profit.

SUGGESTED INSTRUCTION TIME: Combined time for unit.

UNIT 32.0 ESTIMATING AND PLANNING

TASK 32.02 ESTIMATE COST OF MATERIALS FOR SPECIFIC JOB

PERFORMANCE OBJECTIVE:

Given drawings and specifications for new installation or list of necessary parts, materials, etc., for service or repair, the necessary materials, forms, and schedules; estimate the cost of the materials for the specific job. The estimate must include all of the materials, etc., needed to complete the job and contain prices effective at the time the estimate is submitted. The estimate must be within acceptable range determined by the instructor (e.g., 5-10% of instructor's estimate.)

PERFORMANCE ACTIONS:

32.0201 Review drawings and specifications or job requirements.

32.0202 List materials, parts, etc., required. (list schedules)

32.0203 Transfer above information to estimating form provided by instructor and indicate unit cost and extended cost of each item, etc.

32.0204 Total all extended costs listed.

PERFORMANCE STANDARDS:

-Estimate cost of materials, parts, etc., for a specific air conditioning, refrigeration, or heating new installation or repair or service job using provided estimating form and showing unit cost, total cost of extended items, and total of extended costs listed.

SUGGESTED INSTRUCTION TIME: Combined time for unit.

UNIT 32.0 ESTIMATING AND PLANNING

TASK 32.03 ESTIMATE COSTS OF LABOR NEEDED FOR A SPECIFIC JOB .

PERFORMANCE OBJECTIVE:

Given drawings and specifications (or description) for a specific job and a list of all the needed materials, forms, and schedules; estimate the cost of the labor for the job based on labor rates provided by the instructor. The labor rates must represent the labor unit prices effective at the time the estimate is submitted. The estimate must be within +/- 5-10% of that figured by the instructor.

PERFORMANCE ACTIONS:

32.0301 Study the drawings and specifications or description.

32.0302 Compile a labor units schedule. Total the hours needed to complete the job.

32.0303 Calculate the labor cost by multiplying the number of hours times the current cost per hour.

PERFORMANCE STANDARDS:

- Estimate costs of labor needed to do a specific job using given information and materials/forms and using labor rates effective at the time the estimate is submitted.
- The estimate must be within +/- 5-10% of that figured by the instructor.

SUGGESTED INSTRUCTION TIME: Combined time for unit.

UNIT 32.0 ESTIMATING AND PLANNING

TASK 32.04 INVENTORY EQUIPMENT, MATERIALS AND SUPPLIES

PERFORMANCE OBJECTIVE:

Given a supply room or any area containg quantities of equipment, materials, and supplies; inventory the equipment, materials, and supplies as directed by the instructor. The inventory must be accurate when compared to the control inventory and must be completed using the appropriate forms furnished by the instructor.

PERFORMANCE ACTIONS:

32.0401 Sort and separate pieces of equipment.

32.0402 Check equipment for servicable condition and check assigned8necessary accessories (such as test probe leads with instruments.)

32.0403 Sort and separate materials.

32.0404 Sort and separate supplies.

32.0405 Count and record numbers of each item of equipment, materials, and supplies.

32.0406 Recount number of each item comparing second count to record made of first count (<u>or to master inventory</u>.)

PERFORMANCE STANDARDS:

-Inventory equipment, materials and supplies as directed by the instructor, using furnished forms, and comparing the inventory to a master inventory provided by the instructor.

(RECOMMENDATION: Toolroom man may conduct an inventory of tool storage, etc., room daily or as directed by the instructor. This practice should contribute directly to the knowledge and skill development of the student providing the student with experience in inventory; equipment, tool, and component terminology; and an opportunity to check out the condition of tools and equipment.)

SUGGESTED INSTRUCTION TIME: Combined time for unit. See following task.

UNIT 32.0 ESTIMATING AND PLANNING

TASK 32.05 COMPLETE A TROUBLE REPORT ON TOOLS, EQUIPMENT, AND MATERIALS NOT SERVICABLE

PERFORMANCE OBJECTIVE:

Given an area containing equipment, tools, or materials to be maintained, the necessary forms and information; maintain a trouble report on the maintenance of the equipment. The report must be up to date and in accordance with the policy of the instructor.

PERFORMANCE ACTIONS:

32.0501 Review instructor's directions concerning reporting tools, equipment, or materials that are not servicable.

32.0502 Review report form.

32.0503 Note location of all tools, equipment, and materials to be inspected.

32.0504 Use forms to record trouble with tools, equipment, or material.

32.0505 Submit reports to instructor.

PERFORMANCE STANDARDS:

-Complete a trouble report on tools, equipment, or materials not servicable on the forms provided by the instructor, according to the instructor's directions, and the meeting standards of the instructor.

(NOTE: This task may be combined with toolroom duty to expand skill and knowledge development training in that learning experience.)

SUGGESTED INSTRUCTION TIME: Combined time for unit. See preceeding task.

UNIT 32.0 ESTIMATING AND PLANNING

TASK 32.06 PLAN A SEQUENCE OF WORK OPERATIONS

PERFORMANCE OBJECTIVE:

Given a job description and designated results; plan the sequence of work operations that will achieve the desired results. The plan must involve all the tasks necessary to complete the job and the proper order in which they should be completed.

PERFORMANCE ACTIONS:

32.0601 Make a general analysis of the job to be completed.

32.0602 List all the operations (task) needed to complete the job.

32.0603 Arrange the operations in the proper sequence from beginning to completing the job.

32.0604 Review and examine the sequence listed for possible errors or omissions.

32.0605 Submit the proposed sequence to the instructor for review and critique.

32.0606 Complete sequence, if required.

PERFORMANCE STANDARDS:

-Plan a sequence of work operations for the most efficient and effective accomplishment of desired results, outlining or listing job task in the proper order in which they should be completed.
-Meet the instructor's standards.
-Complete the sequence of operations, if required.

SUGGESTED INSTRCUTION TIME: Combined time for unit.

UNIT 32.0 ESTIMATING AND PLANNING

TASK 32.07 COMPLETE WRITTEN FORMS AND RECORDS

PERFORMANCE OBJECTIVE:

Given instruction, sample forms and records to complete, and sample jobs to write up,; complete required forms and records to the instructor's standards.

PERFORMANCE ACTIONS:

32.0701 Explain why service, installation, maintenance, and repair records are essential to maintaining a business.

32.0702 Describe the basic purpose of the following forms and complete example forms as required by the instructor.
- a. Customer call-in record.
- b. Form for serviceman to complete concerning job parts, equipment, materials, mileage, labor, etc.

32.0703 Complete check-sheet lists: (Items to be checked might include the following.)
- a. Leak test
- b. Belts checked
- c. Motors oiled
- d. Noises checked
- e. Vibration eliminated
- f. Amprobe used
- g. Voltage checked
- h. Fuses checked
- i. Blow out dust/dirt from condenser
- j. Clean unit
- k. Check for water leaks
- l. Loose fans or bolts checked
- m. Oil in compressor crankcase checked
- n. Unclog drains
- o. Check switches and lighting

32.0704 Complete material-use tickets: Record material used on job (actual cost if required by instructor): Add mileage, tools, and other expenses (as required by instructor.)

PERFORMANCE STANDARDS:

-Complete written forms and records essential to maintaining a business. Performance must be t instructor's standards.

SUGGESTED INSTRUCTION TIME: Combined time for unit = 9 hours.

UNIT 33.0

CUSTOMER RELATIONS

This Customer Relations unit is designed to introduce the secondary student to the important customer relations aspects of air conditioning, refrigeration, and heating servicing.

The air conditioning, refrigeration, and heating mechanic must be prepared to develop or restore the customer's opinion or confidence in the coo ing or heating system. In part, the mechanic accomplishes this responsibility through the professional manner in which the mechanic conducts himself in talking with the customer by telephone, in dealing with the customer in per on, and in making the necessary technical installation, ac istments, or repairs.

The Rheem Mini Manual Customer Service suggests that "the professional serviceman is courteous, neat in appearance and workmanship, thorough, and businesslike." The serviceman must make an effort to leave a lasting positive impression that he/she and his/her company "are competent and of good quality."

The mechanic must be prepared to familarize the customer concerning the proper operation of newly installed equipment or systems, explain equipment failures, or offer suggestions that may help the customer obtain the maximum efficiency and benefit from the heating or cooling system.

The intent of this customer relations unit is to help the secondary student:

1. become acquainted with "the importance of maintaining satisfactory business relations with all customers,"
2. "acquire an understanding of the importance of favorable first impressions, particularly with a dissatified customer," and
3. develop a comprehension of the customer's viewpoints in regards to the immediate service problem.

This unit overlaps with the units in the "introductory" section of the first year description, especially concerning attitudes and behavior on the job.

Important references used in the development of this unit include:

Customer Service (Mini Manual). Fort Smith, AR: Rheem Air Conditioning Division, City Investing Company, 1976.

HVAC
CUSTOMER RELATIONS
SUGGESTED INSTRUCTION TIMES

HVAC UNIT/TASK		SUGGESTED HOURS
Unit 33.0	CUSTOMER RELATIONS	
33.01	Deal Successfully with Customers	*
33.02	Follow Accepted Practices in Service Calls	*
33.03	Handle Irritated Customer	*
33.04	Build Customer Relations Through Dress, Vehicle, Actions	*
33.05	Promote Customer Relations Through Suggestions for Comfort and Economy	*
	TOTAL HOURS	6

UNIT/TASK	DESCRIPTION
Unit 33.0	CUSTOMER RELATIONS
33.01	(DEAL SUCCESSFULLY WITH CUSTOMERS) Given a simulated (role play) situation in which to deal successfully with a customer, apply the general rules of successful customer relations as outlined in training.
33.02	(FOLLOW ACCEPTED PRACTICES IN SERVICE CALLS) Given a simulated (role play) service call, demonstrate accepted practices in making service calls.
33.03	(HANDLE IRRITATED CUSTOMER) Given simulated (role play) service call where the customer is irritated, demonstrate recommended methods of dealing with irritated customer.
33.04	(BUILD CUSTOMER RELATIONS THROUGH DRESS, VEHICLE, ACTIONS) Given a simulated (role play) service call, build customer relations through dress and appreance, vehcile appearance and organization, and personal actions.
33.05	(PROMOTE CUSTOMER RELATIONS THROUGH SUGGESTIONS FOR COMFORT AND ECONOMY) Given a simulated (role play) service call, promote customer relations through suggestions to the customer for improving comfort and economy.

UNIT 33.0 CUSTOMER RELATIONS

TASK 33.01 DEAL SUCCESSFULLY WITH CUSTOMERS

PERFORMANCE OBJECTIVE:

Given a simulated (role play) situation in which to deal successfully with a customer, apply the general rules of successful customer relations as outlined in training.

