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ABSTRACT

This manual was developed to serve as an aid to administrators and instructors involved with postsecondary air conditioning, heating, and refrigeration programs. The first of six chapters contains general information on program implementation, the curriculum design, facilities and equipment requirements, and textbooks and references. Chapter 2 describes the project procedures utilized in developing the curriculum. Suggested job descriptions and job competencies for air conditioning, heating, and refrigeration are given in the third chapter. Chapter 4 is comprised of the actual curriculum including course outlines for two air conditioning, heating, and refrigeration mechanic courses. For all other courses, brief topical outlines are provided. A detailed listing of equipment necessary to start an air conditioning, heating, and refrigeration mechanic program for eighteen students is given in the fifth chapter. The final chapter, Resources, lists 279 books and 319 training aids. Appended sections include Air Conditioning, Heating, and Refrigeration Tasks: Response from Industry: Tasks by Job Levels: and Air Conditioning, Heating, and Refrigeration Competencies and Criterion Measures. (LRA)

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AIR CONDITIONING, HEATING, AND REFRIGERATION

Competency Based Curriculum Manual

January 1980

Coordinated by

Frank A. Gourley, Jr.

for

Energy Conservation Curriculum and Short Course Project #8208
Program Development Section, North Carolina Dept. of Community Colleges

Project Director
Roger G. Worthington

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CE 027 988

By authority of the State Board of Education, North Carolina Administrative Code, Section 4C.0800, the respective institutions and the state department in the North Carolina Community College System are equal opportunity and affirmative action employers.

FOREWORD

The Department of Community Colleges encourages institutions to continually review and update curriculums designed to prepare students for employment. The Air Conditioning, Heating, and Refrigeration Competency Based Curriculum Manual represents an effort coordinated by the Department and partially funded by the Energy Division of the NC Department of Commerce to update air conditioning, heating, and refrigeration curriculums and to identify energy conservation components of the curriculum using performance competencies as a basis for determining curriculum content and objectives. Most of the institutions offering air conditioning, heating, and refrigeration curriculums have had input into this curriculum manual. Also, many industries and employers across the state have contributed or responded to various parts of the manual during the project. We feel the Air Conditioning, Heating, and Refrigeration Curriculum Manual represents the current best thinking of the instructors and employers involved with this program.

The staff of the Program Development Section and the Air Conditioning, Heating, and Refrigeration Competency Curriculum Committee recommend the curriculum to you. These individuals are available to discuss specific concepts of the curriculum with you.

Larry J. Blake
State President
Department of Community Colleges

HOW TO USE THE AIR CONDITIONING, HEATING, AND REFRIGERATION COMPETENCY BASED CURRICULUM MANUAL

This manual was developed to serve as an aid to administrators and instructors involved with air conditioning, heating, and refrigeration programs in North Carolina. Below are some ways in which the manual may be used by the local institution.

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To articulate program with high school courses	307-346, 367-405
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To determine employer involvement in the development of the curriculum manual	7-11, 23, 277, 279-285, 287-288
To determine instructor involvement in the development of the curriculum manual	1-2, 7-11, 23, 275

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Many individuals contributed to the completion of this publication. Their assistance and cooperation is appreciated. The help of the air conditioning, heating, and refrigeration instructors who served on the curriculum committee was vital to the development of the materials included in this manual. Their creative effort, hard work, knowledge of the training needs of industry, and response to the project resulted in the development of updated concepts included in this manual. Instructors actively serving on the committee include:

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Frank Gourley, Department of Community Colleges, coordinated the work of the committee and compiled the results into this manual.

Thanks are due to those instructors not formally on the committee who reviewed and critiqued the materials at various stages during the development process. Their recommendations and encouragement were helpful in proceeding through the project.

Acknowledgement is extended to the employers who assisted in the career opportunity survey and task survey. Employers from all over the state participated in the validation phase of the project. Their response by letter and through attendance at meetings provided valuable input in determining the final outcomes of the curriculum.

Appreciation is expressed to high school climate control and air conditioning teachers who participated in committee meetings and to Ben Albright, Consultant, Department of Public Instruction for providing continual liaison with the project. Their cooperation in contributing to the effort to identify competencies being taught at different educational levels provides a basis for continued correlation among these programs.

Special thanks are expressed to Joe Steinbeck for his help in writing and compiling course materials for the manual.

Thanks are due to Beverly Cable for secretarial services in preparing the manual for publication, to Peggy Ball and Linda Horton for editorial services and to Bill Pugh for the cover.

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Chapter I

INTRODUCTION

Air conditioning, heating, and refrigeration curriculums have been offered by North Carolina technical institutes and community colleges since their establishment as industrial education centers in 1958. Both the diploma and degree curriculums have been offered to meet the growing need in the state for personnel trained in the air conditioning, heating, and refrigeration fields.

With new and more sophisticated equipment, changes in the emphasis of the industry, and emerging concerns for energy conservation, employers and instructors have expressed the need for a more up-to-date curriculum. Meetings were held to discuss the concerns of employers and instructors. The interest of employers and instructors at these meetings resulted in a curriculum committee being formed to determine educational needs for persons to be employed in the air conditioning, heating, and refrigeration fields in the state. At the time the Program Development Section was negotiating with the Energy Division of the NC Department of Commerce to develop short course and curriculum materials that could be used to teach energy conservation concepts in community colleges and technical institutes. Funds were made available by the Energy Division to help identify and develop energy conservation skills in this curriculum. A mode for curriculum development was based on the competency-based curriculum project already initiated by the Department of Community Colleges at the time.

Presentations were made to instructors and employers to explain the approach to curriculum development to be used in the project and to solicit their assistance. A competency committee of instructors and employers was formed to assist in the project. The committee compiled information to make a job need survey and a task survey of industry. The committee reviewed all responses from the two surveys to determine the job levels and tasks required. Using the results of these surveys the committee was able to review the existing state curriculum guide, recommend modifications to update the content, define performance levels within the curriculum, propose possible early skills development approachs, define performance criteria, and work with industry to outline job exit levels related to the types of skills developed in the educational program.

The committee's activities resulted in an updated curriculum that includes:

1. A model curriculum guide and course outline for the diploma air conditioning, heating, and refrigeration curriculum (V024)

2. Exit performance levels within the curriculum compatible with Dictionary of Occupational Titles (D.O.T.) job categories.

3. Suggested lab experiences and instructional resources for the instructor.

4. Tasks and competencies by job level and by quarter.

5. Structure of program content to provide employable skills at intermediate levels within the diploma and degree programs.

This manual provides information developed to support institutions wishing to implement the revised curriculum. Emphasis of the manual is on the software needed to implement the revisions. In addition to curriculum guides, course outlines and equipment lists, the manual includes job descriptions, job competencies, and performance objectives for the air conditioning, heating, and refrigeration curriculums. This information can be used in helping focus the instructional activities of the curriculum. It can also be used to determine both the advanced placement of students with prior experience or education in the air conditioning, heating, and refrigeration field and the employable skills of early leavers.

The air conditioning, heating and refrigeration curriculum materials have been reviewed and discussed in a statewide meeting of instructors with favorable concensus at the meeting. The concensus of these comments is included in the manual.

Program Implementation

This manual is available as an aid for institutions wishing to update their air conditioning, heating, and refrigeration program as well as for the institution initiating a curriculum in air conditioning, heating, and refrigeration. Items provided in the manual include suggested curriculums by quarter, course descriptions, task analyses, job competencies, course outlines with instructional objectives and suggested learning activities, industry and institutional survey information and equipment information.

The information provided in the manual lends itself to be used in a variety of ways. Some instructors on the curriculum committee began using parts of the material as it was being developed, with each finding a different way to apply it to a particular educational situation. It is recommended that institutions adopt the curriculum guide upon the recommendation of their local advisory committee. Instructional materials are provided to assist the instructor in teaching the program described by the curriculum guide.

The curriculum courses included in the manual supersede the earlier curriculum courses of the same number and title. No official action, other than receipt of a letter of intent by the Department of Community Colleges, is necessary at the state level for the institution to modify its existing curriculum to the new format. If the institution decides to offer curriculums for which it is not presently approved, a new curriculum application will be necessary.

Curriculum Design

The air conditioning, heating, and refrigeration curriculum model is designed as a program with emphasis on the development of specific skills related to employment in the field. Content has been arranged to provide for the development of increasing levels of skills as the student progresses in the program. General skills are taught in the first quarter to familiarize the student with basic principles and the operation of equipment used for heating and cooling. During the second quarter the student will study the basics of electricity and should become more proficient in skills related to refrigeration systems. The third quarter concentrates on air conditioning, automatic controls, and basic welding skills. The fourth quarter covers all year comfort systems, duct construction, and servicing skills that the student will need in working as a mechanic. Energy conservation topcis have been integrated within the curriculum throughout to provide the necessary awareness and skill to implement energy conservation practices into the employment situation.

Related courses have been included in the mechanic curriculum to support the knowledge and skills required by job level as indicated by employers. In addition to communication skills, courses in blueprint reading, math, metallurgy, welding, and applied science are included.

Levels of performance have been described with job titles, performance objectives, competency statements and evaluative criteria to help identify educational and job entry and exit points. Job descriptions have been provided. These statements can be used to describe the educational experiences recommended for students prior to completion of levels within the curriculum. It is recommended that these statements be reviewed and refined by the local advisory committee to assist the institution in meeting local manpower needs. Further assistance might be provided by the local advisory committee in reviewing tasks, competencies, and instructional and performance objectives to determine if all identified skills should be taught as described.

Instructional materials provided in the manual include course outlines, task lists (by job and educational level), task analyses, competencies, and evaluative criteria, texts and references. Course outlines include instructional objectives, content outline, activity experiences, performance objectives and suggested texts. Task lists are organized by content areas and are cross referenced by suggested job and educational levels. Task analyses include skill, knowledge, attitude motivators, competencies and evaluative criteria. Texts and references include standard textbooks, industrial materials, and curriculum materials from other sources.

Faculty

The effectiveness of any program depends largely upon the competence and enthusiasm of the instructional staff. The specialized nature of the air conditioning, heating, and refrigeration program and high degree of shop skills required necessitate that the instructor have an educational background in the field as well as experience as a service technician, contractor, owner, or designer. Other related vocational experience should also be considered. The number of faculty and qualifications for each faculty member should be sufficient to implement the curriculum design and accomplish the objective(s) of the program.

The teaching load of the air conditioning, heating, and refrigeration instructor should be consistent with the teaching load of other instructors in other curriculum areas in the institution. Factors to be considered in making load determination should include: (1) class contact hours, (2) number of preparations, (3) student loads, (4) committee assignments, (5) departmental responsibilities and (6) other special duties. A full time load is usually considered to be from 16 to 25 contact hours per week. The number of students could vary from 12 to 25 depending upon the equipment available with a recommended average class size of 18 full-time student. The instructor should also be responsible for maintaining liaison with industry through advisory committee meetings, personal contacts, and other suitable methods.

As indicated earlier, the successful operation of the air conditioning, heating, and refrigeration program or any program within an institution depends to a great extent on the selection, continuous development, and satisfactory retention of faculty members. The faculty should be able to carry out the objectives of the program and to plan, implement and evaluate learning experiences essential to the program. The faculty should also be able to counsel students, work with individuals and organizations within the community, and through continuing education and/or professional organizations be aware of the changes developing in the field.

Facilities

The community college or technical institute is responsible for providing adequate, safe, and attractive facilities which are appropriately located for instruction.

For the air conditioning, heating, and refrigeration program, at least one laboratory-classroom with equipment for demonstration and laboratory practice is needed. The laboratory should consist of a minimum of 100 square feet of space per student. The laboratory should be properly lighted, ventilated, heated, air-conditioned and fireproofed. Electrical capacities should be a minimum of 200 AMP (single phase and three phase with ground fault protection) from the main source, with proper distribution. Adequate facilities should be provided to safely handle and store refrigerant oils, nitrogen with safety regulators, and fuels used for instructional purposes. Additional laboratory space may be needed if simulation is used in the program. The room(s) should be available for student practice at times other than formal laboratory periods. Compressed air and water facilities are needed for instructional support. Storage facilities (10 sq. ft. per student should be provided for storage of equipment, materials, and supplies. Maple table tops and stools with backs are recommended. If metal table tops are used isolation transformers are recommended for safety reasons. Mechanical building equipment and noisy machines should be isolated from the instructional area.

The number and size of classrooms will depend upon student enrollment, whether or not the classrooms will be used for students in other programs, curriculum design, and methods and media utilized in instruction. Classrooms should be properly lighted, ventilated, heated, air-conditioned and acoustic-proof. Chalkboards and electrical outlets should be located for convenience in audiovisual communication. The classroom should also be equipped with blackout shades or their equivalent and light dimmer controls for convenience in using audiovisual equipment. Soft lighting should be provided to enable students to take notes during audiovisual presentations.

Equipment

The amount and kind of equipment needed for the air conditioning, heating, and refrigeration program will depend on the instructional process utilized by each instructor and could vary widely from one service area to another. Basic equipment information has been provided to suggest equipment for the institution initiating an air conditioning, heating, and refrigeration curriculum.

Textbooks and References

Textbooks and references for teaching any subject area must be reviewed constantly and updated or supplemented based on new knowledge in the field and the results of research in teaching methods and developing concepts.

The textbooks and references for the air conditioning, heating, and refrigeration curriculum have been carefully reviewed and selected by committee members. From the lists presented, it should be possible to select materials that are appropriate for each institution with the understanding that unlisted materials may also be appropriate. From these lists, the instructor should select materials that meet stated teaching objectives and should carefully preview and study materials before they are used.

Preparation of any course in the curriculum requires the instructor to become familiar with texts and references in the course outlines and with others that may be available. By using these techniques the instructor will then be able to select materials that best promote an interesting, high-level technical presentation to the student.

Library

Part of the strength of any program is indicated by the quality of its library. Characteristics of a quality library include qualifications of the librarian; the facilities; the quality, quantity and relevancy of content; and the staffing and organization. Library facilities should be readily accessible to both full-time and part-time students and faculty not only during instructional hours but for hours beyond regular instructional hours. The library should contain up-to-date books, periodicals and other reference materials related to the air conditioning, heating, and refrigeration curriculum.

Air conditioning, heating, and refrigeration instructors and students should be involved in selecting materials for the library and/or approving reference materials for air conditioning, heating, and refrigeration related courses.

Students should learn to use the library; therefore, instruction should involve the students in library work. This develops the habit of using the library as a learning tool and helps foster a professional attitude that regards libraries as a resource for information on new developments in air conditioning, heating, and refrigeration.

Professional Associations

Professional associations are an important source of instructional materials and provide other benefits for faculty members and students. Such associations provide information on publications, reports, new concepts, processes, techniques and equipment available in the air conditioning, heating and refrigeration field.

These associations can also provide support in investigating the need for a program, in promoting the program, in providing work experience for students and in placement of graduates.

The associations may also supply resource people to speak to classes, to host student groups on field trips or for individual student projects.

Instructors should be encouraged to work closely with the associations and to become active or ad hoc members if possible. Membership will enable them to learn quickly of developments in the industry and to become acquainted with persons in the community who are most active in the field.

Early in their studies, students should become aware of these associations and the resources they offer. They should also be encouraged to join those associations which offer affiliate memberships.

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Chapter II

COMPETENCY-BASED CURRICULUM DEVELOPMENT PROJECT

In July 1976, the Program Development Section of the Department of Community Colleges initiated a project to develop compentency-based curriculums on a statewide basis. This project was proposed to further the following purposes: (1) to describe the desired outcomes of occupational programs; (2) to provide guidance for increased consistency among programs, and (3) to provide mechanisms for improved articulation with high school occupational programs. In order to accomplish these purposes the project was designed to solicit the recommendations of instructors in community colleges and technical institutes, employers, and high school occupational teachers to determine the competencies required by employers for successful employment on the job. Information developed in the project was to be utilized to design curriculums with multi-entry, multi-exit levels based on job skill requirements. Materials to be developed for each curriculum included (1) a validated list of tasks performed by employees in a given job, (2) competencies which are required to perform successfully in the job, (3) curriculum guidelines, and (4) curriculum materials based on the guidelines to assist educational personnel in providing quality occupational education programs.