PERFORMANCE ACTIONS:

(Following "general rules" are adapted from:

Air Conditioning and Refrigeration, Book III, Unit III: "Customer Relations" Stillwater, OK: Mid-Atlantic Vocational Curriculum Consortium, Inc., 1981,pp 69-86.)

33.0101 "Be courteous at all times, especially when circumstances have created an unpleasant situation."

33.0102 "Treat all service calls as emergencies. (Service calls are not considered routine maintenance calls.)"

33.1003 "Respect scheduled committments." (If the service call to a customer will be delayed, telephone the customer, explain the delay, and set a new time.)

33.1004
a. Don't share personal problems with the customer.
b. Keep to business: Be polite and businesslike, but generally avoid socializing on the job.

33.1005 Don't make commitments to the customer without company approval unless you have the authority to do so.

PERFORMANCE STANDARDS:

-In a given simulated (role play) job emergency job situation, deal successfully with the customer according to accepted rules of customer relations.

(Rules of customer relations will be clarified by instructor.)

SUGGESTED INSTRUCTION TIME: Total instruction time given for unit.

UNIT 33.0 CUSTOMER RELATIONS

TASK 33.02 FOLLOW ACCEPTED PRACTICES IN SERVICE CALLS

PERFORMANCE OBJECTIVE:

Given a simulated (role play) service call, demonstrate accepted practices in making service calls.

PERFORMANCE ACTIONS:

Recommended "rules" are adapted from:

<u>Air Conditioning and Refrigeration, Book III, Unit III:</u> "Customer Relations". Stillwater, OK: Mid Atlantic Vocational Curriculum Consortium, Inc., 1981, pp. 69-86.

33.0201 Do not soil or leave debris in:
a. Customer's house
b. Customer's driveway

33.0202 On arriving, "identify yourself, your company, and state that you are there to service a specific problem."

33.0203 Verify with customer:
a. "what problem is"
b. "when it started"
c. "how many times it has happened"
d. "what time of day it is most noticable," etc.

33.0204 Make general diagnosis of problem prior to inspecting system. Demonstrate to customer that you know what you are doing.

33.0205 When completed, "make sure work area is clean and that all parts and covers are back in place."

33.0206 "Assure customer that equipment is working well, explain what caused problem," and tell customer what to do if the problem is repeated.

33.0207 "Tell customer what was wrong, what parts were replaced," and when to expect the bill. (Leave old parts for customer to examine.)

PERFORMANCE STANDARDS:

-Follow accepted practices in making service calls. Accepted practices will be reviewed in class by the instructor.

SUGGESTED INSTRUCTION TIME: Total instruction time given for unit.

UNIT 33.0 CUSTOMER RELATIONS

TASK 33.03 HANDLE IRRITATED CUSTOMER

PERFORMANCE OBJECTIVE:

Given simulated (role paly) service call where the customer is irritated, demonstrate recommended methods of dealing with irritated customer.

PERFORMANCE ACTIONS:

(Recommended methods of dealing with irritated customer are taken from:

> Air Conditioning and Refrigeration, Book III, Unit III: "Customer Relations." Stillwater, OK: Mid-Atlantic Vocational curriculum Consortium, Inc., 1981 pp. 69-86.

33.0301 "Show concern by listening carefully."

33.0302 "Show concern by making notes of specific items in complaint and keeping situation on business level."

33.0303 "Allow customer to state entire problem."

33.0304 "Assure customer that equipment under warranty will be replaced free of charge and that the job will be given priority status."

33.0305 "If there has been a misunderstanding concerning a contract, assure customer that a company representative will contact the customer as soon as possible."

33.306 "Apologize for the inconvenience and assure customer that the company will correct the problem as soon as possible."

PERFORMANCE STANDARDS:

-Handle irritated customer according to methods recommended by the instructor and textbook.

SUGGESTED INSTRUCTION TIME: Total instruction time given for unit.

RELATED TECHNICAL INFORMATION:

-Practice allowing customer to "blow off steam"
-Practice setting specific times for call backs, office follow-up, etc.

UNIT 33.0 CUSTOMER RELATIONS

TASK 33.04 BUILD CUSTOMER RELATIONS THROUGH DRESS,VEHICLE , ACTIONS

PERFORMANCE OBJECTIVE:

Given a simulated (role play) service call, build customer relations through dress and appearance, vehicle appearance and organization, and personal actions.

PERFORMANCE ACTIONS:

(Recommended methods of developing customer relations through dress, vehicle, and actions are taken from:

Air Conditioning and Refrigeration, Book III, Unit III: "Customer Relations" Stillwater, OK: Mid-Atlantic Vocational Curriculum Consortium Inc., 1981, pp. 69-86.)

33.0401 "Earn customer's repsect through personal appearance:"
- a. "Wear clean uniform daily."
- b. Use coveralls when working in crawl space or attic, etc., to reduce dirt on uniform.
- c. Use clean rags, etc, to wipe grease and soil from hands and from equipment (such as covers and thermostats.)
- d. Use "drop cloth where dirt might soil carpet or floors."
- e. Do not smoke when making service calls.
- f. Keep tools and tool box clean and neatly organized.

33.0402 Use vehicle to build customer relations.
- a. "Keep business vehicles in clean and in good repair.
- b. "Drive safely and courteously.
- c. "Avoid intoxicants, drugs, horseplay and profanity in the business vehicle."
- d. Report all vehicle incidents or accidents immediately to the company.

33.0403 Build customer relations through personal actions:
- a. SEE RELATED TRAINING IN UNIT I OF THIS INSTRUCTION GUIDE.
  - (1) Unit: Introduction to Leadership/Job communications
  - (2) Unit: Preparing for Work
  - (3) Unit: Introduction to Desireable Job/ Learning Characteristics/Habits/ attitudes

UNIT 33.0 CUSTOMER RELATIONS

TASK 33.04 BUILD CUSTOMER RELATIONS THROUGH DRESS, VEHICLE, ACTIONS

PERFORMANCE ACTIONS: (Con't)

(4) Unit: Read and Write Technical Information
(5(Unit: Basic Math Skills

b. "Leave the company name and telephone number with the customer." (Make use of business cards, stick on lables, stick on labels, .etc.)

PERFORMANCE STANDARDS:

-Build customer relations through recommended dress, vehicle appearance, and serviceman's actions.

SUGGESTED INSTRUCTION TIME: Total instruction time given for unit.

RELATED TECHNICAL INFORMATION:

-See related unit in Introduction of this Guide
-Introduction to Leadership/Job communications
-Preparing for Work
-Introduction to Desirable Job/Learning Characteristics/Habits/Attitudes
-Read and Write Technical Information

UNIT 33.0 CUSTOMER RELATIONS

TASK 33.05 PROMOTE CUSTOMER RELATIONS THROUGH SUGGESTIONS FOR COMFORT AND ECONOMY

PERFORMANCE OBJECTIVE:

Given a simulated (role play) service call, promote customer relations through suggestions to the customer for improving comfort and economy.

PERFORMANCE ACTIONS:

(Recommendations taken from:

<u>Air Conditioning and Refrigeration, Book III, Unit III:</u> "Customer Relations", Stillwater, OK: Mid-Atlantic Cocational Curriculum Corsortium, Inc., 1981 pp. 69-86.

<u>Customer Service - Mini Manual,</u> Forth Smith, AR: Rheem Air Conditioning Division of City Investing Company, 1976.)

33.0501 "Leave company name and telephone number with customer." (Use stick-on labels, etc.)

33.0502 Offer suggestions for improving comfort and economy.

a. "Show customer how to change filters, etc., as appropriate, and explain benefits of changing filters (i.e., improved performance, saves money and energy.)
b. "Show customer proper thermostat operations and settings to improve efficiency, etc."
c. Offer typical suggestions for improving comfort and economy of system.

(See <u>Customer Service - Mini Manual</u> by Rheem, pp. 11-14.)

PERFORMANCE STANDARDS:

-Promote customer relations through suggestions for comfort and economy.

SUGGESTED INSTRUCTION TIME: Total instruction time given for unit. (6 hours)

RESIDENTIAL ENERGY EFFICIENCY

(Based on interview with a commercial energy efficiency consultant)

Typical Uses of Energy in Residences:

60% - AC and Heat
15% - Hot Water
8% - Refrigerator
6% - Lights
4% - Cooking
3% - Clothes Dryer
4% - Misc.

How a House Uses Energy:

1. Insulation
    a. Type
    b. Thickness
2. Infiltration
    a. Doors and Windows
    b. Fireplace
3. Life Style
    a. No. in Family
    b. Typical Thermostat Setting
    c. Ages and No. of Children
    d. Who works (both or just one)
    e. Extent of Family travel (are they home all the time, etc.)
4. Mechanical Systems
    a. Initial Efficiency
    b. Maintenance Qualtiy
    c. Design Efficiency
5. Shape of House (e.g., 2-story uses less energy than ranch)
6. Fuel used (Natural gas more efficient than fuel oil)

"R" Values - What Do They Mean?

"R" Value indicates the resistance insulation presents to heat flowing through it. The bigger the "R" value, the better the insulation. R-20 insulation is twice as effecitve as R-10.

"Insulation that is compressed becomes a poorer insulator than insulation that contains the desing air pockets, etc. (Insulator is the air)."

<u>Recommended</u> levels of Insulation in SC:

1. Attic = R-30
2. Outer walls = R-15-19
3. Floor = R-11-19
4. Duct Insulation = R-7

Types of Insulation:

1. Fiberglass (very safe)
    a. Loose Fill (smaller the better) = R-2.2/inch
    b. Batts of Blankets (***If you can see the paper backing, it is installed wrong) + R-3.1/inch

2. Rock Wool (excellent, but more exspensive)
   s. Loose Fill = R-2.8/inch
   b. Batts or Blankets = R-3.3/inch
3. Cellulose Fiber (ground up newspaper treated with boric acid as fire retardant) = R-3.7/inch
4. Exterior Sheathing (flammable, subject to UV light, etc.)
   a. Polystyrene (molded) = R-4.0/inch
   b. Polystyrene (extruded = denser) = R-5.0/inch
   c. Polyurethane = R-7.1/inch
5. Masonry Insulation:
   a. Vermiculite = R-2.1/inch
   b. Perlite = R-2.7/inch
6. Foam (material with narrow tolerance)
   a. Ure-Formaldehyde = R-4.1/inch
   b. Urethane (very flammable and made at job site) = R-7.1/inch

Attic Ventialtion:

1. Important in Summer because it removes heat.
2. In Winter, removes moisture and keeps attic dry.

What causes attic ventilation?

1. Stack Effect: Hot air rises.
2. Bernoulli Effect: Air passing over a surface, pushes air awawy, causing low pressure.

Different Types of Attic Ventilation Systems:

1. Gable Vents
2. Cornice Soffit (under eves)
3. Continuous Soffit (2-4" strips)
4. Turbine Vent - inexspensive and should be left "uncovered" during winter since it removes moisture from attic: If extra ventilation was needed in summer, then extra ventialtion is needed in the winter.
5. Power Ventilator - Controlled by thermostat --which makes it useful only in the summer unless a humidistat is used to control it in winter.
6. Roof Line Ventilator - "Ridge Cap"

How much attic ventialtion is necessary?

"Possible Rule of Thumb" = $\frac{\text{Attic Sq. Ft.}}{150}$ = Sq, Ft. of Vent Area

(use 1/2 sq. footage for 2-story house)

Energy Wasters:

Thermostat Setting (68° Winter, 78° Summer)
Replace Return Filters (monthle recommended)
Yearly inspection of HVAC system
Attic Hatch (stairs cover)
    Closed during Winter
    Insulated
    Weather stripped with compression Type Material
Hot Water Heater
    Thermostat Setting (140° for preheat, 120° general)
    Use Jacket (insulation)
    Drain Water Heater at least once everey 6 months to remove corrosive material
Flow controllers for water faucets
Close fireplace flue when it is not in use
Open Cinder Box for ventialtion in Winter
Cut off central heat when using fireplace since pressure created by central heat pushes hot air up chimney
When building, place firplace in center of houe since heat is reflected from the back side as well...
Insulation under house should be checked to be sure it is being held up properly... hasn' drooped down.
Check ducts to be sure....
    connected properly... have not been knocked loose, etc.
    properly insulated
Use (look for) masonite baffles to contain insulation around soffits in attic where it otherwise would thin out.
Cover ceiling fan in winter
Use space heaters for small areas
Set back thermostats
Insulate steam or hydronic systems
Use curtains wisely to control heat during summer and drafts during winter
Use cold water detergent for washing
Use ceiling (Cassablanca type) fans
Cork around windows
Weatherstrip doors using
    friction band
    compression bond
Cord around pipes entering house
Use draft stoppers... to insulate outlet and swtich plates etc.

AIR-CONDITIONING & REFRIGERATION INSTITUTE

CONSUMER GUIDE TO EFFICIENT CENTRAL CLIMATE CONTROL SYSTEMS

This Guide has been prepared by the Air-Conditioning and Refrigeration Institute (ARI), a non-profit association of manufacturers. ARI wants to help you get the most out of your central air-conditioning system, whether the system is already at work in your home or you are considering the purchase of a new one.

The companies which have made this Consumer Guide available to you are listed on the inside back cover. These companies support ARI and its many services to consumers. One of the most important of these services is the ARI Certification Program.

Not long ago, people didn't give their home appliances much thought. They simply plugged them in and let them do their work.

However, in today's energy-conscious world, people are becoming aware that appliances—*all* appliances—consume not only just kilowatts, but also ever-increasing portions of their income.

As a result, cost-conscious consumers are beginning to take a hard look at appliances such as their home comfort systems and asking themselves some pointed questions:

- Is my system wasting costly energy?
- Is there something I can do to improve its efficiency?
- Are some air-conditioners more efficient than others?

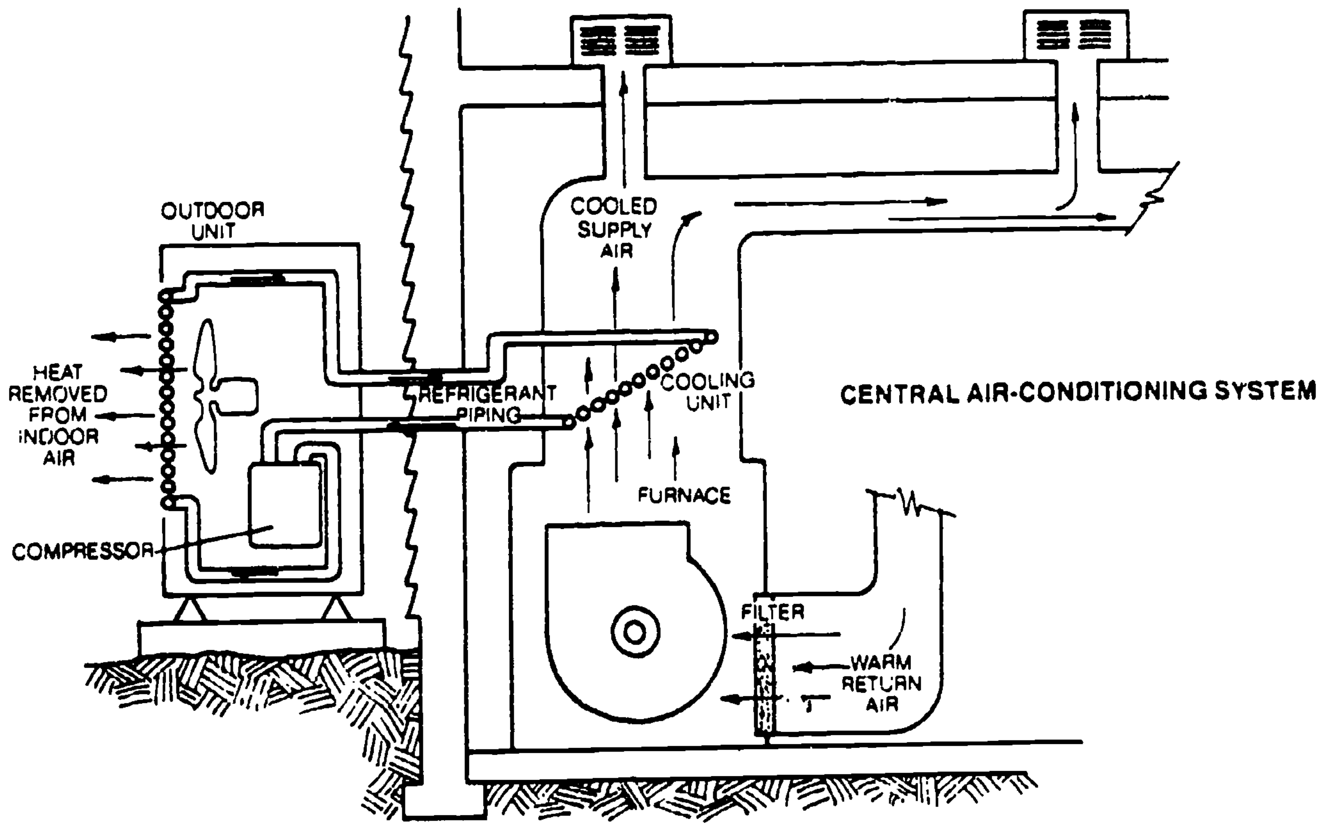
Others thinking of buying a new home or refurbishing an older one also want to know more about the efficient equipment available today.

Air-conditioner manufacturers want you to understand your air-conditioner and how it works so that you can get the most comfort for your energy dollar. In this booklet, you will find simple, relatively inexpensive ideas to improve your system's efficiency.

Also, if you *are* planning to purchase a new air-conditioner or new home, you should be aware that there are differences between units. Information included here can help you make an informed decision.

When you see this seal on central air-conditioning equipment and/or on accompanying sales literature, it's an indication that the manufacturer has certified the performance of the equipment to ARI. Look for the ARI seal when you select new equipment.

WHAT IS AN AIR-CONDITIONER?



Taken literally, air-conditioning includes both the cooling and heating of air, cleaning it and controlling its moisture level: conditioning it to provide maximum indoor comfort.

For our purposes, we'll refer to air-conditioning as most people think of it: the process of cooling air for comfort inside homes and buildings.

Engineers define the process as one in which a system of mechanical components, usually including a compressor, a fan, condenser coil, evaporator coil and a chemical refrigerant, extracts heat from indoor air and transfers it outside, leaving the cooled indoor air to be recirculated.

The cleaning function of air-conditioners is performed by filters which remove dust from the air. In some systems, the filters are permanent and can be washed periodically to remove accumulated dirt. Most systems have disposable filters which can be replaced. When filters become clogged, they restrict the flow of air and cause the system to operate inefficiently.

IS HOME COMFORT A NEW IDEA?

As far back as the ancient Egyptians, Greeks and Romans, man has been trying to control his environment. Early civilizations used air blown over wet mats to cool their homes. British miners improved their working conditions in the mid-16th century through the use of then-new ventilating fans.

In 1902 mechanical cooling equipment began to appear in buildings in New York City. Thirty years later, what had become known as "air-conditioning" was first used in homes and apartments.

Today air-conditioning has become much more than just a matter of comfort. Certain important processes, such as computer operations, would not be possible without reliable air-conditioning systems to keep electronic circuitry from overheating. Extremely warm, humid parts of the United States and the world would have remained undeveloped without the means to control temperature and humidity.

More than ever, air-conditioning is an integral part of our lifestyle.

Homeowner's Air-Conditioning Efficiency Check List

Filters:

- ☐ Permanent — Clean with mild detergent, as per manufacturer's recommendations, every 30-60 days.
- ☐ Replaceable — Replace every 30-60 days.

Windows and Doors:

- ☐ Keep closed when system is running.
- ☐ Caulk and weather-strip to close air gaps.
- ☐ Pull drapes and shades over windows facing sun.

Activities:

- ☐ Wash/dry clothes during coolest times of day (morning or evening).
- ☐ Use exhaust fan when cooking to remove excess heat and humidity.
- ☐ Keep thermostat at desired setting.

Maintenance:

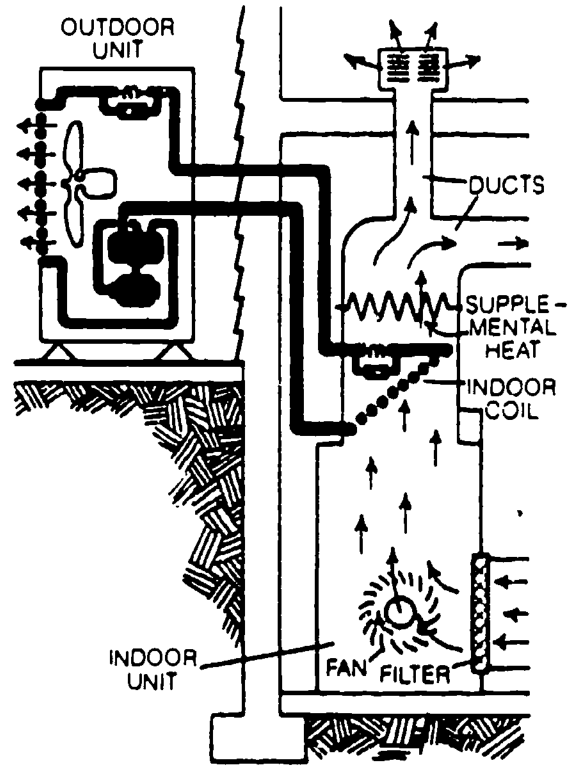
- ☐ Follow manufacturer's routine maintenance directions.
- ☐ Have entire system cheeked once a year.