Air Conditioning, Heating, and Refrigeration Curriculum

The air conditioning, heating, and refrigeration curriculum was chosen as one of the curriculums to be included in the competency-based curriculum project since employers were already suggesting a review of the existing curriculum. The existence of a large number of air conditioning, heating, and refrigeration programs in two year institutions, the availability of funds from the Energy Division of the NC Department of Commerce to cover the costs of meetings, and a number of high school occupational programs in climate control also encouraged the selection of the curriculum to be included in the project. The procedure used in conducting the competency-based curriculum project for the air conditioning, heating, and refrigeration included (1) appointing curriculum committees (Appendix A and B), (2) initiating a resource search (Appendix C), (3) identifying and validating training needs of employers (Appendix G and H), (4) listing and validating tasks by job levels (Appendix I), (5) analyzing tasks (Appendix L), (6) writing competencies and evaluative criteria (Appendix K), (7) specifying tasks by educational level (Appendix J), (8) writing course outlines to include instructional objectives (Chapter IV), (9) developing course descriptions and curriculum guides (Chapter IV), and (10) providing information for instructors on supportive instructional materials (Chapter VI). The results of the project are compiled in this manual.

Organization of Curriculum Committees

Each phase of this project was designed to assure maximum involvement of instructors and employers. In order to assure involvement, the organization plan called for a competency committee and a curriculum advisory committee.

The competency committee was composed of instructors from the Community College System and members of the North Carolina Heating and Air Conditioning Contractors Association (NCHACCA). (Appendix A). The committee was a working committee and was responsible for preparing all materials including the career opportunity survey, task analyses, competencies, and curriculum materials.

The curriculum advisory committee was composed of employers, members of the competency committee, and teachers from high school air conditioning and climate controls programs. (Appendix B). This committee provided advice and counsel on specific questions concerning employment, competency levels, articulation with high school programs, survey data, task analyses, and curriculum.

Resource Search

A resource search was implemented to locate educational materials available that could be used to assist in this project. Curriculum laboratories in other states, ERIC, technical societies, and others were contacted for copies of materials available on air conditioning, heating, and refrigeration instruction. Many of these contacts proved fruitful in providing good instructional materials, but there was very little material available on competencies or tasks for the curriculum. This meant that a large portion of the curriculum materials in this manual had to be written by the committee.

Career Opportunity Survey

A career opportunity survey was conducted to determine air conditioning, heating, and refrigeration jobs available in North Carolina. Selected industries throughout the community college and technical institute service area were surveyed. Industry contact persons were identified with the help of the instructors and the North Carolina Heating and Air Conditioning Contractors Association (NCHACCA). Each instructor on the committee was asked to identify at least five employers in his service area that would participate in the project.

<u>Dictionary of Occupational Titles</u> (D.O.T.) titles for selected air conditioning, heating, and refrigeration oriented occupations were listed in the career opportunity survey. There were 50 job titles listed and space left to add more. Respondents were asked to indicate if they felt a need for these jobs to exist in North Carolina and were asked to add other titles in which they presently employed persons. (Refer to Appendix G, (... Opportunity Survey and Response).

There were 122 career opportunity forms mailed and 42 forms returned for a 34 percent response. The task survey validated the present need for air conditioning, heating, and refrigeration personnel in numerous job categories (Appendix H). The career opportunities identified were rearranged into major job categories according to the level of skills required. These categories, job titles, and job descriptions for a typical job in each job category are listed in Chapter III. With the continuing expansion and new developments in the air conditioning, heating, and refrigeration industry there is an ever increasing need for trained personnel in the field.

Task List

A list of tasks was compiled by the curriculum committee. This list was organized according to major topics required in the air conditioning, heating, and refrigeration field. Major job categories from the Career Opportunity Survey were cross-referenced with the tasks. The committee then identified which tasks were required for each job category This information was sent to one hundred and thirty employers. Thirty-one employers (25%) responded to the survey. (Appendix H, Air Conditioning, Heating, and Refrigeration Tasks by Job Levels: Response from Industry). Information provided by this survey was used to help structure the tasks by educational level later in the project.

Task Analyses

Tasks were analyzed to determine skills, knowledge, and attitudes necessary to perform each major task. Competencies and evaluative criteria were written to support each major task category. Employers serving on the curriculum advisory committee reviewed the task analyses, competencies and evaluative criteria and made revisions to reflect the needs of industry. This information was used later to help define the content, performance objectives, and instructional objectives of the course outlines. Each task analysis with competencies and evaluative criteria provides a concise reference on the skills, knowledge and performance criteria for major tasks (Appendix L, Task Analysis). This information can be used in a variety of ways in the instructional program including use as a teaching guide, evaluation guide, and an outline for designing modular instructional materials.

Specifying Tasks By Educational Level

Tasks were specified by educational level by using the survey data from the task validation phase of the project. The categories of installer's helper, installer, service technician's apprentice, service technician, and designer were analyzed. Initially, tasks were located in quarters according to progressive job levels. This information was then carefully reviewed by the committee and rearrangements were made as necessary to provide an educationally sound program. If advanced instruction or additional practice was needed on a particular task, this was indicated for the quarter in which it was recommended. The result was a detailed list of tasks recommended to be taught on a quarter-by-quarter basis to provide progressive levels of skills for students that would parallel specific job levels in the air conditioning, heating, and refrigeration fields (Appendix J, Suggested Air Conditioning, Heating, and Refrigeration Tasks by Quarters).

Course Materials

Courses for the curriculum were determined from the list of tasks by educational level. After tasks were arranged by quarter, course descriptions were written to define the content to be covered. Where existing course descriptions were satisfactory, these were used. To assist in the development of new course outlines, information was extracted from the task analyses and arranged according to the quarter in which it was to be taught. Instructional objectives, content, activity experiences, performance objectives, and suggested texts and references were included. The resulting outlines provide specifics on the objectives of the course, the content to be taught, materials available to teach each concept, and the desired performance of the learner.

Curriculum Guide

After determining the courses to be taught and the quarter in which they were to be scheduled, the curriculum guide was developed. The preliminary guide was revised by the committee then reviewed and discussed. All questions raised by the committee were resolved, either by explanation or through changes in the curriculum. Basic changes in the new curriculum include the arrangement of the content of courses; rearrangements of the curriculum, such as moving a course to a different quarter; development of new courses; and development of advanced curriculums that build on the diploma program to provide progressive levels of employable skills. These are important changes. They result in curriculum guides with educational levels that provide for multi-entry and multi-exit performance levels based on job skill requirements. The curriculums were developed with the recommendations of both instructors in the post-secondary and secondary programs and employers in the field. The diploma curriculum guide is in the format of earlier curriculum guides and can be readily implemented as a revised curriculum. The advanced curriculum guides are not included in the curriculum manual but are available on request from the Department of Community Colleges. The curriculum guides provide a description of the curriculum, general considerations, a suggested curriculum by quarters, and course descriptions.

Supportive Instructional Materials

Instructional materials were compiled to assist instructors teaching the air conditioning, heating, and refrigeration curriculums. In addition to the task list, task analyses, course outlines, and curriculum guide, there are lists of resource materials. These reference materials were located in the process of developing the manual and are included in the curriculum manual as an example of the variety of materials available to supplement the instructional program.

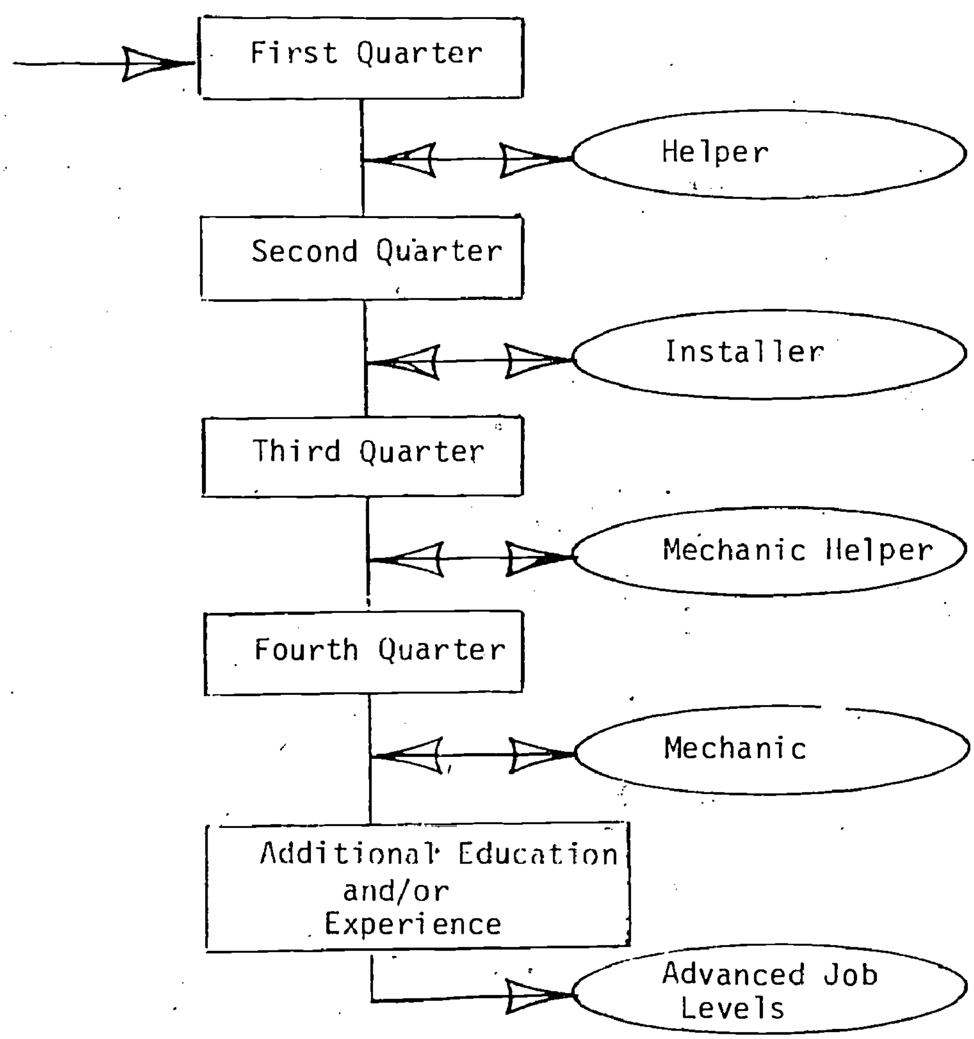
Chapter III

JOB DESCRIPTIONS/JOB COMPETENCIES

Suggested job descriptions and job competencies have been identified for the air conditioning, heating, and refrigeration fields. These general statements can be used to assist in describing the types of educational experiences recommended for students at levels intermediate to the completion of the curriculum. More specific job competency statements and job tasks are included elsewhere in the manual. It is recommended that these statements be reviewed by local advisory committees and used to assist the institution in meeting local manpower needs. The following chart suggest representative jobs that could be filled by individuals as they proceed through the curriculum

Sample Job Opportunities

By Educational Level



Career opportunities for air conditioning, heating, and refrigeration were identified by instructors. Job titles were validated by a survey of industry, grouped by job level, and compared with Dictionary of Occupational Titles (D.O.T.) job titles. A list of job titles by job level and D.O.T. number for progressive levels within the field is given below.

Job descriptions and job competencies have been written for representative titles. For D.O.T. job descriptions of all the job titles listed below refer to Appendix F. It is recommended that these statements be reviewed by local advisory committees and used to assist the institution in identifying local manpower needs.

Air Conditioning, Heating, and Refrigeration
Career Opportunities
(Validated by Survey)

Job Level	D.O.T. Number	Job Title
Entry		Installer Helper
	637.687-010	Air-Conditioning Installer-Servicer Helper, Window Unit
	869.687-030	Furnace Repairer Helper
	862.687-022	Oil-Burner-Servicer-and-Installer Helper
		Installer
	827.384-010	Refrigerator Tester
	862.361-010	Furnace Installer
	637.381-014	Refrigeration Unit Repairer
	637.261-026	Refrigeration-System Installer
	827.464-010	Air-Conditioning Installer, Domestic
	827.464-010	Central Air-Conditioning Installer
	869.664-014	Duct Installer
		Mechanic Helper
	637.664-010	Environmental-Control-System Installer-Servicer Helper
	637.664-010	Air-Conditioning-Mechanic Helper, Industrial
	637.664-010	Heating-and-Air-Conditioning Mechanic Helper
	637.687-014	Refrigeration Mechanic Helper
	637.261-010	Air-Conditioning Installer-Servicer, Window Unit
	862.281-018	Oil-Burner-Servicer-and Installer
	862.381-026	Air Conditioning Mechanic Apprentice
	862.381-026	Refrigeration Mechanic Apprentice

Job Level	D.O.T. Number	Job Title
		Mechanic
	637.261-014	Air-Conditioning Mechanic
	637.261-014	Heating-and-Air-Conditioning Mechanic
	637.261-014	Heating Mechanic
	637.261-014	Environmental-Control-System Installer-Servicer
	637.261-026	Refrigeration Mechanic
Advanced with additional education and/or experience	007.181-010	Heating Technician
	007.181-010	Air Conditioning Technician
	007.181-010	Refrigerating Technician
	007.181-010	Heat Transfer Technician
	Master Title	Supervisor
	Master Title	Sales Engineer
	182.167.010	Contractor
	007.161-026	Engineering Technician
	Master Title	Technician
	Master Title	Sales Representative
	638.281-014	Maintenance Mechanic
	827.361-010	Air-Conditioning-Unit-Tester
	160.267-018	Estimator
	Master Title	Salesperson
	827.261-010	Electrical Appliance Servicer

Installer Helper

Job Description

The installer helper assists the installer by performing a variety of duties, such as transporting and uncrating equipment, identifying parts and materials, reading orders and parts lists, following instructions, observing safe working practices, installing equipment, keeping the workspace clean and orderly and performing other routine duties.

Job Competencies

Assists in installing oil heating equipment
Assists in installing gas heating equipment
Assists in installing electric heating equipment
Assists in installing air conditioning equipment
Assists in installing heat pumps
Assists in installing refrigeration systems
Assists in installing air handlers
Assists in installing ductwork, diffusers, and grills
Assists in installing humidifiers and dehumidifiers
Assists in installing duct insulation
Uses hand tools and materials common to the trade
Reads blueprints and sketches
Performs work according to safety rules and regulations
Performs measurements
Reads work orders, manuals, workbooks, and trade journals
Writes lists, and fills out purchase orders and other forms
Communicates with the installer and customer
Listens to instructions

Installer

Job Description

The installer installs heating and cooling equipment, air handlers, filters, humidifiers, dehumidifiers, ductwork and refrigeration units in private residences and small business establishments, as dictated by individual employer needs. The installer connects necessary drains, piping, wiring, and fixtures to complete the job; directs helper to prepare system for installation; and works with all materials and tools of the trade. The installer may start unit, adjust controls, and listen for indications of malfunction.

Job Competencies

Directs/supervises helper as needed on installation job
Selects and assembles oil heating system components, wires, hangs ducts, erects and hooks up oil tank, and hooks furnace to chimney
Selects and assembles gas heating system components, wires, hangs ducts, connects gas piping, and connects vent flue
Sets in heat pump equipment, erects ducts, installs thermostat, hooks up line voltage source, and runs drains
Installs refrigeration system components, tubing, drain lines, fans, controls, accessories, and defrost systems, and wires components
Installs air handler, pulls line and low voltage wires and hooks up, installs ducts and drains as required, checks fans speed, and alines belts
Hangs ductwork, installs dampers and registers, replaces or repairs duct as needed
Erects exhaust and makeup air system as needed
Installs various types of humidifiers and dehumidifiers, wires and hooks up water lines and drains
Installs air cleaners and filters as needed
Reads wiring diagrams to carry out installation
Installs controls as required by the job
Interprets blueprints for cost estimations
Explains features of installation to customer and answers questions
Sketches installation changes, if required, on drawing for future reference
Reads blueprints to install system
Computes charges, material costs and quantity, and measurements required in installation
Applies basic electrical concepts to installation
Reads written instructions, manufacturers information, and repair and installation manuals
Makes out bills and completes requisitions and purchase orders
Explains job problems to co-workers and supervisor
Follows oral instructions of supervisor to execute job as directed
Recognizes on-the-job problems on sight and corrects or relates to supervisor

Mechanic Helper

Job Description

The mechanic helper assists the mechanic in installing, repairing and servicing residential and commercial environmental-control systems such as heating and cooling equipment, air handlers, filters, humidifiers, dehumidifiers, ductwork and refrigeration units. The helper installs tanks, piping, smoke pipe and ducts. The helper also reads thermometers and gauges, charges refrigerant system, lubricates parts, uses handtools, installs filters, assembles components, sets equipment, and performs other routine duties under the direction of the mechanic.