WHAT IS A HEAT PUMP?

HEAT PUMPS PROVIDE SUMMER COOLING AND WINTER HEATING

One kind of air-conditioning system is called a heat pump. In the summer, a heat pump is exactly like a conventional air-conditioner. It collects heat from the air in your home and expells it outside. But in winter, the whole process is reversed. Heat is extracted from outside air and circulated through the house. A heat pump takes the place of a furnace.

The heat pump can do this because heat exists in all air. Even cold winter air contains heat. For the coldest days, many heat pump installations have a booster electrical resistance heater that automatically switches on to supplement the heat brought in from outside.



WHY A HEAT PUMP?

Rising energy costs and shortages of certain fuels have contributed to the rising interest in heat pumps. By significantly reducing energy consumption, heat pumps can result in major savings on monthly energy bills for many homeowners.

It's the heating cycle that accounts for the significant energy savings that are produced by heat pumps. Unlike a furnace that turns fossil fuel or electricity into heat, the heat pump collects heat that already exists in the outdoor air by means of its refrigeration cycle.

This means the heat pump can supply from one-and-a-half to two-and-a-half times more heat than the energy it uses, depending on efficiency of the heat pump and geographic location.

For example, a heat pump can mean savings of 30 to 60 percent on electric heating bills because it uses 30 to 60 percent less energy to supply the same heat as an electric furnace with a resistance heating element. A measure of this advantage of the heat pump is the Heating Seasonal Performance Factor (HSPF). The higher the HSPF, the more efficient the unit.

THE GEOGRAPHICAL FACTOR

During the heating season, the heat pump's efficiency increases on mild days and decreases on cold days. The Heating Seasonal Performance Factor (HSPF) therefore is higher in a mild climate than in a region where winters are severe. For this reason, many early heat pumps were installed in Southern sections of the country.

Through the years, improvements in design have broadened the geographical range of heat pumps to almost every section of the country. While the HSPF of a heat pump will be lower in areas with colder winters, the heat pump will still be more efficient than other electric heating systems in that area.

HOW MUCH DOES IT COST?

In most areas the initial costs of heat pumps are competitive with high efficiency fossil fuel heating-cooling systems. This makes it possible for the cost of owning and operating a heat pump to be comparable to or lower than alternative heating-cooling systems, depending on the cost of energy.

Despite the higher installation cost, the heat pump's efficiency can produce significant savings on monthly heating costs. This makes it possible for the cost of owning and operating a heat pump to be comparable to or lower than alternative heating-cooling systems, depending on the cost of energy.

Actual energy costs vary widely by region. Your local utility can help you estimate what it would cost you to operate a heat pump in your area. Methods used to calculate costs of unit operation must conform to Department of Energy regulations.

SHOULD I BUY A HEAT PUMP?

Here is a list of things to consider:

Initial Cost

Get two or three contractors to estimate the installation cost of a heat pump for your home versus the cost of an alternative heating/cooling system.

Operating Cost

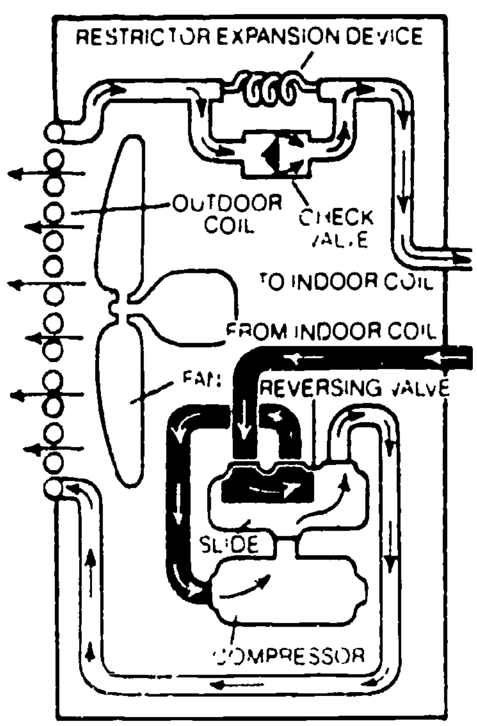
Get an estimate from your utility on the energy cost of a heat pump versus the cost of an alternative system.

Payback

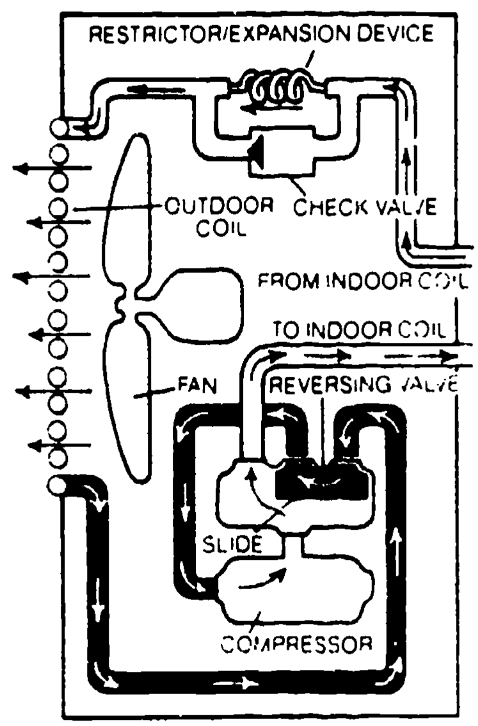
If the heat pump installation costs more than an alternative system, figure out how many years it will take your heat pump to pay back its higher initial cost with lower annual operating costs. You can approximate this by dividing the estimated annual operating savings into the extra cost you pay for a heat pump installation.

Service and Maintenance

Make sure the contractor you deal with is an authorized heat pump dealer. Ask about an extended warranty program for your heat pump.



OUTDOOR UNIT COOLING CYCLE



OUTDOOR UNIT HEATING CYCLE

GETTING THE MOST OUT OF YOUR AIR-CONDITIONER

READ YOUR MANUAL

Most air-conditioners come complete with an owner's manual. If you have a system and can locate the manual, it is a good place to start finding ways to operate your system most efficiently. Tips on maintenance and efficient operation are usually an integral part of these manuals.

In this Guide, we have assembled information which, in addition to the manufacturer's recommendations, should help you get the most comfort from your system at the least cost.

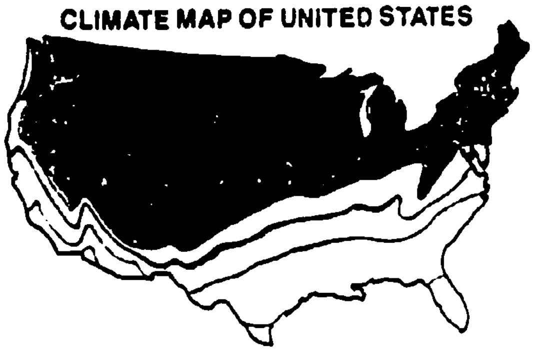
Operation of an air-conditioning system is a lot like an automobile: efficiency depends greatly on the way it is maintained and operated. Cars give better mileage and last longer when they get proper care and attention and are driven moderately. The same thing is true of air-conditioning systems.

CLEAN THE FILTER

Air-conditioning systems do more than just cool the air. They also remove dust and dirt by moving the air through filters.

When these filters become clogged with dirt, the system must work harder to do its job. This wastes energy and can make utility bills rise. Depending on the amount of dust in the air, filters can become clogged in just a month or two of operation. Most residential systems have disposable filters. These should be checked every two months and replaced when necessary. Permanent filters should be cleaned in accordance with the manufacturer's instructions. Under no circumstances should you operate your system without filters. To do so could lead to a need for more frequent cleaning of the heat exchangers.

CLIMATE MAP OF UNITED STATES



AIR LEAKS ARE COSTLY

Some people like to "help" their air-conditioner by opening doors and windows on warm days. But doing so just lets all the cool, dehumidified air rush outside and lets in the hot, humid air. That's not so good unless you're trying to air-condition the whole neighborhood. The more your home seals out heat, humidity, and dust, the more efficiently your system will do its job.

Most people think of thermal insulation, storm windows and weather stripping in connection with reducing *heating* costs. But the benefits of these energy conservation measures apply to *cooling* as well.

The amount of insulation your home needs, as well as the number of hours per day and days per year your air-conditioning system works, varies greatly from area to area. To determine the correct amount, consult a building materials dealer or insulation contractor where you live.

Weather stripping, which plugs holes and gaps around doors and windows, not only blocks out drafts in colder weather, but also helps lock in cool air on warm days and nights. Closing these air leaks will help significantly in maintaining your comfort and reducing energy use.

The sunlight which streams in windows in the winter can provide a great deal of heat inside the home. But that same sunlight during summer or in warmer parts of the country can make an air-conditioning system work harder than it should. Insulated or thermal windows can help. Draperies and shades pulled over the windows when the sun is hitting them directly (especially the western sun in late afternoon) will reduce the cooling load significantly. Some people install awnings over windows and doors to provide shade.

Trees and shrubs strategically planted can also provide welcome shade and protection from direct sunlight.

KEEP DOORS AND WINDOWS CLOSED

LEAVE YOUR THERMOSTAT AT ONE SETTING

If you walk into your home and find it stifling hot because the air-conditioner was turned off, don't be tempted to move the thermostat to a very low setting to cool the house faster. Setting the thermostat lower than usual will not produce more or "colder" air.

Actually this probably would waste energy. There is a good chance you would forget to change the thermostat back to its normal setting, forcing the sytem to work longer than necessary to reach a cooler-than-intended temperature level.

While the system is running, it's best to leave the thermostat alone. Constantly setting the control up or down may waste significant amounts of energy.

Naturally, when the outside temperatures cool down, you may want to turn off the system and let nature handle the cooling. Consider the humidity level outside, though, before opening things up. Your air-conditioner has been working to remove moisture from the air inside your home. Opening doors or windows and letting in highly humid air for a few hours in the evening may be counterproductive in the long run.

At night — or when you'll be away from the house for extended periods of time — you probably will want to make energy-saving adjustments to the thermostat setting by raising the desired temperature. But for normal daytime activities, find a comfortable level and leave the thermostat at that setting.

MORE COST-SAVING TIPS

We've talked about heat coming into the home from outside. But the operation of appliances can generate heat and humidity inside, as well. When they're operating, washers, dryers, ovens and ranges can put out both heat and moisture. Using these appliances during the warmest times of the day, when your cooling system is working hardest, just adds to the burden. By scheduling washing, drying, baking and cooking for mornings or evenings when it is cooler, you can remove this extra burden from your air-conditioning system.

An exhaust fan near an oven or range can help remove not only some of the excess heat but also uncomfortable humidity from cooking. Similarly, make sure your clothes dryer is vented outside.

Preventative maintenance is the least expensive kind. Not only that, but also keeping your system in top shape through regular checkups is the best way to ensure it will keep working for you when you need it most.

The best time to have your system checked by a competent service technician is in early spring, before the cooling season starts. In warm climates, mid-winter is the best time.

Many firms offer a service contract which provides routine maintenance, including lubrication of motors, tightening of belts and checking of refrigerant level. There are some maintenance checks you can make yourself. Check your owner's manual.

REPLACING AN OLD AIR-CONDITIONING SYSTEM

HOW OLD IS "OLD"?

The useful "life" of an air-conditioner can vary greatly. Such factors as climate, maintenance care, and quality and capacity of the original equipment can increase or decrease the service a system will give by months and even years.

On the average, a residential central air-conditioner will last from 10 to 15 years. When a unit begins to show its age, it is usually major components of the air-conditioner, such as motors or the compressor, that wear out. In any case, the homeowner is faced with a decision on whether to patch up the existing system or replace it with newer equipment.

In the short run, replacing failed components will usually cost the least amount of money. But in so doing, the homeowner may be missing an opportunity to greatly improve the overall efficiency of the system and, thereby, save significant amounts of money in operating costs.

In recent years, manufacturers of air-conditioners have made dramatic progress in increasing the efficiency of the units they produce. Therefore, it may make more economic sense to put the cost of repair into a new, more efficient unit which will immediately bring down operating costs. Eventually, the more efficient unit should "pay for itself" through decreased utility bills. In the meantime, a new unit will provide the added advantage of greater reliability and warranty protection.

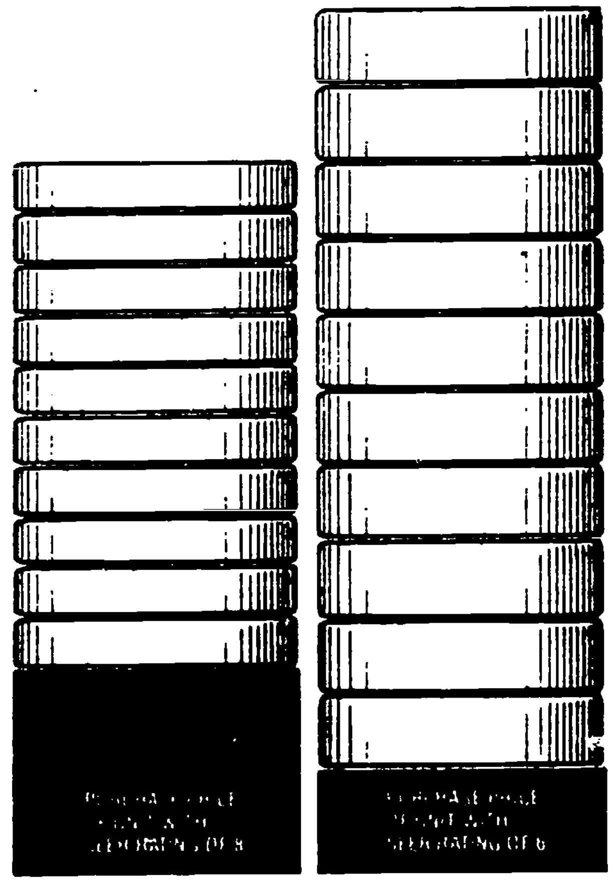
SELECTING THE RIGHT SIZE OF EQUIPMENT

How big a unit should you select for your home?

A competent air-conditioning contractor, after a thorough inspection of your home, can determine how much cooling capacity is required to keep your home comfortable.

It is important to select a correctly sized unit. Too large a unit will cool the space but will not run long enough to remove humidity. The result will be a cold, 'clammy' feeling within the home.

Too small a unit may mean that you will not attain the degree of coolness you want on very hot days, no matter how long the system runs. If you set the thermostat at 78 degrees, an air-conditioner which is too small for the space may only be able to reduce the temperature to 85 degrees on especially hot days.



EACH COIN REPRESENTS ONE YEAR S OPERATING COSTS

EFFICIENCY RATINGS: WHAT *SEER* MEANS TO YOU

The purpose of rating the efficiency of an air-conditioner is to indicate the relative amount of energy needed to provide a specific cooling output. The more efficient the equipment, the less energy will be used to do the same job.

It's similar to the miles-per-gallon ratings for automobiles. Instead of "mpg," central residential air-conditioners now use the designation "SEER" which stands for Seasonal Energy Efficiency Ratio.

> EXAMPLE:
>
> *Assume a home requires a unit with a cooling capacity of 36,000 BTUH and is located where the cooling system necessitates running the unit a total of 1,500 hours. Assume electricity costs residential customers 5 cents per kilowatt hour.*
>
> *In order to determine the projected operating costs of a unit with a SEER of 6.0 compared to one with a SEER of 8.0 apply the following formula:*
>
> $$\frac{\text{Capacity (BTUH)}}{\text{SEER}} \times \frac{\text{Cooling Load Hours}}{1000} \times \text{Electric Rate} = \text{Cost of Operation}$$
>
> *In the case of our hypothetical house, the formula would look like this:*
>
> $$\text{SEER 6.0} \quad \frac{36{,}000}{6.0} \times \frac{1500}{1000} \times .05 = \$450$$
>
> $$\text{SEER 8.0} \quad \frac{36{,}000}{8.0} \times \frac{1500}{1000} \times .05 = \$33[illegible]$$

Previously the air-conditioning industry used the term "EER," which stood for Energy Efficiency Ratio. This was a simple mathematical ratio of cooling output measured in British Thermal Units per hour (BTUH) versus electrical power input (watts). Recently the U.S. Department of Energy developed a more complicated test method which rates the performance of a unit over a wide range of operating conditions. The result (SEER) is indicative of the unit's operation throughout the cooling season.

When purchasing a new air-conditioner, you should be aware of SEER ratings and what they mean. From the boxed example you can see that the higher-efficiency unit would save $113 each cooling season. Obviously this amount will vary in real-life situations depending on (1) whether the unit operates more or less than the 1,500 hours used in the example; (2) family size and living habits, and (3) the electric rates. (Your local electric utility should be able to provide information on cooling load hours for your area as well as electricity rates.)

Nevertheless the example does illustrate that higher efficiency results in lower operating costs. Since the higher-efficiency model is often more expensive, you may want to calculate the pay-back period in which it will "pay for itself" in terms of lower utility bills.

SELECTING AN INSTALLER

A quick glance at the Yellow Pages of your telephone directory will reveal that there are, in all likelihood, a number of firms which sell and install heating and cooling systems.

How do you pick the right one?

You may already have a preference for a certain manufacturer based upon your favorable experience or that of a friend or neighbor. In that case, look for firms that sell and service that particular brand or product.

Or you may have heard about a contractor who does particularly good work.

If you have no preferences or references, call two or three firms and ask them to inspect your home and make proposals, including cost estimates. Don't be bashful about asking for details about the firm's experience, names of customers, its long-term stability and the expertise of its staff. Reputable contractors are always happy to tell you everything you want to know about them. Beware of the one who is evasive or who brushes aside inquiries.

In any case, the installer should make a personal visit to your home and inspect your present heating/cooling system.

You should not assume that replacing your existing equipment with one of similar size is necessarily the correct thing to do. The

CONTINUED ON PAGE 6

Check List for Replacing an Existing Central Air-Conditioning System

Picking the Proper System

- ☐ Determine the proper size unit, based on cooling load calculation.
- ☐ Check compatibility of new equipment with existing system (ductwork, electrical capacity, etc.).

Scheduling the Work

- ☐ For better service, try to schedule installation during the cooler "off season."

Selecting a Contractor

- ☐ Get recommendations from friends and neighbors.
- ☐ Ask for names of firm's previous customers.
- ☐ Obtain written cost estimates.
- ☐ Check out equipment warranties and maintenance services offered.

contractor should calculate the cooling load and give you a copy. If there are significant variances between the recommendations of different contractors, you might ask for a recalculation.

THE BEST TIME TO BUY

If you call an air-conditioning contractor in mid-summer, you may find the firm so busy that it won't be able to serve your needs for several weeks.

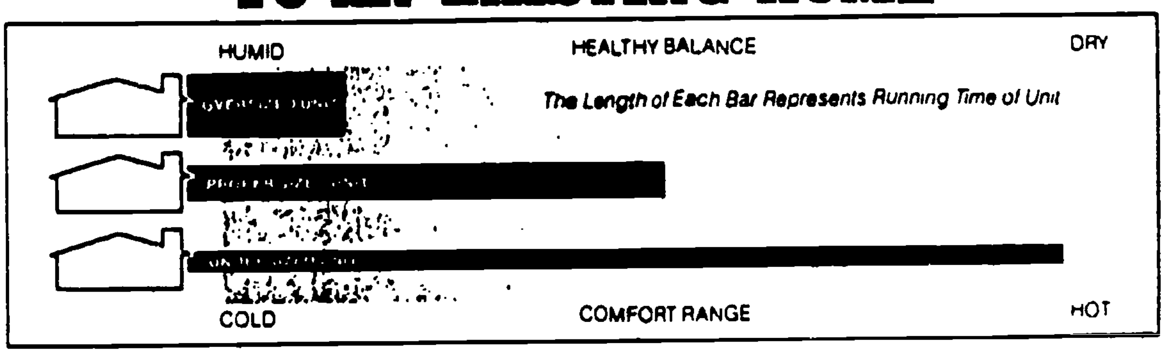
You'll get more favorable time and attention if you contact contractors earlier in the year, in late winter or early spring. Depending on their work load, that may also be a time when they are more willing to bargain on the total system cost. Don't expect contractors to always offer enormous discounts during the "off season." In the warmer parts of the country, successful contractors are busy year-round. No matter where they are, contractors like all business people must operate within a certain minimum profit margin in order to stay in business. Beware of the contractor who offers unrealistically low prices. It may mean corners are being cut in crucial areas.