Job Competencies

Assembles oil furnace, installs oil heating system, and sets up tanks as directed by mechanic
Installs gas heating system under supervision
Installs electric heating units under supervision
Installs residential air conditioning system under supervision
Uses general tools of the trade
Assists mechanic in replacing compressors and evacuating and recharging compressors
Assists the mechanic in installing, repairing, and servicing heat pumps
Assists in replacing compressor, charging system, repairing leaks and similar refrigeration servicing tasks
Assists in servicing air handlers
Checks temperature, wet bulb, dry bulb, and dew point as instructed and supervised by the mechanic
Assists mechanic in installing and servicing refrigerant capillary tube, TEV, or AEV
Assists the mechanic in assuring that mechanical components of heating systems are energy efficient
Installs electrical meters and takes reading

Mechanic

Job Description

The mechanic installs, services, and repairs environmental-control systems in residences and commercial establishments using heating, cooling, and refrigeration theory and skills; follows blueprints or engineering specifications; reads gauges and instruments; adjusts mechanisms; dismantles malfunctioning components; tests components; replaces defective parts; and operates system to observe performance. The mechanic fabricates and installs ductwork, joins tubing or pipes to units, installs relief valves, connects electrical components to control panels, completes and checks out system installation, and starts up system to insure proper operation. The mechanic also directs the helper in installing, servicing and repairing systems.

Job Competencies

Supervises and assists with the installation of oil heating systems
Supervises and assists with the installation of gas heating systems
Supervises and assists with the installation of electric heating systems
Supervises and assists with the installation of air conditioning systems
Sizes, lays out, and supervises installation of residential duct system
Identifies and installs control systems
Services refrigeration systems
Services air handler system
Balances duct system and adjusts controls
Sizes, selects, and services humidifier
Sizes, selects, and services dehumidifier
Supervises installation of various filters
Uses schematic diagrams in troubleshooting control problems
Uses test equipment in checking controls
Determines component coordination and operational sequence
Services and adjusts systems to maintain peak operating efficiency
Maintains records and analyzes charts to determine system efficiencies
Explains energy conservation features of systems to customers
Adjusts and balances a hydronic system
Corrects problems in electric heat system
Makes sketches, reads blueprints, and interprets specifications from drawings
Applies basic math to job related problems
Determines efficiencies of systems based on input and output
Troubleshoots electrical circuits and components for proper system operation

General Competencies By Educational Level

Below are listed some general competencies that the student should have acquired upon completing the successive levels of the air conditioning, heating, and refrigeration mechanic curriculum as outlined by the curriculum guide. The student should be able to do the tasks below after the time indicated.

FIRST QUARTER

Recognize and define the general terms used in the air conditioning and refrigeration industry.
Understand basic operation of cooling equipment using a refrigeration cycle and use hand tools related to refrigeration equipment
Perform mathematics operations including addition, subtraction, multiplication, division, percentages, decimals, and fractions
Read and comprehend reading material used in the trade
Interpret three view and exploded drawings to determine correct assembly/disassembly procedures

SECOND QUARTER

Install and service domestic refrigerators, window air conditioning units, and single unit commercial refrigeration systems
Use test equipment to troubleshoot refrigeration units
Install and service various types of heating units and be familiar with their operation
Communicate with customer to be effective in solving complaints
Have a knowledge of basic physical principles and their application to air conditioning, heating, and refrigeration
Place equipment and read wiring diagrams for wiring equipment

THIRD QUARTER

Select, assemble, install and test cooling and ventilating systems
Use the basic concepts of automatic control systems to test, adjust, and replace domestic and commercial controls
Apply understanding of basic human behavior to solve problems within a work situation
Surface weld, using steel, bronze, and silver alloys and use flame-cutting techniques applicable to mechanical work

FOURTH QUARTER

Service and repair heating, cooling, ventilating and refrigeration systems
Install, service, and repair heat pumps and auxilliary heat systems
Fabricate, install, and insulate duct work
Understand the operation of a small business

Chapter IV

CURRICULUM

The air conditioning, heating, and refrigeration curriculums and course outlines have been developed by the competency committee to assist institutions in revising their existing curriculum or in implementing the curriculum as a new program in the institution. For the institution revising its air conditioning, heating, and refrigeration mechanic curriculum the suggested curriculum guide follows the format of the earlier mechanic curriculum. However, changes have been made in titles, descriptions, and organization to more nearly represent what the industrial surveys indicated was needed for each job level. Skills taught within the mechanic curriculum should prepare the student to begin work as a helper, installer, mechanic apprentice and mechanic as increasing levels of skill are mastered.

Course outlines are included for the specialty air conditioning, heating, and refrigeration mechanic courses. For all other courses, brief topical outlines are provided. For a copy of the complete course outline on other courses, the institution should contact the Program Development Section, Department of Community Colleges, Education Building, Raleigh, NC 27611 and request the course outline by title and number.

MECHANICAL-MANUFACTURING

AIR CONDITIONING, HEATING, AND REFRIGERATION MECHANIC

INTRODUCTION

Purpose of Curriculum

The Air Conditioning, Heating, and Refrigeration Mechanic Curriculum is designed to give students practical air conditioning, heating, and refrigeration knowledge that will enable them to become capable service mechanics in the industry. Technical and related instruction is provided for the understanding of basic principles involved in the construction, installation, operation, and maintenance of climate control equipment. Courses in blueprint reading, duct construction, welding, circuits and controls, math, science, and general education are included to help provide supporting skills necessary for the mechanic to function successfully in the trade.

Job Description

The air conditioning, heating, and refrigeration mechanic installs, maintains, services, and repairs environmental control systems in residences, department and food stores, office buildings, industry, restaurants, institutions, and commercial establishments. Job opportunities exist with companies that specialize in air conditioning, heating, and commercial refrigeration installation and service. The graduate should be able to assist in installing mechanical equipment, ductwork, and electrical controls necessary in residential and commercial projects. With experience the graduate should be able to service various air conditioning, heating, and refrigeration components, troubleshoot systems, and perform preventive maintenance required of mechanical equipment. The mechanic is employable in areas of maintenance, installation, sales and service in the growing field of air conditioning, heating, and cooling.

Career Opportunities

The graduate of the air conditioning, heating, and refrigeration mechanic program may start in one or more of the following jobs: duct installer, mechanic helper, mechanic apprentice, air conditioning mechanic, heating and air conditioning mechanic, heating mechanic, and refrigeration mechanic. Advanced jobs in the field include: environmental-control system installer-servicer, estimator, salesperson, contractor, supervisor and mechanic on industrial systems.

General Considerations

The air conditioning, heating, and refrigeration mechanic curriculum is structured to provide specific job skills at points within the one-year program as well as at the end of the program. Possible job opportunities corresponding with the curriculum sequence include:

First quarter - installer helper, refrigeration mechanic helper

Second quarter- installer, refrigeration system installer, domestic air conditioning installer, furnace repairer helper, duct installer

Third quarter - mechanic helper, air conditioning mechanic helper, refrigeration mechanic apprentice, heating mechanic helper

Fourth quarter- service mechanic, air conditioning mechanic, heating mechanic, refrigeration mechanic

Content has been arranged to provide experiences appropriate for entry to these jobs. Courses in math, blueprint reading, electricity, welding, and other related subjects are recommended in specific quarters of the curriculum to support the development of skills at the performance levels identified.

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° See Appendix A and B for complete addresses   * Deceased

AIR CONDITIONING, HEATING, AND REFRIGERATION MECHANIC

SUGGESTED CURRICULUM BY QUARTERS

		Course Title	Hours Per Week Class	Hours Per Week Lab	Quarter Hours Credit
FIRST QUARTER					
AHR	1121	Principles of Refrigeration	3	12	7
PHY	1111	Applied Science	3	2	4
MAT	1101	Fundamentals of Mathematics	5	0	5
ENG	1101	Reading Improvement	2	0	2
DFT	1104	Blueprint Reading	0	3	1
			13	17	19
SECOND QUARTER					
AHR	1122	Domestic and Commercial Refrigeration	3	6	5
ELC	1102	Applied Electricity	3	3	4
AHR	1115	Fundamentals of Heating	2	6	4
ENG	1102	Communication Skills	3	0	3
DFT	1116	Blueprint Reading: Air Conditioning	1	3	2
			12	18	18
THIRD QUARTER					
AHR	1123	Principles of Air Conditioning	3	12	7
AHR	1128	Automatic Controls	3	6	5
PSY	1101	Human Relations	3	0	3
WLD	1101	Basic Gas Welding	0	3	1
			9	21	16
FOURTH QUARTER					
AHR	1124	Air Conditioning, Heating, and Refrigeration Servicing	3	6	5
AHR	1126	All Year Comfort Systems	3	6	5
MEC	1120	Duct Construction and Installation	3	6	5
		Elective	3	0	3
			12	18	18
		Total			71

3.3

AIR CONDITIONING, HEATING, AND REFRIGERATION MECHANIC

COURSE DESCRIPTIONS BY QUARTER

FIRST QUARTER	Hours Per Week Class	Lab	Quarter Hours Credit
AHR 1121 Principles of Refrigeration	3	12	7

An introduction to the principles of refrigeration. Terminology, the use and care of tools and equipment, and the identification and the function of the component parts of refrigeration systems are covered. Practical work with hand tools, materials, piping, and ductwork is given to develop basic skills in the installation of refrigeration systems. Standard procedures and safety measures are stressed.
Prerequisite: None.

PSY 1111 Applied Science	3	2	4

An introduction to physical principles and their application in industry. Topics in this course will support the particular curriculum in which the course is offered and will be selected from the following: measurement, force, motion, work, energy, power, solids, liquids, gases, heat, thermometry, electrical principles, properties of matter, sound, and light.
Prerequisite: None

MAT 1101 Fundamentals of Mathematics	5	0	5

Practical number theory. Analysis of basic operations: addition, subtraction, multiplication, and division. Fractions, decimals, powers and roots, percentages, ratio and proportion, plane and solid geometric figures used in industry, measurement of surfaces and volumes. Introduction to algebra used in trades. Practice in depth.
Prerequisite: None

ENG 1101 Reading Improvement	2	0	2

Designed to improve the student's ability to read rapidly and accurately. Class drills used to broaden the span of recognition, to increase eye coordination and word group recognition and to train for comprehension in larger units. Reading weaknesses are analyzed for improvement and principles of vocabulary are stressed.
Prerequisite: None.

DFT 1104 Blueprint Reading	0	3	1

Interpretation and reading of blueprints. Information on the basic principles of the blueprint, lines, views, dimensioning procedures and notes.
Prerequisite: None.

SECOND QUARTER

AHR 1122 Domestic and Commercial Refrigeration 3 6 5

Domestic refrigeration servicing of conventional, and hermetic systems. Cabinet care, controls, and system maintenance in window air conditioning units and domestic refrigerators and freezers are stressed. Commercial refrigeration servicing of display cabinets, walk-in cooler and freezer units, and mobile refrigeration systems are studied. Manufacturer's catalogs are used in sizing and matching system components and a study of controls, refrigerants, heat reclamation maintenance, and servicing methods is made. The American Standard Safety Code for Refrigeration is studied and its principles practiced.
Prerequisite: AHR 1121.

ELC 1102 Applied Electricity 3 3 4

The use and care of test instruments and equipment used in servicing electrical apparatus for air conditioning and refrigeration installations. Electrical principles and procedures for troubleshooting of the various electrical devices used in air conditioning, heating, and refrigeration equipment. Included will be transformers, various types of motors and starting devices, switches, electrical heating devices and wiring.
Prerequisite: PHY 1101.

AHR 1115 Fundamentals of Heating 2 6 4

An introduction to the fundamentals of heating and heat transfer related to various types of heating systems. The use and care of tools, using instruments to measure combustion efficiencies, and installing equipment and ductwork to make up a heating system are covered. Also introduced are comfort surveys, heat loss and gain, equipment selection, and maintenance, solar heating and heat distribution systems.
Prerequisite: None.

ENG 1102 Communication Skills 3 0 3

Designed to promote effective communication through correct language usage in speaking and writing.
Prerequisite: ENG 1101.

DFT 1116 Blueprint Reading: Air Conditioning 1 3 2

A specialized course in drafting for the air conditioning, heating, and refrigeration student. Emphasis will be placed on reading of blueprints that are common to the trade; blueprints of mechanical components, assembly drawings, wiring diagrams and schematics, floor plans, heating system plans including duct and equipment layout plans, and shop sketches. The student will make tracings of floor plans and layout air conditioning systems.
Prerequisite: DFT 1104.

THIRD QUARTER

AHR 1123 Principles of Air Conditioning 3 12 7

Course covers various heating, cooling, and ventilating systems, and the investigation and control of factors affecting air cleaning, movement, temperature, and humidity. Use is made of psychrometric charts in determining equipment needs to produce optimum temperature and humidity control. Air conditioning equipment is selected, assembled, installed, wired, calibrated, and tested. Sizing, installing, and balancing of ductwork is performed as needed.
Prerequisite: AHR 1122.

AHR 1128 Automatic Controls 3 6 5

Types of automatic controls and their function in heating and cooling systems. Included in the course will be electric, electronic, mechanical, and pneumatic controls for domestic and commercial heating and cooling along with zone controls, unit heater and ventilator controls, commercial fan system controls, commercial refrigeration controls, and radiant panel controls.
Prerequisite: ELC 1102, AHR 1122.

PSY 1101 Human Relations 3 0 3

A study of basic principles of human behavior. The problems of the individual are studied in relation to society, group membership, and relationships within the work situation.
Prerequisite: None.

WLD 1101 Basic Gas Welding 0 3 1

Welding demonstrations by the instructor and practice by students in the welding shop. Safe and correct methods of assembling and operating the welding equipment. Practice will be given for surface welding, bronze welding, silver soldering, and flame-cutting methods applicable to mechanical repair work.
Prerequisite: None.

FOURTH QUARTER

AHR 1124 Air Conditioning, Heating, and Refrigeration Servicing 3 6 5

Emphasis is placed on the maintenance and servicing of equipment used in the cleaning, changing, humidification and temperature control of air in an air conditioned space. Shop work involves locating and correcting equipment failures and controlling, testing, and adjusting heating and cooling equipment to maximize energy conservation.
Prerequisite: AHR 1123.

AHR 1126 All Year Comfort Systems	3	6	5

Equipment used to provide heating and cooling for "all year" comfort will be studied. Included will be heat pumps, oil fired, gas fired, water circulating, electric-resistance and an introduction to solar heating and cooling systems. Specialized controls required for all year comfort systems, preventive maintenance, and balancing are included in the course.
Prerequisites: AHR 1123, AHR 1128.

MEC 1120 Duct Construction and Installation	3	6	5

Study of the fabrication, installation, and maintenance of ducts using various materials and fittings to achieve correct air flow. Course covers safety, fabrication, tools and equipment, cutting and shaping, fasteners and fabrication practices, fans, insulation, ventilating hoods, layout methods, and development of duct systems. The student will study the installation of various duct systems and perform on-the-site modifications.
Prerequisites: None.

ELECTIVES

The following is a list of electives for this curriculum from which the institution may select courses to complete the program of study. The institution has the prerogative to develop new courses for the electives or modify courses from the suggested list to fulfill local objectives. It is suggested, however, that technical courses be related to the major area of study. These courses should not change or alter the major objectives of the program nor create a false impression of proficiency in an area either related or foreign to the major. The institution may elect to require certain electives or may let the student select an appropriate elective.

BUS 1105 Industrial Organizations	3	0	3

Methods, techniques, and practices of modern management in planning, organizing and controlling operations of a manufacturing concern. Introduction to the competitive system and the factors constituting product cost.
Prerequisite: None

ISC 1101 Industrial Safety	3	0	3

A study of the development of industrial safety: accident occurrence and prevention; analysis of accident causes and costs; basic factors of accident control; safety education and training; accident reporting and records; employer and employee responsibility; safety organizations; first air; mechanical safeguards; personal protective equipment use; materials handling; fire prevention and protection; safety codes; and accident statistics.
Prerequisite: None

BUS 1103 Small Business Operations	3	0	3

An introduction to the business world, problems of small business operation, basic business law, business forms and records, financial problems, ordering and inventorying, layout of equipment and offices, methods of improving business, and employer-employee relations.
Prerequisite: None

COURSE OUTLINE

AHR 1121 PRINCIPLES OF REFRIGERATION

Developed By

Air Conditioning and Refrigeration

Competency Curriculum Committee

October, 1979

PROGRAM DEVELOPMENT
DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

AHR 1121 - PRINCIPLES OF REFRIGERATION

DESCRIPTION OF COURSE:

An introduction to the principles of refrigeration. Terminology, the use and care of tools and equipment, and the identification and the function of the component parts of refrigeration systems are covered. Practical work with hand tools, materials, piping, and ductwork is given to develop basic skills in the installation of refrigeration systems. Standard procedures and safety measures are stressed.