WARRANTIES AND SERVICE CONTRACTS

The warranty on your equipment will vary according to the manufacturer. Make sure you fully understand the terms of the warranty. If you are uncertain about any provision in your warranty, ask your contractor to explain its meaning. If necessary, call the manufacturer for an explanation.

Many dealers and contractors offer service contracts which call for periodic maintenance of equipment and repairs, as needed. The fee for such contracts is usually well worth the investment.

ADDING AIR-CONDITIONING TO AN EXISTING HOME



As real estate costs continue to escalate and the cost of commuting from distant suburbs climbs steadily, many people are turning to the purchase of older homes closer to urban centers.

Although such homes offer many attractions, including larger rooms and mature trees, they often lack a central air-conditioning system. Families used to the benefits of air-conditioning may want to add this basic feature to the remodeled older home.

The most important factor to consider is the presence or absence of ductwork in the house. If the existing system uses steam or hot water in radiators, that usually means there are neither air ducts in place nor a central blower.

In such cases, ductwork may be installed in the basement and/or attic or during a major remodeling when the contractor can open walls, install the ductwork and finish the walls as necessary. Otherwise the ductwork must be routed where it might be visible.

If the existing heating system is of the "forced air" type, incorporating a blower and ducts, then addition of air-conditioning should be comparatively simple. Essentially, all that is necessary in most cases is the addition of a cooling coil, the outdoor condensing unit and the proper controls.

However, modification or replacement of existing ducts might be necessary if they are too small. Your heating/cooling contractor can determine that.

As in all other cases, choosing the right contractor is important. In an existing home where ductwork must be added, it will take more thought, planning and ingenuity to get the job done.

Another important factor to check is your power supply. The contractor or your local electric utility can determine if your present electrical power supply is adequate to handle the added load of an air-conditioner or a heat pump.

The size of the unit must be selected carefully. Too large a unit will result in short operating cycles which will not adequately remove humidity, resulting in a cold, clammy feeling. Too small a unit will mean that you may not be able to attain a comfortable temperature on the hottest days.

Along with your new air-conditioning system, you should take a close look at the energy effiency of the structure. It would not be cost-effective to install a high-efficiency unit in a house that was poorly insulated or drafty; the remodeling phase would also be the best time for caulking, weather-stripping and insulating.

Your local utility company is available to perform an energy audit of your home. In some cases there may be a fee for this service. They will inspect the structure and give you detailed recommendations on how to improve its energy efficiency. They can give you an estimate of what such measures will cost and approximately how much you can expect to reduce your energy costs by installing them. They may even help you arrange financing. It's well worth the small effort to give them a call!

Check List for Adding Central Air-Conditioning to an Existing Structure

- ☐ Check to see if there is already ductwork in place.
- ☐ If there is no ductwork, schedule installation during major remodeling phase.
- ☐ Select correct unit size.
- ☐ Choose a contractor who has installed systems in existing homes
- ☐ Check energy efficiency of structure with help from your local utility company.
- ☐ Check your power supply.

BUYING AN AIR-CONDITIONED HOME

When buying a home, whether it is new or has been lived in, many consumers find that the decision on air-conditioning already has been made by the previous owner or the builder.

Because the heating/cooling system is such an important part of a home, you may want to evaluate the system as part of your decision-making process on whether or not to buy. Some questions you might ask:

- Is the system adequate for the size of the home?
- Has the system been properly maintained and is it in good condition?
- Is the equipment of the high-efficiency type, or is it likely to be an energy-waster?

If the existing system *is* unsatisfactory for some reason, you might want to consider modifying or replacing it and then including that cost in your total home financing package.

SIZE OF UNIT

For reasons explained earlier, a correctly sized unit is important. If you have doubts about the adequacy of the system, you may want to ask a local contractor for advice. Describe the type of house, the approximate square footage, the insulation level, and the cooling capacity of the installed unit (expressed in BTUH).

If the unit is drastically under-sized (or over-sized) the contractor will probably be able to tell you.

CONDITION OF EQUIPMENT

An air-conditioner which is in poor condition could mean big repair bills after you have moved in. There are some things you can look for before closing the transaction.

If the equipment is more than 10 years old, it can generally be assumed that certain repairs may be needed in the near future.

Turn the unit on and listen to it. If the outdoor fan or indoor blower makes a clattering noise, that could mean its bearings are worn out. If belts squeal, it may be an indication of little or no past maintenance.

Check the thermostat. Lower or raise the setting and see if the unit responds. Listen for peculiar noises when the unit starts or when it shuts off.

These are only superficial indicators of a unit's condition, analogous to driving a car "around the block" to see how it runs. If you want a more reliable evaluation, have a contractor conduct a thorough examination of the system. Although some firms may provide such assistance free of charge, others may require a nominal fee.

Another source of advice and assistance is the Customer Services Department of your local electric or gas utility. Most utilities have active programs designed to help their customers conserve energy. You can often find a knowledgeable, friendly person at your utility. Explain your needs and ask if they could provide an "energy audit" of the home.

DETERMINING ENERGY EFFICIENCY

Is the home you are considering for purchase an "energy glutton"?

Aside from the number of occupants and their living habits, there are two other things which will influence the energy consumption of a home:

1. The thermal integrity (or "tightness") of the structure;
2. The relative efficiency of the heating/cooling system.

Engineers refer to the outside walls, floor and roof of a structure as the "thermal envelope." Think of it in terms of how much heat and cold goes out or comes in through that envelope. The less change in temperature which the structure allows, the more energy efficient it is.

Depending on what part of the country you live in and the climate there, proper thermal insulation can make a big difference in energy consumption. (See map, page 2.)

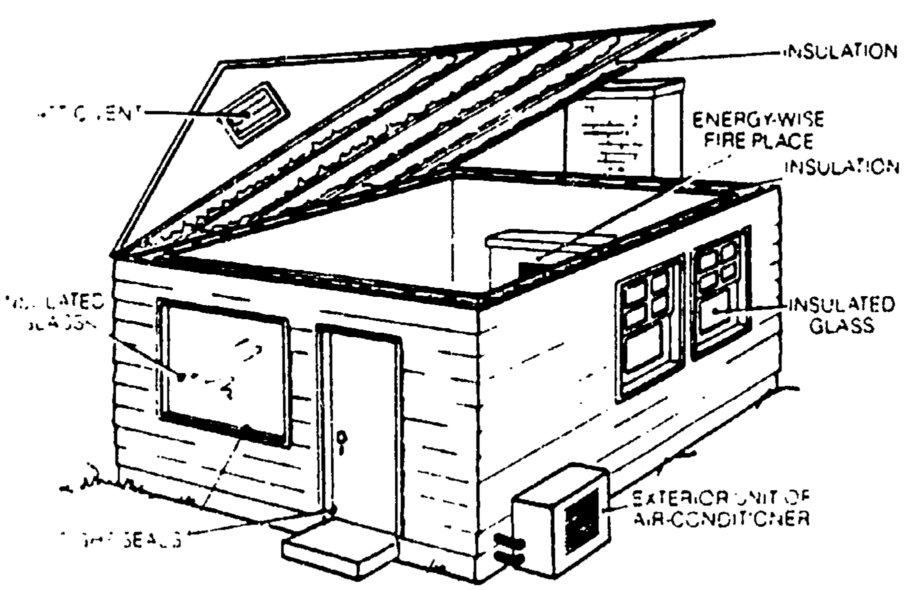
Storm doors and windows, weather stripping and other conservation measures will also determine the energy performance of the structure. The absence of such features, particularly in severe climates, can be a warning of higher than necessary utility bills.

Here, again, your local utility or air-conditioning contractor can help you evaluate the structure. A little time and effort before you commit to buying could save you big dollars in the years ahead.

The relative efficiency of the air-conditioning system can also be a significant cost factor. In recent years, the air-conditioning industry has made giant strides toward improving the energy efficiency of its products. Certain new, high-efficiency models will cool the same amount of space as an older unit while consuming much less energy.

Depending on electrical rates in your area, it could be a very cost-effective move to replace that old, low-efficiency model with a new one. (See formula on page 5 for calculating cost-effectiveness of various units.)

In any air-conditioning equipment, old or new, make sure it has the ARI Certification Seal on the equipment or the literature accompanying it. This means that the manufacturer has certified that the unit's actual output matches its claimed performance.



Check List for Assessing Suitability of an Existing Central Air-Conditioning System

Existing and New Homes

- ☐ Determine whether system is correctly sized.
- ☐ If you doubt the condition of the system, get a contractor or utility representative to help you.
- ☐ Determine the energy efficiency of the structure, i.e., insulation, weather stripping, double-glazing, etc.
- ☐ Determine the relative efficiency of the heating/cooling system with help, if necessary, from a contractor or utility representative.
- ☐ Look for the ARI Certification Seal.

UNIT 34.0

AIR CONDITIONING, REFRIGERATION, AND HEATING

SHOP PROJECTS AND LIVE JOBS

An intergral part of the secondary air conditioning, refrigeration, and heating program is the use of shop projects and live jobs in the shop and field to promote skill development and to provide on-the job learning experiences in controlled setting.

Typically, air conditioning, refrigeration, and heating shop projects and "live work" will be used to accomplish a "group" of objectives rather than being used on an objective-by-objective method. Air conditioning, refrigeration, and heating projects may utilize a combination of tasks from several different units such as measuring, basic electricity, refrigerant, principles, etc.

Learning projects may be designed by the instructor for skill development or for the demonstration of competencies in performance processes in the installation, service or repair of heating and cooling systems.

UNIT 34.0

HVAC SHOP PROJECTS AND REAL JOBS

NARRATIVE

RATIONAL

Air conditioning, refrigeration, and heating (HVAC) projects or real actual jobs provide an opportunity where the secondary student can apply theoritical training and can practice and develop skills in simulated or real job situations.

Shop projects and real jobs should be coordinated as closely as possible with theritical training so that the student logically moves from the study of the fundamentals to practical exercises and finally to real jobs or competency testing in simulated or actual job situations.

Emphasis in air conditioning, refrigeration and heating shop projects will be on operations that are related directly to the development of knowledges and skills that are being learned at that time of instruction. With the instructor's approval, the students may bring in or accept real jobs where instruction has been given and competencies have been mastered. Occasionally, the HVAC program may need to take advantage of "installation, service, or repair" opportunities that may not be repeated at a later date: Under supervision of the instructior, basic instruction and live work may be conducted together in a practical job situation.

Generally, the production of the secondary-level HVAC student in applied training (practical work) will be low and slow compared to industry because the primary purpose of the student is learning. Emphasis in HVAC lab is placed on developing the correct skills for installation, maintenance, and repair of systems and equipment: A job not done "right" may have to be done over by the student.

Air conditioning, refrigeration, and heating shop training projects or actual jobs provide a unique opportunity for the student to encounter, in a controlled setting, day-to-day installation, maintenance, and repair operations that can not be simulated. "Hands on" work in the HVAC lab provides learning experiences that otherwise might only be acquired through trial-and-error on the job.

Worthwhile projects and actual jobs in air conditioning, refrigeration, and heating require more instructor planning. Careful scheduling is necessary to ensure that the student is competent to accomplish the job within the given time and resources. In addition, actual installation, maintenance or repair jobs must be scheduled in the proper instructional dwquence so that the student can complete the assigned projects so competency development will proceed property (i.e., the instructor should not have to complete unfinished projects due to poor planning or over committments.)

Practical learning opportunities involving actual jobs or shop projects may be designed for the special need student, for the career interests of the student, or to meet the needs of potential employers at a particular time. A secondary student already empolyed in the air conditioning, refrigeration, or heating or a related HVAC field may be able to gain specialized competencies through "additional experiences" provided by well-planned shop porjects and real jobs.

Air conditioning, refrigeration, or heating projects and actual jobs provide the instructor with an optimum situation in which to test student knowledges and skills in realistic, "hands-on" examinations. In some situations, the live job may be utilized by the instructor as a method of conducting a final examination (competency test) of a unit or units of instruction.

A side benefit that often accompanies shop projects and actual jobs is when the student tends to develop good work habits and attitudes in addition to increasing technical knowledges and skills in HVAC installation, maintenance or service, and repair.

Today, secondary-level vocational programs such as Air Conditioning, Refrigeration, and Heating (HVAC) are being taught in a more realistic manner and setting. Where student interest is high, basic HVAC instruction may be followed-up by applied live projects in the lab or, when practical, in the field.

A simulated or live project may involve only air conditioning, refrigeration, and heating students or may allow HVAC students work jointly with students from other vocational areas such as electricity, sheet metal fabrication, plumbing, welding, and carpentry. Some projects might even involve students in secretarial science or accounting to simulate ordering and accounting of HVAC materials.

Real HVAC projects or jobs shouldbe selected carefully so that there will be no direct competition with local businesses. The improvement of low-income family dwellings and the improvement of the community should be given high priority in the selection of real HVAC jobs. Jobs should be selected for the learning value to the students.

Well planned, field HVAC projects can provide exceptional opprotunities. HVAC instructors from two career centers might combine their students at one field training site. In addition to increasing student manpower, joint training might provide students with a situation where they could benefit from the diversified trade experience of two instructors instead of one instructor.

Typically, field or shop HVAC projects for private individuals should involve a small fee to cover the cost of materials and expendibles and to provde the vocational program with a small fund to help support optimum training. A small fee will help ensure that instructional funds are not diverted from their primary purpose.

Field jobs for private individuals should be certified by the instructor, etc., to ensure that the job is done correctly, meets NEC or other applicable codes, and results in no fire or electrical hazard. Proper steps should be followed to ensure that the instructor of school is not placed in a situation where they become liable as a result of a training project.

Shop project such as the repair of controls, motors, etc., of window air conditioner, heating, etc., units should be organized to fit within the curriculum plan. When undertaking shop or field projects, a detailed plan outlining objectives, actions necessary to obtain objectives, standards of performance and production, the criteria for evaluation should be developed and followed. (see accompanying form.)

SHOP PROJECTS: ______________________________

RELATED CURRICULUM TOPIC: ______________ ______________

TASK NOS: ________, ________, ________, ________, ________

PERFORMANCE OBJECTIVE:

(What is student given? What behavior is expected of student? What standard of performance is expected?)

DESCRIBE MAJOR STEPS OF TASK (JOB):	STEPS COMPLETED WHEN BELOW STANDARDS DEMONSTRATED
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

STANDARDS (CRITERIA) OF PERFORMANCE THAT INDICATES THAT STUDENTS HAS COMPLETED TASK:

PLANNED INSTRUCTIONAL TIME: ________ Hours

Estimated travel to/from: ________ Hours On Job: ________ Hours;

DATE TASK STARTED: ______________ DATE TASK FINISHED: ______________

RELATED KNOWLEDGE TRAINING	RELATED SKILL TRAINING

NOTES COMMENTS:

BEST COPY AVAILABLE

INSTRUCTOR: ATTACH PLANS, INSTRUCTIONS, TESTS, ETC.

UNIT 34.0 HVAC SHOP PROJECTS AND REAL JOBS

NARRATIVE SUGGESTIONS

1. Air conditioning, refrigeration, and heating (HVAC) projects should begin with a clear, concise written objective or/and set of specifications.

2. Real shop jobs for outside of school (public)use that expend materials should not begin until there is a specific description of the HVAC installation, maintenance, service, or repair desired.

3. Real shop jobs for outside of school use that expend materials should not begin until a deposit has been obtained to cover the cost of materials. The educational program/institution should not be expected to pay installation, service, or repair expenses from the instructional budget.

4. HVAC projects and real jobs undertaken should be compatible with curriculum objectives. Students should not undertake work until they have been introduced to the appropriate theory, techniques, and procedures required for the job.

5. Each HVAC project should have appropriate checkpoints established and work should not progress beyond checkpoints until the job has been inspected by the instructor.

6. Equipment, materials, and parts provided by outside individuals should be appropriately protected.

7. Students should be able to verbally describe the objectives and training purposes of the specific HVAC job they are to perform.

8. A record or log should be kept of all materials and parts used in a real HVAC job (generally omitted in training projects.)

9. Students should record their time involved in HVAC real jobs and indicate their name on the service/repaired equipment/system or job ticket.

10. Students should not begin a HVAC installation, service, or repair without authorization from the instructor.

11. Work should not begin or continue if a safe situation does not exist.

12. HVAC test instruments and special equipment should not be used unless the student has been checked out in the proper use and operation of the instruments and equipment has the instructor's authorization to use the instruments or equipment, and has need to use the instruments or requipment.

    ATTENDITON INSTRUCTOR: "INSERT COPY OF SHOP RULES AND PROCEDURES IN THIS GUIDE.

13. HVAC installations, service, and repairs accompl shed by the student should be checked by the student and approved by the instructor.

14. No "rush" HVAC jobs should be undertaken.

15. Prior to approving a HVAC installation, service, or repair for the public, the instructor should verify the accuracy of the HVAC job.

    Consideration might be given to obtaining a limited release of responsibility from the public customer, if applicable (i.e., job accomplished as part of student training.)

NARRATIVE

TOOL ROOM WORKER (OPTIONAL)

Practical activities in the secondary air conditioning, refrigeration, and heating (HVAC) program may include related training and experiences in the shop (lab) tool room. Purposes that may be served by assigning the student to tool room duty on a rotating basis include the following:

1. Assigning the student to periodic duty in the tool room, on a rotating basis, provides a means of controlling expensive public property, essential to HVAC.

2. Through tool room duty, the student should learn responsibility, an important trait to successfully holding a job.

3. Tool room duty can contribute directly to a reduction in damaged or missing tools and equipment. Misuse of tools, test instruments, and equipment can be identify and a student can be held responsible for the loss of tools, instruments, or equipment.

4. Through maintaining a log of all tools and equipment signed out and returned, there will be a <u>current inventory</u> of the tool or equipment room. Tools and equipment in use or borrowed can be identified as to location and user.

5. The activities of the tool room duty student should include identifying tools, test instruments, equipment, and supplies by their proper names; proper storage of tools, test instruments, equipment, and supplies; and inspection, cleaning, and care of tools, instruments, and equipment. This task should include a regular inventory of tool boxes or pouches to identify missing or unservicable components.

6. In addition, the tool room duty student may be assigned the task of assisting the instructor in observing the shop (lab) area for possible safety infractions and fire hazards. In this task, the student can help the instructor.

   As a safety observer, the tool room duty student should take action to prevent obstructed aisles and cluttered storage areas that might cause injury to others.

The tool room duty student should review posted first aid directions and be prepared to alert the instructor concerning accidents and to assist fellow students who receive injuries.

The tool room duty student should aid fellow students in following prescribed safety practices of the shop. For example, the student might remind others concerning the use of safety eye goggles, the use of "WARNING" markers/tags to indicate power should not be turned on while a system is being installed, serviced, or repaired.

The tool room duty student should assist in recovering oily rags and waste materials in proper containers and seeing that flammable solvent, oil, and chemicals are properly stored.

The tool room duty student should observe the shop for potential electrical hazards such as exposed wires, switch boxes or breakers that are not marked with warning tags and that might be thrown by accident while students are working on potentially dangerous circuits.

The tool room duty student should be prepared to notify the instructor of questionalbe situations, locate and use fire extinguishers, and assist students with first aid in minor injuries.

7. The knowledges and skills of the student assigned to tool room duty might be expanded through individualized study assignments or worksheets selected to prepare the student for a career opportunities in counter or warehouse work in the HVAC supply field.

SECOND YEAR
SUMMARY OF INSTRUCTIONAL
PLANNING TIMES

Air Conditioning Calculations	105 hours
Psychrometrics	***
Residential Heat Loss and Heat Gain	***
Duct Design and Sizing	***
Air Treatment (humidifiers)........................	***
Residential Air Conditioning Servicing	45 hours
Commercial Refrigeration	165 hours
Commercial/Industrial Air Conditioners	135 hours
Heating Systems and Servicing	45 hours
Electric Heating	**
Heat Pumps	**
Gas Heating	**
Oil Heating	**
Hydronics	**
Solar (Introduction)	**
Automotive Air Conditioning Maintenance	30 hours
Planning and Estimating	9 hours
Customer Relations	6 hours
Total Hours (2nd Year) =	540 hours

***-See above designated ho rs of instruction.
**-See above designated hours of instruction.

PROFICIENCY REPORT

PROFICIENCY EVALUATION AID

This description aid is designed to possibly assist the air conditioning, refrigeration, heating instructor in standardizing the proficiency evaluation of students.