Course Hours Per Week:	Class, 3; Laboratory, 12.
Quarter Hours Credit:	7
Prerequisite:	None.
Course Objectives:	Specific objectives are included in the outline of instruction.
Course Outcomes:	The student will develop skills in principles of refrigeration as they apply to refrigeration and air conditioning systems. The course is structured to provide hands-on skills with the student using appropriate tools in installing, servicing, and maintaining refrigeration components of an AHR system. Practical work includes fabricating tubing to various components, soldering, piping, installing ductwork, leak testing, evacuating, and charging air conditioning and refrigeration systems and using common hand and power tools while observing safety standards and developing working skills.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	REFRIGERATION			
3.10	TOOLS AND MATERIALS			
3.11	Flare tubing, bend tubing to fit cabinet wall, use swagging tools to connect tubing, and hang ductwork.	I. Using hand tools a. Use and care b. Basic tools c. Special tools	1* Pages 40-45 49-50	I. Use hand tools (flaring, swagging, bending)
3.12	Student will install tubing and use refrigerants safely to charge units	II. Working with materials a. Tubing and its properties b. Fittings and applications c. Operations with copper tubing d. Refrigerants	1 Pages 47, 48, and 51	II. Working with materials (tubing, refrigerants)
3.13	Use gauges and thermometers to check unit pressures and temperature	III. Using test instruments a. Thermometers b. Gauges and manifolds c. Electrical instruments	1 Pages 60-65	III. Use test instruments (gauges, thermometers)
3.20	MECHANICAL COMPRESSION SYSTEMS			
3.21	Check unit and name all components	I. Recognizing cycle components a. Install and adjust the component and know what purpose it serves b. Manufacturers data	1 Pages 99-113	I. Recognize and identify cycle components

*Number refers to source listed in suggested Texts and References section.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
3.22	Connect components and adjust	II. Connecting cycle components a. Install and adjust the component b. Know what purpose it serves	1 Pages 114, 433-436	II. Recognize cycle components
3.23	Install capillary tube, AEV, and TEV charge units and check each unit	III. Operating a cycle a. Install and service all metering devices b. Know what would be involved to substitute one with another	1 Pages 108-113	III. Operate a cycle using a capillary tube, an AEV, a TEV
3.24	Check capillary tube AEV and TEV charge units for pressures and temperatures	IV. Recording pressures and temperatures a. Know the instrument b. Where the sensing element should be located c. How long the recording should be made	1 Pages 60-66	IV. Record pressures and temperatures
3.26	The student will use a. Soap solution b. Halide torch c. Electronic detector to test for leaks	VI. Leak testing a system a. Determine if the system is working properly b. Know what reaction will take place if a leak is detected	1 Pages 496-497, 285, 361-362, 381, 508	VI. Leak test a system using three methods of detection

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
3.27	The student will use a. Deep vacuum b. Triple vacuum to evacuate system.	VII. Evacuating a system a. Why evacuation is necessary b. How much evacuation has been sufficient	1 Pages 507, 384-388	VII. Evacuate a system using a vacuum pump
3.28	The student will charge a system.	VIII. Charging a system a. Refrigerant should be determined b. Determine charging method and how to determine when adequate charge has been completed 1. Gas (vapor) a. Frost line method b. By weight c. Sight glass method d. Gauge 2. Liquid on high side a. By weight b. Sight glass method c. Gauge pressure	1 Pages 300-388 508-509 2 Pages 109, 124, 69, 72	VIII. Charge a system
3.30	<u>MOTORS AND CONTROLS</u>			
3.31	The student will check a group of motors and recognize the various types of motors and their use.	I. Recognizing various types of motors a. Shaded pole b. Permanent split capacitor c. Capacitor start d. Capacitor start,	1 Pages 209-212 216-219, 223	I. Recongize various types of motors

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		capacitor run e. Belt driven f. Direct driven		
3.32	The student will use diagrams to wire a complete system.	II. Installing and wiring a. Wire from schematic wiring diagram b. Install according to standard installation practices	1 Pages 217-220	II. Install and wire (connect) an electric motor (use unit diagram)
3.33	The student will install and operate the different types of relays.	III. Wiring in different types of starting relays a. Determine type and load b. Current relay c. Potential relay d. Hot wire e. Magnetic	1 Pages 243, 259-265	III. Wire in different types of starting relays (use diagram)
3.34	The student will install and adjust thermostat on commercial unit.	IV. Installing a thermostat a. Select proper location b. Importance of being level, away from vibration, drafts, and heat generating equipment	1 Pages 245-246	IV. Install a thermostat
3.36	The student will install complete system and check operation.	VI. Connecting a defrost system a. Install necessary piping and drains b. Install frost detector method c. Install defrost	1 Pages 271, 306, 311-315, 426	VI. Connect a defrost system

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		termination control		
3.50	REPAIR OF CABINETS AND MECHANISMS-MECHANICAL			
3.52	Student will locate and repair a leak in a condenser by silver brazing.	II. Repairing a condenser a. Locate leak b. Repair leak	1 Pages 44, 47, 362, 505	II. Repair a condenser
3.53	The student will repair an evaporator.	III. Repairing leaking evaporator a. Locate b. Repair	1 Pages 51, 377, 530	III. Repair leaking evaporator
3.56	The student will take a leaking system, locate leak discharge, repair leak, evacuate, and recharge system.	VI. Repairing a system leak and recharge a. Dropping charge b. Making repair c. Test procedures d. Evacuation e. Recharging	1 Pages 2 Pages 109, 124, 69, 72	VI. Repair a system leak and recharge
3.57	The student will clean a restricted capillary tube by use of pump.	VII. Repairing a restricted capillary tube a. Inspection b. Repair	1 Pages 163-165	VII. Repair a restricted capillary tube
3.58	Repair a compressor unit not working.	VIII. Diagnosing a system a. Test the symptoms b. Repairing or replacing c. Determine whether electrical or mechanical problem	1 Pages 494-495, 238-239	VIII. Diagnose a system that has an inefficient compressor

39

SUGGESTED TEXTS AND REFERENCES

1. Modern Refrigeration and Air Conditioning
   Althouse, A.D., Turnquist, C. H., and
   Pracciano
   Chicago: Goodhart-Wilcox Co., 1975

2. Refrigeration and Air Conditioning
   Air Conditioning and Refrigeration Institute
   Englewood Cliffs, NJ: Prentice-Hall, Inc.

OTHER RESOURCES

Heating and Cooling Safety
Lang, V. Paul
Albany, NY: Delmar, 1977

Manufacturer's Specification Sheets

National Electric Code 1978
National Fire Protection Association,
Boston: No. 70-1978

NFPA Handbook of National Electric Code
Watt
National Fire Protection Association
Boston

Principles of Refrigeration
Olivo, C.T. and Marsh, R. W.
Albany, NY: Delmar, 1979

Refrigeration Servicing
Goliber, Paul
Albany, NY: Delmar, 1976

Servicing Comfort Cooling Systems
North American National Heating and
Air Conditioning Wholesalers Association
Columbus, OH

35mm Slides and Cassettes can be obtained from
Carrier Air Conditioning Company
Syracuse, NY

NOTE: Number beside source agrees with numbering system used in Activity Experience column.

APPLIED SCIENCE, an introduction to physical principles and their application in industry. Topics in this course will support the particular curriculum in which the course is offered and will be selected from the following: measurement, force, motion, work, energy, power, solids, liquids, gases, heat, thermometry, electrical principles, properties of matter, sound, and light.

PREREQUISITE: None.

	Class Hours	Lab Hours	Credit Hours
MAJOR DIVISIONS	3	2	4

I. Units of Measurement

II. Development and Use of the "Scientific Method"

III. Principles and Applications: (to be selected from the following)

A. Properties of Materials
B. Mechanics
C. Heat
D. Light and Sound
E. Electricity and Magnetism

SUGGESTED REFERENCES:

Olivio, C.Thomas. Fundamentals of Applied Science. Albany: Delmar Publishers, 1964.

Dull, Charles E., Metcalfe, H. Clard, and Brooks, William O. Modern Physics. New York: Holt, Rinehart & Winston Company.

Efron, Alexander. Basic Physics. New York: John F. Rider Publishing Company, 1958.

Harris, Norman C. and Hermmerling, Edwin M. Introductory Applied Physics. New York: McGraw-Hill Book Company, Inc.

White, Harvey E. Physics, An Exact Science; Latest Edition. Princeton: D. Van Nostrand Company, Inc.

FUNDAMENTALS OF MATHEMATICS. Practical number theory. Analysis of basic operations: addition, subtraction, multiplication and division. Fractions, decimals, powers and roots, percentages, ratio and proportion, plane and solid geometric figures used in industry; measurement of surfaces and volumes. Introduction to algebra used in trades. Practice in depth.

PREREQUISITE: None

	Class Hours	Lab Hours	Credit Hours
MAJOR DIVISIONS	5	0	5

I. Introduction to the set of real numbers and the base - 10

II. Common fractions and decimal fractions

III. Powers and roots

IV. Percentages

V. Rules and formulas

VI. Ratio and proportion

VII. Geometric figures

VIII. Introduction to algebra

SUGGESTED TEXT:

Van Leuven, Edwin P. General Trade Mathematics. New York: McGraw-Hill Book Company, Inc.

SUGGESTED REFERENCES:

Kaltenborn, H. S., Anderson, Samuel A. and Kaltenborn, Helen. Basic Mathematics. New York: The Ronald Press.

Palmer, Claude and Bibb, Samuel F. Practical Mathematics: Parts I and II; Fifth Edition. New York: McGraw-Hill Book Company, Inc.

Wolfe, John H. and Phelps, Everrette R. Practical Shop Mathematics: Vol. I. New York: McGraw-Hill Book Company, Inc.

READING IMPROVEMENT is designed to improve the student's ability to read rapidly and accurately. Class drill is used to broaden the span of recognition, to increase eye coordination and word group recognition and to train for comprehension in larger units. Reading weaknesses are analyzed for improvement and principles of vocabulary are stressed.

PREREQUISITE: None

	Class Hours	Lab Hours	Credit Hours
MAJOR DIVISIONS	2	0	2

I. Introduction

II. Common faults of slow readers, and their correction

III. Broadening the span of recognition

IV. Accuracy of interpreting symbol forms

V. Apprehension and eye-hand coordination

VI. Building word recognition ability

VII. Numbers and letters

VIII. Vocabulary building

IX. Continuing improvement of speed and comprehension

SUGGESTED REFERENCE:

Leedy, P. E. Reading Improvement for Adults. New York: McGraw-Hill Book Company, Inc., 1956.

BLUEPRINT READING, covers interpretation and reading of blueprints. Information on the basic principals of the blueprint, lines, views, dimensioning procedures and notes.

PREREQUISITE: None.

	Class Hours	Lab Hours	Credit Hours
MAJOR DIVISIONS	0	3	1

I. Introduction to blueprint reading

II. Shape description methods in drawings

III. Visualizing: blueprint to object; object to blueprint

IV. Special views on blueprints

V. Representation of dimensions and finish

SUGGESTED TEXTS:

McCabe, Keith and Farnham. Mechanical Drafting Essentials; Third Edition. Englewood Cliffs: Prentice-Hall, Inc.

Ihne and Streeter. Machine Trades Blueprint Reading; Third Edition. Chicago: American Technical Society.

Olivo, C. Thomas and Payne, Albert V. Basic Blueprint Reading and Sketching. Albany: Delmar Publishers, Inc.

COURSE OUTLINE

AHR 1122 DOMESTIC AND COMMERCIAL REFRIGERATION

Developed By

Air Conditioning and Refrigeration

Competency Curriculum Committee

October, 1979

PROGRAM DEVELOPMENT
DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

AHR 1122 - DOMESTIC AND COMMERCIAL REFRIGERATION

DESCRIPTION OF COURSE:

Domestic refrigeration servicing of conventional, and hermetic systems. Cabinet care, controls, and system maintenance in window air conditioning units and domestic refrigerators and freezers are stressed. Commercial refrigeration servicing of display cabinets, walk-in cooler and freezer units, and mobile refrigeration systems are studied. Manufacturer's catalogs are used in sizing and matching system components and a study of controls, refrigerants, heat reclamation maintenance, and servicing methods is made. The American Standard Safety Code for Refrigeration is studied and its principles practiced.

Course Hours Per Week:	Classroom, 3; Laboratory, 6.
Quarter Hours Credit:	5
Prerequisite:	AHR 1121
Course Objectives:	Specific objectives are included in the outline of instructions.
Course Outcomes:	The student will develop skills in reading, diagnosing electrical circuitry conforming to the National Electrical Codes, locating motor controls and faults, reading trouble-shooting charts, sketching external and internal circuits and recognizing compressor troubles and those of major components. In addition, the student will practice skills in laboratory of leak testing, evacuating, and charging systems.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
2.50	SYSTEM CLEANUP AFTER BURNOUT			
2.51	Student will disconnect tube and flush to prepare for system cleanout.	I. Disconnecting a tube and flushing a. Know what and where a tube is b. Know how to remove tube c. Know how to flush d. Know what cleaner to use	1* Pages 375, 538 5 Chapters 13 and 15	I. Disconnect a tube and flush
2.52	Tear down TEV, clean with solvent, reassemble, and adjust. Change oil in compressor. Install liquid line dryer. Install suction line filter.	II. Tearing down TEV and flushing a. Know what and where a tube is b. Know how to remove tube c. Know how to flush d. Know what cleaner to use	5 Chapters 13 and 15	II. Tear down TEV and flush
2.53	The student will learn to clean condensers.	III. Pumping through condenser a. Know how to flush b. Cleaning condenser	5 Chapters 13 and 15	III. Pump cleaner through condenser
2.54	The student will learn to clean evaporators.	IV. Pumping through evaporator a. Know how to flush b. Cleaning evaporator	5 Chapters 13 and 15	IV. Pump cleaner through evaporator
2.55	The student will clean all refrigeration piping and remove cleaner from the system.	V. Cleaning all refrigeration piping a. Know how to flush refrigeration piping b. Know how to remove cleaner from system	5 Chapters 13 and 15	V. Clean all refrigeration piping

* Number refers to source listed in Suggested Texts and References section.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
2.56	The student will evacuate and flush system using same refrigerant used in system, replace components and put system back into operation.	VI. System start-up a. Alternate evacuation method; use cleanup filter-drier, let the compressor do the cleaning b. Replace components c. Test system	5 Chapters 13 and 15 1 Pages 375, 538	VI. Replace compressor and put system into operation
3.20	MECHANICAL COMPRESSION SYSTEMS			
3.21	The student will check unit and name all components.	I. Recognizing cycle components a. Install and adjust the component and know what purpose it serves b. Manufacturers data	1 Pages 99-113	I. Recognize and identify cycle components
3.25	The student will install and check pressure and temperature valves.	V. Observing cycle component behavior a. Test the performance of pressure and temperature valves to determine if they are operating normally b. Test cycle performance	1 Pages 99, 144, 150 433-437	V. Observe cycle component behavior
3.30	MOTORS AND CONTROLS			
3.35	The student will check all defrost systems.	V. Having a knowledge of various defrost systems a. How a hot gas defrost is used. b. How a resistance heater is used.	1 Pages 371, 306, 309-315, 393, 425-431	V. Have a knowledge of various defrost systems

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		c. Why the drain is part of the defrost system d. Additional methods of defrosting such as hot water, time, electric and hot gas		
3.37	The student will install and adjust ice maker after electrical service and plumbing has been installed.	VII. Installing an ice maker a. The variables which decide the proper location b. Run proper electrical service to machine c. Have adequate water supply and water drain d. Have proper ventilation	1 Pages 85, 417, 427	VII. Install an ice maker
3.40	REFRIGERATED CABINETS			
3.41	The student will be trained to use books and specifications of manufacturers.	I. Recognize key features a. Cabinet, finish and trims b. Interior and exterior	1 Pages 330-333	I. Recognize key features of different styles and models
3.42	The student will check and operate a reach-in and walk-in cooler.	II. Checking and servicing a. Compressor b. Evaporator c. Condenser d. Metering devices	1 Pages 109-113, 344, 377, 529-531, 407, 588, 521	II. Check and service a cabinet

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
3.50	REPAIR OF CABINETS AND MECHANISMS-MECHANICAL			
3.51	Student will install and operate a compressor	I. Replacing a compressor a. Removal of silver (brazing) b. Evacuation c. Adding oil and refrigerant d. Servicing - by repair or replacement	1 Pages 350, 367, 374 376, 377, 380, 381, 384	I. Replace a compressor
3.54	The student will install heater using meter to check.	IV. Replacing a defrost heater a. Test procedure in order to ascertain condition b. Replace	1 Page 430	IV. Replace a defrost heater
3.55	The student will check motor and contacts in timer, determine defrost timing, select new timer, and install.	V. Replacing a defrost timer a. Test procedure b. Removal c. Replacing	1 Pages 244, 238-239. 376, 513, 520	V. Replace a defrost timer
3.60	TROUBLESHOOT AND REPAIR CABINETS AND MECHANISMS-ELECTRICAL			
3.61	Student will select and install correct relay.	I. Checking and replacing a defective start relay a. Identify correctly from memory the type or relay (current) (solid state) or (hot wire relay) b. Replacing relay	1 Pages 260-265	I. Check and replace a defective start relay

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
3.62	The student will change a hermetic compressor.	II. Checking and replacing a defective hermetic compressor a. Identify make, type, size, etc. b. Checking and replacing	1 Pages 238-240	II. Check and replace a defective hermetic compressor
3.63	Student will use an ohmmeter to check capacitors, then replace capacitors as necessary.	III. Checking and replacing defective run and start capacitors	1 Pages 232-233	III. Check and replace defective run and start capacitors
3.64	Student will check water circuit, wiring, and refrigerant circuit.	IV. Checking and repairing a defective ice maker	1 Pages 85, 269, 478	IV. Check and repair a defective ice maker
3.65	Student will be given a motor compressor dryer, vacuum pump and other necessary material to check and replace a compressor.	V. Checking and replacing a hermetic compressor after a burnout a. Evacuation b. Recharging c. Resetting controls	1 Pages 367, 495-498, 538, 565 3 GTA-2	V. Check and replace a hermetic compressor after a burnout
3.70	COMMERCIAL REFRIGERATION SYSTEMS			
3.71	The student will draw a schematic and wiring diagram of a complete system.	I. Diagram an electrical wiring system a. Wiring diagrams b. Schematic diagrams	1 Pages 423-425, 427, 436-443	I. Diagram an electrical wiring system from the disconnect switch
3.72	The student will use code book to size wire for above.	II. Selecting wire size a. Know circuit voltage b. Know circuit amps c. Know wattage at start up	4 1 Pages 204-206, 940-941, 950	II. Select wire size for each circuit

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
3.76	The student will study manufacturer's specifications of multiple evaporator units and inspect working units.	VI. Knowing purpose and application of multiple evaporator systems a. Two temperature applications b. More than one fixture used with one condensing unit	3 GTR-5A, 6A, 7A, and 15A. 1 Pages 590-600	VI. Know purpose and application of multiple evaporator systems.
3.77	The student will match major components using product information.	VII. Selecting major components a. Size and temperature range of evaporators b. Types	3 GTR-5A, 6A	VII. Select major components and arrangements of multiple evaporator systems
3.78	Student will install and adjust valves and controls.	VIII. Installing and adjusting evaporator pressure regulator, etc. a. Thermostatic expansion valves: size and adjustment b. EPR valves: size and adjustment	1 Pages 443-445, 154	VIII. Install and adjust evaporator pressure regulator, EPR valves and refrigerant controls
3.79	Student will check pressure drop through various coils and select correct valve.	IX. Selecting and knowing when to use internal equalizer, external equalizer, etc. a. Pressure drop through coil b. From manufacturer's data	1 Pages 159, 584-586	IX. Select and know when to use internal equalizer, external equalizer, and pressure limiter thermostatic expansion valves
3.710	Instruction will be provided in the various types of head pressure controls and reasons for a larger gas charge.	X. Installing and adjusting heat pressure controls a. Knowledge of conditions when required b. Know gas charge will be different	1 Pages 296, 399-406	X. Install and adjust head pressure controls if condensors are exposed to outdoor weather temperature.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	and receiver for all weather conditions.	c. Set correct head pressure		
3.711	Knowledge of all types of heat exchangers will be explained.	XI. Knowing types and purpose of heat exchangers a. Increase capacity of refrigerant controls b. Increase capacity of system	1 Pages 432-433, 584	XI. Know types and purpose of heat exchangers
3.712	The student will be taught about heat exchangers that are used on applied systems.	XII. Know where and when heat exchangers should and should not be installed a. Install near evaporator b. Do not install without manufacturer's approval c. Could cause motor-compressor-burn-out	1 Pages 109 and 584 Manufacturer's Data	XII. Know where and when heat exchangers should and should not be installed.
3.713	Instruction is provided for installation of accumulators with emphasis on proper sizing for job.	XIII. Know advantages of accumulators and where to install a. Protect compressors from liquid sludging b. Install a suction line near compressor	1 Page 102 3 CTR-10A 2 Pages 252, 253, and 262	XIII. Know advantages of accumulators and where to install
3.714	Student will be instructed about principle of oil separator and how oil is returned to compressor.	XIV. Knowing type and purpose of oil separators, their location, and installation requirements. a. Purpose to keep oil in compressor where needed.	1 Pages 104-105, 448-450 3 GTA-1	XIV. Know type and purpose of oil separators, their location, and installation requirements.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		b. Total system more efficient c. Install in discharge line near compressor d. Make sure no refrigerant condenses in separator		
3.715	The student will be instructed about evaporator types used in storage of different commodities.	XV. Determining the correct storage life, etc. a. From available material compile data for best storage of various commodities b. Sizing equipment	1 Pages 555-562	XV. Determine the correct storage life, temperature, and humidity of various commodities
3.716	Instruction is provided in triple purge and soak method of removing moisture from system to prevent equipment failure.	XVI. Knowing reason for evacuating a. Prevent high head pressure b. Acid formation c. Motor burn out	3 GTR-12A 2 Pages 28, 29, 109, and 110	XVI. Know reason for evacuating a refrigeration system
3.717	The student will be instructed in use of single and two stage vacuum pump and triple gas evacuation.	XVII. Knowing evacuating procedures a. Deep vac. (100 microns) b. Triple vac. (Three times to 500 microns)	2 Pages 109-113	XVII. Know evacuating procedures
3.718	Instruction will be provided on selection of liquid or vapor charging methods, frost line bleed-off for low temperature units sight glass.	XVIII. Knowing charging procedures a. Sight glass method b. Frost line method c. Weight method d. Liquid charging e. Vapor charging	3 GTR-13A 1 Pages 508-509 2 Pages 113-115	XVIII. Know charging procedures and determine correct charge

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
3.719	Student will be instructed in methods of determining correct charge for comfort cooling.	XIX. Charging a comfort cooling unit a. Use of refrigerants b. Measurements specified by manufacturer (high side) c. Suction pressures	3 GTR-13A 2 Page 296-300 2 Pages 124, 126, 127	XIX. Charging a comfort cooling unit
3.80	REFRIGERATION SERVICING			
3.81	Student will receive instruction in proper color coding for refrigerant containers and proper color coding for wiring of electrical motor speeds, etc.	I. Banding refrigerants and electrical wiring a. OSHA regulations b. Local and state codes c. Company policies and standards	3 Carrier SM-1 Chapter 1, Refrigerants 2 Pages 46, 55, 83, 84, and 88	I. Adhere to safety rules pertaining to banding of refrigerants and electrical circuits
3.82	Student will use blueprint reading to follow electrical schematics, pipe blueprints, and materials specifications.	II. Piping blueprints and electrical schematics a. Electrical and blueprint symbols b. Abbreviations of parts, pieces, and components c. Pipe size, etc. d. Suitable materials	1 Pages 172, 173, and 760	II. Read and follow piping blueprints and electrica schematics
3.83	The student will demonstrate how to properly diagnose, replace and adjust electrical and mechanical components in a safe manner.	III. Servicing electrical and mechanical refrigeration components a. Replace the function not the part b. Proper electrical connections c. Clean copper joints	2 Pages 302-312 1 Pages 37-50 3 GTR-16A Slides and Cassettes	III. Be able to service or suitably replace electrical and mechanical refrigeration components

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
		d. Use of fluxes e. Select proper fittings f. Use of swedging tools g. Use of various solder and brazing agents h. Use of oxyacetylene welding and brazing and soldering		
3.84	The student will demonstrate the ability to diagnose malfunctions by the "What, Why, Where, When" method and then make a correct adjustment, repair, or replacement.	IV. Locating malfunctioning components in refrigeration system a. Understanding refrigeration cycle b. Using testing equipment, volt meter, amp meter, cable tracer, etc. c. Use of compound gauges d. Function of each component part and how to check it e. Using pressure-temperature charts f. Flushing and cleaning of the system g. Proper refrigerant and charge h. Using thermometers and gauges to set superheat	1 Pages 344-350	IV. Locate malfunctioning components in a refrigeration system

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
3.85	The student will demonstrate the ability to safely and systematically diagnose, adjust, repair, or replace a malfunctioning component.	V. Repairing malfunctioning components a. Take proper equipment to job; ladder, extension cord, flashlight, cleaning materials, etc. b. Have a representative inventory on service truck of controls, parts and pieces organized in an orderly fashion c. Have proper instruments, supplies, and tools on the truck in good repair d. Knowledge of concepts e. Knowledge of components f. Knowledge of failure reasons g. Testing h. Process of elimination i. Repair or replace component j. Procedure for handling warranty defects, i.e., nature of defect, model and serial number of unit	1 Pages 37, 40-43, 47, 50, 52, 55, 57, 60-61, 63, 68, and 70	V. Organize a systematic method of repair of malfunctioning component
3.86	Instruction will be provided to enable student to install different types of refrigeration systems.	VI. Installing types of systems a. Self contained b. Remote c. Applied	2 Pages 69-72	VI. Install refrigeration system

SUGGESTED TEXTS AND REFERENCES

1. Modern Refrigeration and Air Conditioning
   Althouse, A. D., Turnquist, C. H., and
   Bracciano
   Chicago: Goodhart-Willcox Co., 1975

2. Refrigeration and Air Conditioning
   Air Conditioning and Refrigeration Institute
   Englewood Cliffs, NJ: Prentice-Hall, Inc.

3. 35mm Slides and Cassettes can be obtained from
   Carrier Air Conditioning Company
   Syracuse, NY

4. National Electric Code 1978
   National Fire Protection Association
   Boston: No. 70-1978

5. Servicing Comfort Cooling Systems
   North American Heating and Air Conditioning Wholesalers Association
   Columbus, OH

OTHER RESOURCES

ASHRAE Guide and Data Book
American Society of Heating, Refrigeration,
and Air Conditioning Engineers
New York

Environmental Control: Air Conditioning and Refrigeration Theory and Application
Weaver, M. K., and Kirkpatrick, J. N.
Scranton, PA: Harper and Row, 1974

Modern Refrigeration Practice
King, G. R.
New York: McGraw-Hill, 1971

Principles of Refrigeration
Dossat, R. J.
New York: John Wiley & Sons, 1978

Principles of Refrigeration
Olivo, C. T., and Marsh, R. W.
Albany, NY: Delmar, 1979

Refrigeration and Air Conditioning
Langley, Bill
Reston, VA: Reston Publishing Co., 1978

Refrigeration Servicing
Goliber, P. F.
Albany, NY: Delmar, 1976

NOTE: Number beside source agrees with numbering system used in Activity Experience columns.

APPLIED ELECTRICITY - The use and care of test instruments and equipment used in servicing electrical apparatus for air conditioning and refrigeration installations. Electrical principles and procedures for troubleshooting of the various electrical devices used in air conditioning, heating, and refrigeration equipment. Included will be transformers, various types of motors and starting devices, switches, electrical heating devices and wiring.

PREREQUISITE: PHY 1101

Class Hours	Lab Hours	Credit Hours
3	3	4

MAJOR DIVISIONS

I. Safety in installing and servicing electrical equipment.

II. Electrical terms and units

III. Resistance - Ohm's Law - circuits

IV. Principles, use, and care of volt, ampere, ohm, and watt meters

V. Inductance

VI. Capacitance

VII. Alternating current

VIII. Transformers (SMALL TYPE - OPTIONAL)

IX. Relays

X. Service entrance (1-phase, 3-wire)

XI. Circuit breaders

XII. Repulsion type - induction start motor

XIII. A-C motors: split-phase type

XIV. A-C motors: capacitor type

XV. PSC motor

XVI. A-C motors: polyphase type

XVII. A-C motors: dual-voltage type

XVIII. Troubleshooting information for split-phase and capacitor-start motors

SUGGESTED TEXTS AND REFERENCES:

Adams, James E. Electrical Principles and Practices. New York: McGraw-Hill Book Company, Inc.

Green, Philip T. Electrical Testing and Troubleshooting. New York: The Industrial Press, Latest Edition.

Lister, Eugene C. Electric Circuits and Machines. New York: McGraw-Hill Book Company, Fourth Edition, 1968.

Loper, O. E. and A. F. Ahr. Electricity and Electronics. Albany, NY: Delmar Publishers, Inc.

Loper, O. E. and J. F. Duff. Basic Electricity I, II, III, and IV. Albany, NY: Delmar Publishers, Inc.

Marcus, Abraham. Basic Electricity. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1969.

McIntyre, R. L. Electric Motor Control Fundamentals. New York: McGraw-Hill Book Company, Inc., 1968 or Latest Edition.

Mileaf, Harry. Electricity One-Seven, (Seven paperbound volumes or individual clothbound.) New York: Hayden Book Company, Inc.

Navpers 10546-B. Electrician's Mate-One, Two and Three, Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.

Richter, H. P. Practical Electrical Wiring. New York: McGraw-Hill Book Company, 7th Edition.

Siskind, Charles S. Electrical Machines - Direct and Alternating Current. New York: McGraw-Hill Book Company, Inc., Latest Edition.

Stout, M. B. Basic Electrical Measurements. Englewood Cliffs, NJ: Prentice-Hall, Inc., Latest Edition.

Timbie and Pike. Essentials of Electricity. New York: John Wiley and Sons.

Van Valkenburgh, Nooger and Neville. Basic Industrial Electricity. New York: Hayden Book Company.

Woodward, Robert L., J. Lyman Goldsmith, and Alfred E. Block. An Introduction to Applied Electricity - Electronics. Englewood Cliffs, NJ: Prentice-Hall, Inc.,

OTHER AIDS:

Anderson, C. J., A. Santanelli, and Fred R. Karris. Direct and Alternating Current Circuits and Measurement (A Self-Instructional Programmed Manual). Englewood Cliffs, NJ: Prentice-Hall, Inc.

National Electrical Contractors Association. National Electrical Code, An American Std. 610 Ring Building, Washington, DC 20036, Latest Edition.

Student Manuals #P92 and Trainers Model S 1000 A; Electronic Aids, Inc., 6101 Falls Road, Baltimore, MD 21209.

COURSE OUTLINE

AHR 1115 FUNDAMENTALS OF HEATING

Developed By

Air Conditioning and Refrigeration

Competency Curriculum Committee

October, 1979

PROGRAM DEVELOPMENT
DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

AHR 1115 - FUNDAMENTALS OF HEATING

DESCRIPTION OF COURSE:

An introduction to the fundamentals of heating and heat transfer related to various types of heating systems. The use and care of tools, using instruments to measure combustion efficiencies, and installing equipment and ductwork to make up a heating system are covered. Also introduced are comfort surveys, heat loss and gain, equipment selection and maintenance, solar heating and heat distribution systems.