PROFICIENCY	LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Description	No skill development or proficiency training not given in the skill.	Individual's skill level is not that expected for entry level employee.	Individual's skill level probably is that expected for entry-level employment, but the individual probably will need close on-the-job supervision for a while longer	Individual's skill level is that generally expected for entry-level employment.	Individual's skill level is equal to that of a worker with some on-the-job experience.
			PLANNING AND PROCEDURES		
Procedure	No skill demonstrated or proficiency training not given.	Did not work according to procedure.	Some steps wrong or missing.	Few minor changes in procedures needed.	Correct procedure followed; no changes needed.
Drawing Schematics and Diagrams	" " " "	Incorrectly drawn, wrong symbols, etc.	Able to use with some changes.	Minor changes needed.	Able to use; no change needed.
Design Systems	" " " "	Could not calculate HVAC problems or use psychrometric chart; unable to satisfactorily layout system.	Performed HVAC calculations and read psychrometric chart with difficulty; Needed assistance to complete system layout.	Calculate and apply HVAC rules with minor difficulty; few minor changes needed in system layout.	Correctly apply rules of HVAC; calculate HVAC problems accurately; use psychrometric chart; plan and layout HVAC system with no errors.
			TROUBLESHOOTING AND PROBLEM-SOLVING ABILITY		
Problem-Solving Ability	" " " "	Solved no problems.	Solved only easy problems.	Solved nearly all problems.	Solved all problems.
Troubleshooting and Servicing	" " " "	Could not diagnose trouble; did not follow trouble-shooting procedure.	Needed help in diagnosing problem; followed procedure with difficulty.	Diagnosed trouble with minor difficulty	Diagnosed trouble; followed troubleshooting procedures.

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Applied Safety Practices	"" ""	Frequent violations of safe work habits, school/co. safety practices, etc.	Had to be reminded of safety rules and practices sometimes.	Interpreted, followed most safe work habits, school safety rules. Minor violations.	Interpreted, followed and applied safe work habits, company/school safety rules, etc.
		WORK SKILLS			
Installation or Service Appearance	"" ""	Assembled poorly; not cleaned up.	Not very neatly assembled; soil, debris, etc., left.	A few final touches needed. Not completely cleaned or finished.	Clean, neat, and commercial in appearance.
Method of Service	"" ""	Used own method; "cut and try".	Made poor use of methods shown.	Followed correct methods most of the time.	Use the demonstrated method; recommended or correct procedure.
Use & Care of Tools and Test Equipment	"" ""	Careless with tools	Used tools correctly most of the time.	Correctly used tools at all times.	Correctly used and cared for tools at all times.
Materials Use	"" ""	Wasteful and careless with materials.	Wasteful with materials at times.	Usually careful of materials.	Conserves materials at all times.
Work Accuracy	"" ""	Failed to meet specifications.	Work is approximately correct.	A few measurement are off.	Meets all specifications.
Working Time	"" ""	Little or no effort made to use time wisely.	Time used fairly well.	Wasted small amount of time.	Used time to best advantage.

COMPETENCY CHECKLIST
AIR CONDITIONING, REFRIGERATION, & HEATING

STUDENT: ______________________
Entered: 19___ Completed: 19___
Career Center: ______________________
Instructor: ______________________
Student's High School: ______________________

DIRECTIONS: Check each applicable item to indicate the student's competency level. Items left blank will be considered training not given or not completed. Check to indicate (1) orientation training-competency not developed (2) student needs additional training or experience to be competent, or (3) student has demonstrated acceptable competency for employment.

CHECK AS APPLICABLE	Orientation or No competency training given	Needs additional training OR experience for competency	Competency Demonstrated
INTERPRETED AND APPLIED SAFETY PROCEDURES			
Followed school/shop safety procedures			
Interpreted & follows fire safety procedures			
Orientation to first aid & fire extinguisher use			
Properly handled & stored checmicals (refrigerants)			
Used electrical "DISCONNECT" procedures			
Wears safety apparel and accessories			
Used safe lifting techniques			
COMMUNICATED AND DEMONSTRATED PERSONAL COMPETENCY			
Arrived to class/job on time			
Projected self-through dress, grooming, posture, hygiene			
Displayed self-confidence in handling typical job			
Listened & followed directions			
Respected other student's work			
Demonstrated patience on the job			
Managed work time efficiently			
Worked satisfactorily with fellow students/employees			
Developed positive student-teacher relations			
Gave vocational training full value			
Projected professional serviceman image			
READ AND INTERPRETED CHARTS, DRAWINGS, AND SCHEMATICS			
Electrical symbols			
Electrical ladder diagrams			
Electrical schematics			
Interpreted electrical loads			
Interpreted electrical values			
Hand sketched electrical schematics correctly			
Mechanical symbols			
Pnuematic diagrams			
Interpreted piping tables			
Interpreted refrigeration tables			
Identified types of refrigerants typically encountered			
Interpreted manufacturer's specifications			
INTERPRETED AND APPLIED APPLICABLE CODES			
Electrical			
Mechanical, plumbing, gas piping, duct and ventilating			
Building			

CORRECTLY OPERATED AND MAINTAINED TOOLS AND TEST EQUIPMENT			
Ohmmeter			
Voltmeter			
Clamp-on ampmeter			
Multimeter			
Capacitor check			
Watt meter			
Phase identifier			
Module analyzers			
Leak detectors			
Compound gauges			
Micron analyzer			
Temperature gauges			
Manometers			
Velometers			
Dry and wet bulb meters			
Digital R/H meters			
Meggers			
Vacuum pump			
Electrical hand tools			
Mechanical hand tools			
Special refrigeration, AC, & heating tools			
Duct work hand tools			

SOLDERED AND WELDED CORRECTLY			
Correctly used oxyacetylene equipment			
Correctly used air-propane torch outfit			
Correctly used air-acetylene torch outfit			
Soft soldered swage joints correctly			
Silver brazed joints and copper tubing			
Soldered aluminum tubing			
Brazed hole in aluminum tubing			
Welded with oxyacetylene outfit			
Cut with oxyacetylene outfit			
Used electric welder			

PERFORMED GENERAL MAINTENANCE TASKS			
Followed standard inspection form			
Checked belts			
Lubricated as specified			
Inspected system structure for needed repairs			
Disassembled & repaired pumps			
Maintained control air compressor & refrigeration air dryer			
Checked for & repaired Freon leaks			
Evacuated & charged a system			
Calibrated controls			
Checked electrical & pnuematic controls for proper operation			
Amp motors			
Cleaned & repaired supply & return fans			
Maintained & kept equipment clean			

PERFORMED PREVENTATIVE MAINTENANCE FUNCTIONS			
Applied basic wood working techniques			
Applied basic sheet metal technicques			
Refinished & painted			

INSTALLED AND SERVICED "CONTROL SYSTEMS" (ABLE TO TROUBLESHOOT)			
Thermostats			
Contractors & relays			
High/low pressure switches			
Oil pressure switches			
Pnuematic metering devices			
Electrical metering devices			
Thermal metering devices			
Pressure metering devices			
Safety controls			
Defrost control			
Hot gas bypass system			
Outdoor thermostats			
Time delays			
Humidistats			
Aquastats			
Gas controls			
Oil controls			
Electric heat controls			
Solar system controls			
Flow controls			
Dampers			
Stack dampers			
Solid-state devices (diodes, triax, SCR,etc)			
Microprocessor-based programmable controls			

INSTALLED EQUIPMRNT (OR SERVICED INSTALLED EQUIPMENT)			
Air handling unit			
Condensing unit			
Piping			
Evaporating unit			
Water to air heat pump			
Air to air heat pump			
Electric motors			
Coolers and freezers			
Humidifying & dehumidifying system			
Heat recovery system			
Solar system			
Gas heating system			
Electric heating system			
Oil heating system			
Chilled water system			
Absorption system			
Cascade system			
Ventilating system			
Cooling tower			
Evaporative cooler			
Boiler			
Electronic air filter			
Pumps			
Ice machine			
Restaurant equipment			
Water fountains			

PERFORMED PREVENTATIVE MAINTENANCE TASKS			
Performed annual inspection of air distribution system			
Cleaned & inspected grilles & ducts			
Cleaned, inspected, & repaired vanes & splitters			
Inspected & repaired duct hangers			
Balanced air flow			
PERFORMED INSPECTION AND MAINTENANCE OF ATOMIZERS			
Disassembled, cleaned,& rebuilt atomizers			
Checked & set float levels of water box			
Disassembled & cleaned air filters & water filters			
Checked atomizer			
Cleaned atomizer tips as needed			
Checked & repaired free blow valve			
Drained air lines			
Maintained atomizer air compressor			

PERFORMED SCHEDULED INSPECTION AND MAINTENANCE OF AIR WASHERS AND SUMPS			
Cleaned eliminator & eliminator wheels			
Inspected & cleaned spray nozzles			
Cleaned & painted washers			
Checked & repaired dampers			
Cleaned reheat coils & air filters			

PERFORMED SCHEDULED INSPECTION AND MAINTENANCE OF COOLING TOWERS			
Inspected spray heads or distribution nozzles			
Checked for & repaired vibrations			
Performed lubrication			
Checked float & suction screens			
Checked & repaired tower stucture & ponds			
Drained & cleaned towers & ponds			

PERFORMED ANNUAL INTERNAL INSPECTION OF REFRIGERATION MACHINES AS SCHEDULED			
Disassembled & inspected couplings			
Changed & cleaned oil pump & sump			
Inspected tolerance on bearings			
Inspected Freon & oil filters			
Meg motors			
Inspected, cleaned, & changed oil in gear box			
Checked alignment of couplings			

PERFORMED ANNUAL EXTERNAL INSPECTION OF REFRIGERATION MACHINES AS SCHEDULED			
Removed Freon & replaced filter			
Repaired purge pump			
Pulled & inspected oil pump, cleaned sump, & changed oil			
Inspected starter contacts & dash-pot			
Checked timers for accuracy			
Performed semi-annual oil analysis			
Read & interpreted oil analysis report			
Cleaned chiller & condenser tubes			
Inspected & cleaned lighting arrestors			
Replace ruptured discs as needed			
Performed Eddy-current tests			
Repaired insulation			
Meg motors			

DESIGN SYSTEMS CORRECTLY			
Calculated air flow			
Calculated power load			
Calculated pressure drop			
Calculated & applied fan laws			
Calculated heat load			
Interpreted & applied psychrometric chart			
Calculated duct size			
Calculated air changes			
Sized pipe			
Selected equipment size			
Designed control systems			
Calculated & determined structural load bearing			
Planned & laid out physical location of system			
Designed system to meet applications			
Designed refrigeration system			
Redesigned existing system			
Designed humidifying & dehumidifying system			
Designed electronic air filter system			
Designed evaporative cooler			
Designed ventilating system			
MAINTAINED WATER TREATMENT			
Applied safety regulations			
Ran water tests			
Added chemicals			
Bled off solids			
Maintained & filed report			
INTERPRETED AND APPLIED BUSINESS PRACTICES			
Took inventory			
Planned & organized personal work assignments			
Followed safety procedures			
PERFORMED COMMUNICATIONS FUNCTIONS			
Requisitioned supplies			
Maintained records			
Prepared reports			
Responded satisfactorily to complaints			

COMMENTS:

INSTRUCTOR: ____________________ DATE: ____________

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