Course Hours Per Week:	Class, 2; Laboratory, 6.
Quarter Hours Credit:	4
Prerequisites:	None
Course Objectives:	Specific objectives are included in the outline of instruction.
Course Outcomes:	1. Student will be able to properly place an oil or gas hot air furnace in a residential or light commercial building, make necessary flue connections, pipe or install fuel supply tank and lines in accordance with building and electrical codes. 2. Student will troubleshoot systems by locating and correcting faults in an operating oil and gas furnace (mechanical or electrical). 3. Student will adjust a gas and/or oil furnace to its greatest heating efficiency. 4. Using wiring diagram, student will place all low and line voltage wires on a gas or oil furnace and wire thermostat.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE
1.10	HEATING OIL HEAT		
1.11	Student must be familiarized with state and local codes related to oil heating systems. Student will be instructed in how to install galvanized piping by sizing for fill and vent pipe. Also, how to install copper piping according to elevation of oil pump and tank.	I. Installing storage tank (a) Code requirements (1) Depth (2) Distance from building (3) Pitch (4) Archimedes law (b) Piping (1) Fill (2) Vent (3) Oil lines (a) One pipe (b) Two pipes (4) Thread pipes	2* 3 Chapter Six 4 Sections 1300-1320 5 Chapter Four
1.12	Student will size copper piping from sizing chart. Student will read malfunctions specifications and install filter from accessible location. Student will install safety relief valves in hot water or steam installation.	II. Run oil lines, install filters, etc. (a) Piping, one pipe, two pipes (1) Sizing (2) Materials (b) Filters (1) Sizing (2) Media (3) Positioning (c) Safety valves (1) Code pertaining to safety (2) Sizing (3) Materials	2 3 Chapter Six 4 Sections 1300-1320

* Number refers to source listed in Suggested Texts and References section.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
1.13	Student will be instructed in proper piping procedure for vent and fill pipe according to code.	III. Run vent and fill lines (a) Sizing (b) Materials (c) Location (d) Code	3 Chapter Six 4 Sections 1300-1320 5 Chapter Four	III. Run vent and fill lines
1.14	Show student how to select equipment from heat loss calculation and determine type or style to use by reading blueprints of project. Size ducts if not indicated on drawings.	IV. Select equipment to be installed (a) Manufacturer's specifications (b) Size requirements (c) Style (upright-horizontal, etc.)	7 Manual J 8 Manual K 3 Pages 37-39 5 6	IV. Select equipment to be installed
1.15	Student will learn state codes and install unit accordingly using correct materials.	V. Install equipment (a) Handling during delivery (b) Code requirements (1) Clearances (2) Location (3) Materials	4 Section 520 5 Chapters Nine and Six	V. Install equipment
1.16	Student will learn from proper code chart, flue pipe size, and material thickness according to BTU input of fossil fuel equipment.	VI. Connect to prefabricated and masonry flue (a) Clearances (b) Materials for connection (c) Size (diameter and length) of connection (d) Code requirements	4 Section 520 and 807 5 Chapter Six	VI. Connect to prefabricated or job erected flue

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
1.17	Fossil fuel test kit will be used in class to achieve an adjustment that will produce 10 to 12% CO_2 resulting in at least 75% efficiency where possible. Install oil pressure gauge on oil pump to maintain 100 PSIG.	VII. Selected service equipment (a) Oil gauge (b) Smoke tester (c) CO_2 thermometer (d) Stack thermometer (e) Duct thermometer (f) Hand tools	9 Bacharch Mfgr. Data Manufacturer's Data (Service Manuals) 5 Chapter Six Page 116 Manufacturer's Data (Service Manuals) 10 Manufacturer's Data (Service Manuals)	VII. Service equipment
1.20	GAS HEAT			
1.21	Student will read piping chart and select piping material according to location (above or below grade), install gauge, and pressure test for 24 hours. (Copper not recommended for Natural Gas.)	I. Install gas piping (a) Sizing (1) Diameters (2) Lengths (3) Schedule (b) Materials (1) Steel (2) Aluminum (3) Copper (c) Code requirements (d) Pressure testing (1) Low pressure (2) High pressure	3 Chapter Six 4 Sections 1404-1411	I. Install piping for gas line
1.22	Show student how to select equipment from heat loss calculation and determine type or style (upflow, downflow, or horizontal) to use by reading blueprints of project. Size duct system.	II. Equipment selection (a) Manufacturer's specification (b) Size requirements (c) Style	7 8 10 Manufacturer's Sheets	II. Select equipment

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
1.23	Student will be taught state and local codes and how to install gas equipment accordingly, using correct hangers for ductwork.	III. Equipment installation (a) Handling during delivery (b) Code requirements (1) Clearances (2) Location (3) Supporting materials	4 Tables 1 - 7 3 Chapter Six	III. Install equipment
1.24	Student will learn from state code book charts, proper flue size and material thickness according to BTU input of fossil fuel equipment.	IV. Connect to prefabricated or masonry flue (a) Clearances (b) Materials for connection (c) Size (diameter and length) of connection (d) Code requirements	4 Tables 1-7 3 Chapter Six 5 Chapter Six	IV. Connect to prefabricated or job erected vents and flues
1.25	Fossil fuel test kit will be used by student in classroom to prove efficiencies of 80% or greater from manifold adjustment. "H" tube manometer will be used to achieve pressure of 3.5 inches Hg for natural gas and 11 inches Hg for L.P. gas.	V. Service equipment (a) Selected (1) CO tester (2) CO_2 tester (3) "U" tube manometer (4) Stack thermometer (5) Duct thermometer (6) Gas gauges (7) Hand tools (b) Installed gas gauges	8 Chapter Six 9 Pages 873 and 874	V. Service equipment.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
1.40	HEAT LOSS CALCULATIONS			
1.41	Instruct student on building heat loss, then use Manual "J" heat transfer multiples as an accurate, short, time-saving method. For heat gain, add internal load multipliers in addition to external multipliers.	I. Heat loss calculation for air (a) Manual J-residential (b) ACCAA (c) ASHRAE	7 Entire book 12 Entire book 11 Pages 645-695	I. Calculate air heating heat loss and heat gain
1.42	Instruct student on building heat loss then use IBR Manual H-21 as an accurate method.	II. Hydronic heat losses (a) IBR Manual H-21-Residential and Commercial (b) Detailed method (c) Short cut method	7 Entire book 13 That which is appropriate	II. Calculate hydronic heat loss
1.50	COMBUSTION			
1.51	Student must explain nozzle size and angle or of how orfice size is measured. Location and changing procedure	I. Choosing type heater (a) Heat content of the fuel (b) Limits of equipment	1 Chapter #19	I. Match proper nozzle or orfice size to heating equipment and building
1.52	Student explain basic differences in equipment used to transfer heat by warm air, water, or steam.	II. Selecting means of transferring heat (a) Cooling/heating medium (b) Air (c) Water (d) Steam	1 Chapter #19	II. Selecting heating medium

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
1.53	Student must explain the fuels available to create heat for warm air, water, and steam.	III. Draft and combustion equipment (a) Warm air (b) Boiler (c) Hydronics	1 Chapter #19	III. Select heating equipment
1.54	Select and evaluate draft and combustion equipment.	IV. Draft and combustion equipment (a) Forced or gravity flues (b) Chimneys	1 Chapter #19	
1.55	Demonstrate proper use of draft gauge, smoke tester, thermometer and CO_2 indicator.	V. Combustion air requirements (a) Draft (b) Smoke sample	1 Chapter #19	V. Determine combustion air requirements
1.56	Student to explain effects on combustion of too little and too much primary air.	VI. Combustion by-products (a) Reduce contamination (b) Filter and clean	1 Chapter #19	VI. Determine combustion by-products
1.57	Student to choose one of three nozzles for oil burner that gives the best efficiency.	VII. Burners and nozzles (a) Combustion required (b) Nozzle configuration to fit combustion chamber	1 Chapter #20, Pages 708-711	VII. Choose burner shape and nozzle to match heat exchanger and building.
1.58	Student must demonstrate the use of test instruments.	VIII. Maximum efficiency (a) Use CO_2 - 0 - analyzer	1 Chapter #20, Pages 710, 718-719	VIII. Obtain peak operating efficiency using test instruments

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.60	ENERGY CONSERVATION OIL BURNER EFFICIENCIES			
9.61	The student will study the heat content of each type of fuel.	I. Heat content of fuels (a) API tables and charts (b) BTU's	1 Chapter #27, Page 948	I. Know the heat content of each type of fuel
9.62	The student will study the advantages and disadvantages of fuels.	II. Comparison of fuels (a) BTU per unit (b) Cost per unit (c) Pollution aspects	1 Chapter #27, Page 948	II. Evaluate the advantages and disadvantages of the fuels
9.63	The student will study the components needed to handle a certain fuel.	III. Components required for a given fuel (a) Preparation (b) Delivery (c) Storage	1 Chapter #20, Pages 713-716	III. Determine the components needed to handle a certain fuel
9.64	The student will study the type of burners being used and those things required to burn the fuels completely.	IV. Burner types (a) Burners (b) Ignition assemblies	1 Chapter #20, Page 709	IV. Identify the type of burner being used and those things required to burn the fuel completely
9.65	The student will study the advantage of each type of furnace.	V. Furnace advantages (a) Design features (b) Efficiencies	1 Chapter #20	V. Determine the advantage of each type of furnace
9.66	The student will research how much fuel can be burned in the combustion chamber.	VI. Combustion chambers (a) Product specifications (b) Nozzles (c) Liners	1 Chapter #20, Page 709	VI. Determine how much fuel can be burned in the combustion chamber

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.67	The student will calculate the amount of air required to burn the fuel.	VII. Air supply to combustion chamber (a) Products of combustion (b) Complete/Incomplete combustion	1 Chapter #20, Pages 705-712	VII. Determine the amount of air required to burn the fuel
9.68	The student will evaluate the ventilation for the furnace or boiler room.	VIII. Ventilation Calculate air requirement based on BUT input	1 Chapter #20, Page 706	VIII. Determine the proper ventilation for the furnace or boiler room
9.69	The student will identify the chemicals needed for complete combustion and why excess air is required.	IX. Complete combustion (a) Principles of efficient combustion (b) Fuel supply (c) Vibration and pulsation (d) Excessive oil consumption (e) Contaminant	1 Chapter #20, Pages 705-707	IX. Know the chemicals needed for complete combustion and why excess air is required
9.610	The student will explain the by-products of combustion and how to use instruments to measure the CO_2 level.	X. Combustion by-product (a) Combustion test instruments (b) Smoke and soot	1 Chapter #20, Pages 706-707	X. Know the by-products of combustion and how to use instruments to measure the CO_2 level

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.611	The student will decide from the shape of the combustion chamber the correct angle of the nozzle needed.	XI. Nozzles (a) Product specifications (b) Services	1 Chapter #20	XI. Determine from the shape of the combusion chamber the correct angle of the nozzle needed
9.612	The student will study locations of burners in the combustion chamber.	XII. Burners (a) Install (b) Adjust	Instructor's Notes	XII. Place burner in the proper location in the combustion chramber
9.613	The student must demonstrate how to adjust an oil fuel pump and the primary air on burner.	XIII. Oil pressure and air supply (a) Testing and adjusting (b) Vibration and pulsation	1 Chapter #20	XIII. Adjust the burner oil pressure and adjust the air supply for a proper CO_2 reading.
9.614	The student will use the smoke spot tester to determine if any sooting is taking place.	XIV. Smoke spot tester	1 Chapter #18, Pages 660-664	XIV. Use the smoke spot tester to determine if any sooting is taking place
9.615	The student will determine if the blast tube and turbulator are properly set.	XV. Blast tube and turbulator	1 Chapter #20	XV. Determine if the blast tube and turbulator are properly set
9.616	The student will measure combustion draft and make changes necessary for proper draft.	XVI. Combustion draft Draft gauge adjustments	1 Chapter #20, Page 705	XVI. Measure combustion draft and make changes necessary for proper draft

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE		ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.70	GAS BURNERS - EFFICIENCIES				
9.71	Student will explain gross and net furnace output to match building heat loss on design day.	I. Heat loads (a) Match design condition to calculated heating demand (b) Heat loss calculations	1	Chapter #15, Pages 555-567	I. Calculate heat load
9.72	Student will explain minimum flue size and pitch of flue to thimble.	II. Chimneys and flues (a) Calculate and design chimney and flue piping to furnace size (b) Criteria	1	Chapter #20, Pages 701-707, 726	II. Size chimney for draft and combustion
9.73	Student will explain building code as to position of furnace in relation to combustible material.	III. Gas burners (a) Position, mount, or install as per print or form rating (b) Code	1	Instructor's Notes Chapter #20	III. Install gas burner according to building code
9.74	Student will explain manufacturer's specifications for fuel piping size.	IV. Piping charts (a) Pressure (b) Gas type	1	Chapter #20 Chapter #27, Page 948	IV. Size fuel piping to match pressure
9.75	Install wiring from diagram with proper electrical connections.	V. Wiring (a) Controls according to codes (b) Wire according to codes	4		V. Install electrical wiring to all loads and controls

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.76	Demonstrate the use of a Bacharch (or other) fuel efficiency instrument.	VI. Troubleshooting (a) Use meters, gauges and charts to establish correct combustion and efficiencies (b) Adjust and service burners	Instructors Notes	VI. Troubleshoot and service gas burners

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SUGGESTED TEXTS AND REFERENCES

1. Modern Refrigeration and Air Conditioning
   Althouse, A.D., Turnquist, C.H., and Bracciano
   Chicago: Goodhart-Willcox Co.

2. Pamphlets and brochures
   North Carolina Oil Jobbers Association
   Raleigh, North Carolina 27612

3. Fundamentals of Heating
   North America Heating and Air Conditioning Wholesalers Association
   Columbus, OH

4. North Carolina State Building Code, Vol. III
   North Carolina Building Code Council and North Carolina Department of Insurance
   Raleigh, NC

5. Comfort Heating
   Langley, B.
   Reston, VA: Reston Publishing Co., 2nd ed., 1978

6. Getting Started in Heating and Air Conditioning Service
   Russell, A.
   Birmingham, MI: Business News Publishing Co., 1977

7. Manual "J" - Residential Load Calculation
   Air Conditioning Contractors of America
   Washington, DC 20036

8. Manual "D" - Residential Duct Design and Equipment Selection
   Air Conditioning Contractors of America
   Washington, DC 20036

9. Bacharach Test Kits and Instructions

10. Manufacturer's Specification Sheets

11. Air Conditioning and Heating Practice
    Laub, Julian M.
    New York: Holt, Rinehart, and Winston

12. Heat Loss Calculating Guide, = H-21
    Hydronics Institute
    Berkeley Heights, NJ: IBR

13. ASHRAE Guide and Data Book
    American Society of Heating, Refrigeration, and Air Conditioning Engineers
    New York

OTHER RESOURCES

Carrier Air Conditioning Slides and Cassettes
Series GTE, GTH, GTA
Carrier Air Conditioning Company
Syracuse, NY 13221

Heating, Ventilating, and Air Conditioning Library
Brumbaugh, James;
Indianapolis, IN: Theodore Audel, 1976 Vol. 3

OTHER RESOURCES con't

Manual "N" - Load Calculation for Commercial Summer and Winter Air Conditioning
Air Conditioning Contractors of America
Washington, DC

RSES Service Application Manual
Refrigeration Service Engineers Society
Des Plaines, IL: Vol. 2

NOTE: Number beside source agrees with numbering system used in Activity Experience column.

COMMUNICATION SKILLS is designed to promote effective communication through correct language usage in speaking and writing.

PREREQUISITE: ENG 1101

	Class Hours	Lab Hours	Credit Hours
MAJOR DIVISIONS	3	0	3

I. Sentence structure

II. Written expression

III. Talking and listening

IV. The report form

SUGGESTED TEXT:

Shurter, Robert LeFevre. Written Communications in Business. New York: McGraw-Hill Book Company, Inc., 1957.

SUGGESTED REFERENCES:

Hodges, John C. Harbrace College Handbook; Fourth Edition. New York: Harcourt, Brace and World, Inc.

Sherman, Theodore Allison. Modern Technical Writing. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958.

Webster's New Collegiate Dictionary. Springfield, Massachusetts: G. & C. Merriam Company.

DFT 1116

BLUEPRINT READING: AIR CONDITIONING - A specialized course in drafting for the heating, air conditioning and refrigeration student. Emphasis will be placed on reading of blueprints that are common to the trade; blueprints of mechanical components, assembly drawings, wiring diagrams and schematics, floor plans, heating system plans including duct and equipment layout plans, and shop sketches. The student will make tracings of floor plans and layout air conditioning systems.

PREREQUISITE: DFT 1104

	Class Hours	Lab Hours	Credit Hours
MAJOR DIVISIONS	1	3	2

I. Study of the prints of refrigeration and cooling conditioning equipment and its placement

II. Tracings and prints

III. Shop sketches

IV. Study of heating code requirements

V. Study of prints of the heating and cooling

VI. Tracings and prints

VII. Warm air heating systems layout

VIII. Practice - using plan and elevation tracing - (information from calculations and heat loss course)

SUGGESTED TEXTS AND REFERENCES:

Althouse, Andrew D., Carl H. Turnquist, and A. E. Bracciano. Modern Refrigeration and Air Conditioning. Honewood, IL, 1968.

American Society of Heating, Refrigeration, and Air Conditioning Engineers. Heating Ventilating Air Conditioning Guide. New York, 1961.

Building Trades Blueprint Reading. Albany, NY: Delmar Publishers, Inc.

Coover, S. L. and C. H. Groneman. Drawing, Sketching, and Blueprint Reading. New York: McGraw-Hill Book Company, Inc., 1954.

Coover, S. L. Drawing and Blueprint Reading. New York: McGraw-Hill Book Company, Third Edition, 1966.

Harris, Norman C. Modern Air Conditioning Practice. New York: McGraw-Hill Book Company, Inc., 1959.

Johnston, Phillip M. Related Instructional Material for Sheet Metal Technology. Sheet Metal 1, 2, 3 & 4. Albany, NY: Delmar Publishers, Inc., 1968.

Nicholson, F. S. Mechanical Drawing. New York: D. Van Nostrand Company, 1946.

Strock, Clifford, editor. Handbook of Air Conditioning Heating and Ventilating. New York: The Industrial Press, 1959.

The Trane Air Conditioning Manual. Lacross, WI: The Trane Company.

Warm Air Heating and Air Conditioning Library. Cleveland, OH: National Warm Air Heating and Air Conditioning Association.

Air Conditioning, Heating and Refrigeration Materials. Air-Conditioning and Refrigeration Institute, 1815 North Fort Myer Drive, Arlington, VA 22209.

McCabe, Francis T., Charles W. Keith, and Walter E. Farnham. Mechanical Drafting Essentials. Prentice-Hall, Inc., Fourth Edition. 1967. Part VI - Sheet Metal Drafting, Chapter 21.

COURSE OUTLINE

AHR 1123 PRINCIPLES OF AIR CONDITIONING

Developed By

Air Conditioning and Refrigeration

Competency Curriculum Committee

October, 1979

PROGRAM DEVELOPMENT
DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

AHR 1123 - PRINCIPLES OF AIR CONDITIONING

DESCRIPTION OF COURSE:

Course covers various heating, cooling, and ventilating systems, and the investigation and control of factors affecting air cleaning, movement, temperature, and humidity. Use is made of psychrometric charts in determining equipment needs to produce optimum temperature and humidity control. Air conditioning equipment is selected, assembled, installed, wired, calibrated, and tested. Sizing, installing, and balancing of ductwork is performed as needed.

Course Hours Per Week:	Classroom, 3; Laboratory, 12.
Quarter Hours Credit:	7.
Prerequisite:	AHR 1122.
Course Objectives:	Specific objectives are included in the outline of instructions.
Course Outcome:	The student will develop skills in the principles of air conditioning as related to distribution. Course is structured to provide for the development of skills in installing and connecting ducts, mounting condensate drains, aligning drive systems, wiring motors and controls, determining pulley ratios and direction of rotation and measuring current draw. Additional laboratory experience will be given in reading blueprints, installing diffusers and grills, checking hangers, making and sealing joints, and adjusting for proper air flow and sound levels. Adjusting mechanical and electrical controls, checking humidifiers and filters, and balancing the system will be covered.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	AIR CONDITIONING AND HEAT PUMPS			
2.30	HAND TOOLS			
2.31	The student will be taught the proper use of each hand tool with particular emphasis on cost and care of tools	I. Know how to use basic hand tools a. Know the tools used in this trade b. How to properly use these tools c. How to care for tools d. Cost of tools e. What tool to use for each procedure	1* Chapter 2 5 Care and use of tools of the trade	I. Use basic hand tools
2.32	The student will be taught the use of specialized tools	II. Using specialized tools (Same as a-e above)		II. Use specialized hand tools
2.40	ELECTRICAL INSTRUMENTS			
2.41	The student will select meter, set scale and check circuit, making voltage, current, and resistance checks.	I. Determining current, voltage, and resistance a. Know which instruments are used for each test b. Know the difference between volt, amp and ohm meters c. Understand basic electricity d. Know how to test each type of circuit	1 Chapter 6 6 Chapters 3 and 15	I. Use electrical instruments to determine current, voltage and resistance

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*Number refers to source listed in Suggested Texts and Reference section.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		e. Know the current, voltage, and resistance required		
2.42	Read name plates and use instruments to determine if phase, voltage and current are correct.	II. Determining power (Same as a-e above)	4 Chapters 3 and 15 5 Recommended uses and procedures	II. Use electrical instrument to determine power
	AIR DISTRIBUTION			
4.10	AIR HANDLER			
4.11	The student will, using appropriate instructions, place and put into operation an air handling unit that will meet noise abatement requirements.	I. Set air handler a. Blueprints b. Locations c. Special considerations d. Measurements e. Sizes	3 Pages 142-170 2 Pages 604, 606-609	I. Set air handler
4.12	The student will gain understanding of vibration isolation principles including rubber pads, springs, and canvas connector.	II. Leveling air handler a. Method of mounting b. Vertical, horizontal, down-flow and suspended types	2 Pages 66, 291-293	II. Level air handler
4.13	The student will demonstrate the ability to service electrical-mechanical and filtering of air handling.	III. Tightening screws and bits a. Code requirements b. Safety		III. Tighten screws and bits

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
4.14	The student will learn to recognize appropriate types of filter medice, proper direction of air flow and understand need for precipitator.	IV. Installing air filters a. Air directions b. Provisions for our precipitators	2 Pages 619, 722, 577	IV. Install air filters
4.15	The student will demonstrate the different drives and methods of alignment, and how to detect misalignment.	V. Installing and aligning drive system a. Pulley alignment b. Belt tightness c. Bearings d. Lubrication e. Sound and rattles preventing (shipping bolts and screws removed)	3 Page 145	V. Install and align drive systems
4.16	The student will learn to identify motors, locate the lead or terminal and determine the wire size necessary to run the motor.	VI. Wiring motor a. Electrical schematics b. Voltage, phase, cycle conductor amperage c. Motor protections d. Code e. Grounding requirements f. Ambient temperature	1 Page 265	VI. Wire motor
4.17	Student will demonstrate proper use of tachometer, ammeter, and volt meter as they relate to starting an electric motor and assuring proper rotation of that motor.	VII. Checking rotation and RPM a. Startup procedures b. Determining rotation and RPM		VII. Check amperage and voltage

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
4.18	The student will learn the proper and safe use of electrical test instruments.	VIII. Checking amperage and voltage a. Use electrical instruments to determine current, voltage, resistances and grounding b. Read under loaded conditions	3 Page 209-240	VIII. Check amperage and voltage
4.19	The student will demonstrate the ability to install, pitch and by code install double and single pan equipment.	IX. Installing condensate drain pipe a. Correct pitch b. Open drainage c. Code	2 Page 577	IX. Install condensate drain pipe
4.110	Student will check compliance with code and proper operation by filling pan with water and assuring no leaks and proper drain off.	X. Check for proper drainage a. Code b. Testing		X. Check for proper drainage
4.111	The student will demonstrate weight distribution-canvas connectors and springs as related to air handling.	XI. Installing and vibration eliminators a. Pad b. Springs c. Felt d. Canvas connectors in all supply ducts	2 Pages 66, 291-293, 741	XI. Install vibration eliminators

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
4.20	DUCT SYSTEMS			
4.21	The student will be able to size duct and fittings to deliver the proper amount of air to a given point.	I. Designing duct system a. Heat load calculations b. Air requirements for each outlet c. Air velocity d. Type of system e. Location of duct system	3 Page 171-189	I. Properly design duct systems
4.22	The student will be able to pick up all materials necessary to do a duct system from the working drawing.	II. Installing duct systems a. Check for accuracy and codes from blueprint (double check it) b. Check for obstructions and incidentals that may conflict with blueprint c. Check work orders (materials check)	2 Pages 618-619 625-646	II. Install duct systems from working drawings
4.23	Student will be able to install any duct fittings and supports.	III. Checking hangers, joints, and dampers materials check against work order	3 Page 293-296	III. Check all hangers, joints, and dampers
4.24	The student will be able to insulate a duct system.	IV. Insulating duct system a. Types of insulation b. Check against specifications for thickness, density, vapor barrier	3 Page 142-189	IV. Insulate duct systems

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
4.25	The student will be able to add openings of any type to a duct system.	V. Cutting openings a. Work as close to working plans and blueprints as possible b. Go to general contractor for deviations from blueprints		V. Cut openings for ducts, diffusers, grills
4.26	The student will be able to select and install grills and diffusers.	VI. Installing diffusers and grills a. Follow working plans and blueprints b. For deviations go to general contractor		VI. Install diffusers and grills
4.27	The student will be able to air balance a duct system by use of proper instruments and check all registers/diffusers for proper air volume.	VII. Balancing system a. Check outlets with velometer b. Convert to CFM c. Adjust quantity as per outlet shown on plans d. Check duct size e. Check fittings and registers for proper delivery of air f. Make necessary adjustments to insure proper air quantity	3 Page 303-308	VII. Balance system for proper quantity and direction of air flow
4.28	The student will be able to determine what the control should do and make adjustments so it.	VIII. Adjusting controls a. Follow system cycle b. Use gauges (pressure), thermometers (temp.), and electrical instru-	3 Page 281-283 3 Control systems check 289-290	VIII. Adjust mechanical and electrical controls

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	will perform properly.	ments for overload protection (safety) c. Working media		
4.29	The student will be able to do the job safely.	IX. Applying safety rules a. Applicable in all phases of installation b. OSHA regulations	2 Page 55	IX. Apply good safety rules
4.30	EXHAUST AND MAKEUP AIR SYSTEM			
4.31	The student will know what size the opening should be made and where to make it.	I. Cutting openings a. Selection of tools to be used b. Tools available when needed and in good operable condition c. Have blades, bits, etc., for replacement	3 Air cycle Pages 11-16	I. Cut proper openings
4.32	A student will be able to mount equipment and determine its performance.	II. Adjust the setting of fans and/or louvers a. Adjust fan RPM by adjusting pulley b. Manual or motorized damper/louvers	3 Air distribution outlets Page 158-170 3 Duct sizing Page 171-189	II. Adjust fan and/or louvers
4.33	The student will calculate and adjust air quantities required, using ap-	III. Checking and adjusting air quantities a. Use velometer reading times area of supply to convert to CFM	3 Page 303-308	III. Check and adjust air quantities

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	propriate meters and gauges, and selection of appropriate controls.	b. Close or open for quantity required		
	AIR TREATMENT			
5.10	CHECKING CONDITION OF AIR			
5.11	Student will demonstrate ability to use a sling, psychrometer to find wet and dry bulb temperature and plot an psychrometric chart.	I. Use of psychrometer a. Wet bulb reading b. Dry bulb reading c. Relation to comfort and % of humidity in the air	1 Pages 643,644	I. Use psychrometer
5.12	Student will demonstrate skill in using approved air velocities and keeping notebook data when taking air measurements.	II. Chart tables a. Grain of moisture per lb. of air b. Dewpoint c. Plotting of unknowns on charts using references from the psychrometer readings	1 Page 645	II. Use psychrometric charts and tables
5.13	Velometer will be used by student to demonstrate ability to arrive at proper reading of air delivery	III. Use approved air measuring device to determine cubic feet of air per minute	1 Page 651-652, 655	III. Check air volume
5.14	The student will demonstrate by the use of psychrometric chart or tables how to find the enthalpy of air.	IV. BTU/LB dry air	1 Page 645	IV. Determine enthalpy

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
5.20	HUMIDIFICATION			
5.21	The student will recognize and install humidifier after calculating requirements of moisture, piping operation and size.	I. Install humidifier a. Location b. Wiring c. Size d. Type e. Operation f. Water supply hook ups	1 Page 743, 745	I. Install humidifier.
5.22	The student will demonstrate the ability to check and service a humidifier.	II. Servicing humidifier a. Repair float assembly b. Clean and replace nozzle c. Clean or replace filters d. Check air flow and temperature e. Check or install (humidistats and relays) f. Check operation cycle	1 Page 699, 743-745	II. Service humidifier
5.23	The student, given required information, will select a humidifier, identify various types of humidifiers, utilize their various	III. Calculate from type of service a. Determine quantity of water b. What part of system installed	1 Page 742, 744	III. Size and select humidifier

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	applications and Calculate humidity requirements of a given area by using volume of area and physcrometric chart expressing answer in pounds or grains.	c. Select, using product literature		
5.30	DEHUMIDIFYING AIR			
5.31	The student will determine capacity of unit required, select physical location and connect necessary piping, controls, and wiring.	I. Install dehumidifier a. Size b. Location c. Application	1 Page 742-743	I. Install dehumidifier
5.32	The student will determine the desired relative humidity, make continuity tests of control system, and clean and recondition unit using proper chemicals.	II. Servicing dehumidifier a. Check dew point temperature b. Check air condition c. Check control circuits d. Check blower-damper motors and controls e. Check chemical content f. Add or replace chemicals	1 Page 643, 648	II. Service dehumidifier
5.33	The student will, where air humidification is desirable, determine unit size and type based on information which can	III. Know demand for structure and occupancy a. Determine moisture content b. Size and select	1 Page 645 1 Page 743, 744	III. Size and select dehumidifier

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	be obtained from phy-scrometric charts and use of instruments and the amount of air to be treated.			
5.40	<u>CLEANING AIR</u>			
5.41	The student will install filter, using proper size and thickness, with proper air flow direction.	I. Filters (porous media) a. Selection b. Installation and location c. Clean	1 Page 742, 743	I. Install or service filters (porous media)
5.43	The student will determine the condition of a power pack and rectifier using test instruments; locate filter unit upstream from heating elements, and use chemicals for cleaning procedures.	II. Installing or servicing electronic air filters a. Selection of filter b. Location for installation c. Electrical controls d. Wiring e. Use proper test instruments for checking defective filter f. Proper cleaning process	1 Pages 792, 797	II. Install and/or service electronic air

SUGGESTED TEXTS AND REFERENCES

1. Modern Refrigeration and Air Conditioning
   Althouse, A.D., Turnquist, C.H., and Bracciano
   Chicago: Goodhart-Willcox Co.

2. Refrigeration and Air Conditioning
   Air Conditioning and Refrigeration Institute
   Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979

3. Principles of Air Conditioning
   Lang, V. Paul,
   Albany, NY: Delmar, 3rd ed.

4. 35mm Slides and Cassettes can be obtained from
   Carrier Air Conditioning Company
   Syracuse, NY

5. Manufacturer's Specification Sheets

6. Servicing Comfort Cooling Systems
   North American Heating and Air Conditioning Wholesalers Association
   Columbus, OH

OTHER RESOURCES

ASHRAE Guide and Data Book
American Society of Heating, Refrigeration, and Air Conditioning Engineers
New York

Air Conditioning and Heating Practices
Laub, Julian M.
New York: Holt, Rinehart, and Winston, 1963

Air Conditioning for Building Engineers and Managers
Price, Seymour G.
New York: Industrial Press, 1970

Carrier Manual of Air Conditioning Systems Design
Carrier Air Conditioning Company
Syracuse, NY

Environmental Control: Air Conditioning and Refrigeration Theory and Application
Weaver, Michael K., and Kirkpatrick, James N.
Scranton, PA: Harper and Row, 1974

Handbook of Air Conditioning, Heating, and Ventilating
Strock, Clifford, and Koral, Richard L.
New York: Industrial Press, 2nd ed.

Manual J - Load Calculation and Manual K - Equipment Selection, and System Design
Air Conditioning Contractors of America
Washington, DC

Modern Air Conditioning Practice
Harris, Norman C., and Conde, D.F.
New York: McGraw-Hill, 2nd.Ed.

Modern Refrigeration Practice
King, Guy R.
New York: McGraw-Hill, 1971

The Environmental Systems Library
Air Conditioning Contractors Association
Washington, DC 20036

Trane Air Conditioning Manual with Psychrometric Chart
Trane Company
La Crosse, WI 54601

NOTE: Number beside source agrees with numbering system used in Activity Experience column.

COURSE OUTLINE

AHR 1128 AUTOMATIC CONTROLS

Developed By

Air Conditioning and Refrigeration

Competency Curriculum Committee

October, 1979

PROGRAM DEVELOPMENT
DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

AHR 1128 - AUTOMATIC CONTROLS

DESCRIPTION OF COURSE:

Types of automatic controls and their function in heating and cooling systems. Included in the course will be electric, electronic, mechanical, and pneumatic controls for domestic and commercial heating and cooling along with zone controls, unit heater and ventilator controls, commercial fan system controls, commercial refirgeration controls, and radiant panel controls.

Course Hours Per Week: Class, 3; Laboratory, 6.

Quarter Hours Credit: 5

Prerequisites: AHR 1122, ELC 1102.

Course Objectives: Specific objectives are included in the outline of instruction.

Course Outcome: The student will develop skills in the reading and interpretation of electrical symbols; understanding of mechanical controls; construction of electrical diagrams; accurate identification and knowledge of function of electrical, mechanical, and pneumatic controls; and the diagnosing of control problems and applications using correct test equipment. Additional expertise will be practiced in the laboratory: calibrating, mounting, identifying, and repairing controls and their load devices. Motor circuits and components will be tested, replaced, and adjusted. Temperature controls devices will be installed, wired, and appropriate adjustments made.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
3.30	MOTORS AND CONTROLS			
3.31	Check a group of motors and recognize the various types of motors and their use	I. Recognizing various types or motors a. Shaded pole b. PSC c. CS d. CSR e. Belt driven f. Direct driven	1* Pages 209-212; 216-219; 223	1 Recognize various types of motors
3.32	Student will use diagram to wire a complete system	II. Installing and wiring a. Wire from reading schematic wiring diagram b. Install according to good installation practices	1 Page 217-220	II. Install and wire (connect) an electric motor (use unit diagram)
3.33	Student will install and operate the different types of relays	III. Wiring in different types of starting relays a. Determine type and load b. Current relay c. Potential relay	1 Pages 243-259, 265	III. Wire in different types of starting relays (use diagram)
	CONTROLS			
6.10	WIRING DIAGRAMS			
6.11	Identify various electrical components from diagrams and explain their function. Draw and create wiring diagrams to accomplish a determined objective	I. Recognizing and using the symbols of control diagrams a. Relate symbol to parts b. Electric c. Electronic d. Pneumatic	1 Pages 173 2 Pages 36-148 3 Pages 33-34, 47-48 52-53, 140-150, 165-177	I. Recognize and use the symbols of control diagram

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*Number refers to source listed in Suggested Texts and Reference section.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
6.12	Draw schematic control systems using proper symbols to describe the overall function and use in trouble-shooting	II. Composing a schematic diagram of control systems a. Think function of system b. Use of symbols c. Draw straight lines	1 Pages 243-275 2 Pages 113-148	II. Compose a schematic diagram of control systems
6.13	The student should be able to recognize the effect of temperature, pressure and humidity on a system and understand the function of the components	III. Comparing mechanical control elements a. Temperature control b. Pressure control c. Humidity control	2 Pages 78-94 3 Pages 214-216	III. Compare mechanical control elements
6.14	Use controls to point out differences and identify characteristics	IV. Illustrating the differences between mechanical, electrical, electronic and pneumatic control a. Mechanical 1. Use 2. Type b. Electrical 1. Type 2. Use c. Electronic 1. Use in heat pumps 2. Use in oil and gas d. Pneumatic 1. Use in industrial control 2. Type	3 Pages 214-216	IV. Illustrate the differences between mechanical, electrical, electronic, and pneumatic control

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
6.15	Function should be stressed and how to determine if a control is actually defective or is responding to a condition as it should. This is the actual act of troubleshooting and will require the knowledge and skill in the use of various testing devices.	V. Using schematic diagrams in the process of diagnosing control problems a. To trace circuits b. To check voltages c. To check parts in control system d. To check current	2 Pages 149-184	V. Use schematic diagrams in the process of diagnosing control problems.
6.20	<u>TEST EQUIPMENT</u>			
6.21	Use test equipment in the lab to check out systems. Each test instrument should be used in in as many applications as can be found. Advanced use of instruments should prepare the student for additional applications.	I. Using test equipment for checking a. Ohms b. Amps c. Volts d. Microfarads e. Milliamps f. Temperature g. Humidity h. C.F.M.	1 Pages 174-179	I. Use test equipment for checking

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
6.22	Student should learn proper use of test equipment to determine malfunctions, defective parts, incorrect wiring, etc. Thru use of instruments determine power factors, conversions factors, resistances, and comparisons of different types of conductors.	II. Diagnosing problems in control circuits a. V.O.M. use b. Amprobe use c. Appropriate recording equipment	3 Pages 126-130, 221-227 4 Pages 248-287	II. Diagnose problems in control circuits
6.23	Student will use a manometer plus other diagnostic instruments to set gas unit in operation. Thru the use of instruments determine combustion efficiencies, check cad cell, determine continuity and normal switch position, trace oil burner electrical circuits, and determine malfunction by locating and replacing defective components	III. Testing and replacing oil burner controls a. Heat anticipator b. Thermostats c. Flame controls d. Fan and pump controls	3 Pages 118-121, 222-223, 225-226, 284	III. Test and replace oil burner controls

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
6.24	Student should recognize burned out elements, use instruments to find defective thermal overloads, and check for proper wiring	IV. Testing and replacing oil burner controls a. Thermostats b. Flame safety controls c. Gas controls	1 Pages 852-859 3 Pages 229-230, 295-296	IV. Test and replace gas burner and oil burner controls
6.25	Student should recognize electric furnace and its controls and components	V. Testing and replacing electric heat controls and elements a. Thermostats b. Safety controls c. Elements		V. Test and replace electric heat controls and elements
6.26	Zone control systems use motorized dampers or valves (hydronic) to meter the flow of a liquid or a gas in response to the demand of a heat controlling device. How to control this metered flow requires test equipment.	VI. Diagnosing zone control systems a. Thermostats b. Dampers motors c. Dampers type d. Valves	3 Pages 15, 20, 231-235, 316-321, 267-279, 346 373-374	VI. Diagnose zone control systems
6.30	COMPONENTS			
6.31	Have the students actually handle the individual controls, properly identify them and explain how they work.	I. Recognizing the different types of relays, starters and their application	1 Pages 260-265, 845 2 Pages 78-94	I. Identify the different types of relays and state their application

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
6.32	Have the student to identify the types of unit heaters, their controls, and use.	II. Identifing the types of unit-heater control systems, unit ventilator control methods, outdoor thermostats a. Fan control b. Basic rate control c. Hot water controls d. Steam controls e. Damper controls f. Building control using outdoor control	3 Pages 274-279, 349-353, 227-229, 273-274, 136-137	II. Identify the types of unit-heater control systems, unit ventilator control methods, outdoor thermostat controls
6.33	Have students select a location, install, and adjust the heat anticipator on a thermostat.	III. Installing and calibrating a thermostat a. Correct location b. Adjust heat anticipant c. Check calibration d. Not in draft e. Not near electric appliance f. Seal hole back of thermostat g. Level correctly h. Mount properly	3 Pages 88-101 4 Pages 184-192 1 Pages 844-845	III. Install and calibrate a thermostat
6.34	Have the student explain the burner cycle. What happens when the thermostat calls for heat. What happens if the flame is established; what happens if the	IV. Determining component coordination and operational sequence a. Thermostat call for heat b. Ignition c. Flame d. Flame out	4 Pages 184-346	IV. Determine component coordination and operational sequence

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	flame is not established.	e. Safety control f. Must be reset		
6.35	Determine and recognize the function of the many types of controls. Determine their individual operation as it affects the entire control system.	V. Installing electric and pneumatic controls a. Air source b. Air lines c. Air valves d. Air relays e. Air, motors f. Wiring g. Voltages	3 Pages A-162, 209-210 B-161 C-171-172, 200-202 D-202-207 E-198-201 3 Pages 212-266, 267-279 4 Pages 184-344 1 Pages 169-208	V. Install electric and pneumatic controls for domestic and commercial heating and cooling
6.36	Have students select and explain function of domestic and commercial refrigeration controls.	VI. Identifing the types of controls and their function a. Relays b. Thermostats c. Safety controls d. Operational controls	3 Pages 243-275	VI. Identify the types of controls and their function in domestic and commercial refrigeration
6.40	<u>REFRIGERANT CONTROLS</u>			
6.41	The student will install and adjust all types of refrigerant controls.	I. Repairing or replacing refrigerant controls a. Thermostatic expansion valve b. Automatic expansion valve c. Hi-side float d. Low-side float e. Capilliary tube f. Electric expansion valve	1 Pages 141-167	I. Repair or replace refrigerant controls for refrigeration and air conditioning

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
6.42	The student will install and put in working condition valves and controls	II. Using solenoid valves, modulating controls, and three way valves to control the distribution of refrigerant	1 Pages 443-447, 863	II. Use solenoid valves, modulating controls, and three way valves to control the distribution of refrigerant
6:50	WIRING AND CONTROLS			
6.51	Identify the amp draw of load devices and select the proper size and style relay for replacement	I. Determining ampere draw and installing proper relay a. Relation of control relay in relation to motor horsepower b. Ampere draw c. Install proper relay	3 Pages 39-55	I. Determine ampere draw and install proper relay to control small fractional horsepower motors.
6.52	Use amp meter to determine actual amp draw. Select proper contactor for replacement.	II. Determining ampere draw and install proper contactor a. Determine ampere draw of motor b. Install contactor	2 Pages 36-68	II. Determine ampere draw and install proper contactor for larger horsepower motors
6.53	Position valve properly in line, and make correct electrical connections	III. Installing electric solenoid valve a. Mechanical and electrical methods of installation b. Solenoid valves	1 Pages 446, 394	III. Install electric solenoid valve for pump down control on commercial refrigeration system.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
6.54	Use electrical wiring diagrams to wire diagrams to wire solenoid correctly in circuit	IV. Wiring electric solenoid a. Schematics b. Applications	1 Page 446	IV. Wire electric solenoid from wiring schematic
6.55	Identify and select proper overload based on amp draw requirements and physical adaptability	V. Installing motor overload a. Follow wiring diagram b. Install proper size overload	1 Chapter 10	V. Install motor overload on domestic freezer or refrigerator
6.56	Select and identify proper amp draw of overload device and show how to adapt it to the motor.	VI. Wiring internal motor overload on air conditioner	1 Page 259 Page 22-24	VI. Wire internal motor overload on air conditioner
6.57	Select and identify proper amp draw of overload device and show how to adapt it to the motor.	VII. Wiring external motor overload a. Determine from wiring schematic how overload is wired in system b. Wire overload device to motor	2 Page 22-24	VII. Wire external motor overload on air conditioner
6.58	Mount controls level and free from all other heat sources, sensing only indoor air temperature.	VIII. Mounting Bi-metallic thermostat a. Return air sensing b. Effect of radiant heat on bi-metal controls	3 Page 89-90, 303	VIII. Mount Bi-metallic thermostat in proper location for air conditioner

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
6.59	Select proper size conductors and show how to make proper electrical connections when wiring bi-metal thermostat	IX. Wiring bi-metal thermostat a. Read schematic wiring diagram b. Wire thermostat c. Check thermostat	4 Pages 261-264	IX. Wire bi-metal thermostat into control system using wiring schematic
6.510	Student will be able to determine and replace the proper thermostat and adjust to conform at the proper temperature.	X. Installing thermostat on domestic refrigerator or freezer a. Determine length of capillary tube (external-internal location) in capillary tube well b. Replace thermostat	1 Pages 243-252	X. Install temperature type thermostat on domestic refrigerator or freezer
6.511	Student will install a primary and secondary thermostat	XI. Installing pressure type thermostat on commercial refrigeration system a. Determine length of capillary tube b. Make internal or external installation	1 Pages 258, 433-439	XI. Install pressure type thermostat on commercial refrigeration system
6.512	Student will install a low pressure and a high pressure control	XII. Wiring high-low pressure switch a. Read schematic wiring diagram b. Install high-low control	1 Pages 258, 433-439	XII. Wire high-low pressure switch on commercial refrigeration system from wiring schematic

SUGGESTED TEXTS AND REFERENCES

1. Modern Refrigeration and Air Conditioning
   Althouse, A.D., Turnquist, C.H., and Bracciano
   Chicago: Goodhart-Willcox, Inc., 1975

2. Electric Motor Control Fundamentals
   McIntyre, R.L.
   New York: McGraw-Hill, 1974, 3rd ed.

3. Automatic Controls of Heating and Air Conditioning
   Haines, John E.
   New York: McGraw-Hill, 2nd ed.

4. Domestic and Commercial Oil Burners
   Burkhardt, Charles H.
   New York: McGraw-Hill, 3rd ed.

OTHER RESOURCES

Control Systems for Heating, Ventilating, and Air Conditioning
Haines, R. W.
Albany, NY: Delmar, 1978

Electric Controls for Refrigeration - Air Conditioning
Langley, William C.
Englewood Cliffs, NJ: Prentice-Hall, 1974

Fundamentals of Automatic Controls
Honeywell, Inc.
Minneapolis, MN: RS44

Honeywell Service Handbooks - Oil, Gas, Commercial Air Conditioning and Cooling Controls
Honeywell, Inc.
Minneapolis, MN

NOTE: Number beside resource agrees with numbering system used in Activity Experience column.

HUMAN RELATIONS is a study of basic principles of human behavior. The problems of the individual are studied in relation to society, group membership, and relationships within the work situation.

PREREQUISITE: None

	Class Hours	Lab Hours	Credit Hours
MAJOR DIVISIONS	3	0	3

I. Basic principles of human behavior

II. Striving to understand human relations

III. Behavior and problems in living

IV. Striving to become an effective worker

SUGGESTED REFERENCES:

Textbook: Milliken, Mary Elizabeth, Understanding Human Behavior. Albany, New York: Delmar Publishers, 1969.

Dennis, Lorraine Bradt. Psychology of Human Behavior for Nurses. Philadelphia; W. B. Saunders Company, 1967.

Gilmer, B. von Haller. Applied Psychology: Problems in Living and Work. New York: McGraw-Hill Book Company, 1967.

Heckel, Robert V., and Rose M. Jordan. Psychology: The Nurse and the Patient. St. Louis: C.V. Mosky Company, 1967

Heider, Fritz. The Psychology of Interpersonal Relations. New York: John Wiley and Sons, Inc., 1958.

Hepner, Harry Walker. Psychology - Applied to Life and Work. Englewood Cliffs, N.Y.: Prentice Hall, Inc., 1957.

Laird, Donald A., and Eleanor C. Laird. The Technique of Handling People. New York: McGraw-Hill Book Company, 1954.

Laird, Donald A., and Eleanor C. Laird. Human Relations and Motivation. New York: McGraw-Hill Book Company, 1967.

BASIC GAS WELDING demonstration by the instructor and practice by the students in the welding shop. Safe and correct methods of assembly and operating the welding equipment. Practice will be given for surface welding, bronze welding, silver-soldering and flame cutting methods applicable to mechanical repair work.

PREREQUISITE: None

Class Hours	Lab Hours	Credit Hours
0	3	1

MAJOR DIVISIONS

I. Equipment

II. Safety

III. Types of Flames

IV. Setting Up Equipment and Lighting Torch

V. Welding Symbols

VI. Brazing with Bronze Rods

VII. Silver Soldering Nonferrous Metals

VIII. Silver Soldering Ferrous Metals

IX. Soft Soldering

SUGGESTED TEXTS AND REFERENCES:

Griffin, Ivan and Roden, Edward M., Basic Oxyacetylene Welding, Delmar Publishers, 1977

Jefferson, T. B., The Welding Encyclopedia, Jefferson Publishers, 1974

COURSE OUTLINE

AHR 1124 AIR CONDITIONING, HEATING, AND REFRIGERATION SERVICING

Developed By

Air Conditioning and Refrigeration

Competency Curriculum Committee

October, 1979

PROGRAM DEVELOPMENT
DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

AHR 1124 - AIR CONDITIONING, HEATING, AND REFRIGERATION SERVICING

DESCRIPTION OF COURSE:

Emphasis is placed on the maintenance and servicing of equipment used in the cleaning, changing, humidification, and temperature control of air in an air conditioned space. Shop work involves locating and correcting equipment failures and controlling, testing, and adjusting heating and cooling equipment to maximize energy conservation.

Course Hours Per Week: Class, 3; Laboratory, 6.

Quarter Hours Credit: 5.

Prerequisite: AHR 1123.

Course Objectives:

1. To teach the student methods of trouble-shooting and servicing domestic and commercial systems.
2. To teach the use of proper check-out and repair procedures.
3. To develop an attitude of taking the necessary precautions for personal safety and care of the equipment in all service procedures.

Course Outcomes: Given experience; the student can quickly diagnose and repair (or restore) systems to provide efficient performance.

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	HEATING			
1.10	OIL			
1.17	Service equipment	I. Service and maintenance on oil burners a. Adjusting for higher combustion efficiency b. Nozzle problems c. Ignition problems d. Fuel pumps	7* Pages 401-407	I. The student will service oil heating systems
1.20	GAS			
1.25	Service equipment	I. Gas heating devices a. Classification of gases b. Atmospheric injection burners c. Power gas burners	7 Pages 408-415	I. The student will service gas heating systems
1.30	ELECTRIC			
1.35	Service equipment selected and installed	I. Electric resistance heating units a. National and local electrical code requirements b. Resistance units in ducts c. Duct furnaces d. Wall panel electric heat	7 Pages 416-421	I. The student will service heat pumps

* Number refers to source listed in Suggested Texts and Reference section.

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	AIR CONDITIONING AND HEAT PUMPS			
2.10	MECHANICAL DIAGNOSIS AND SERVICING			
2.12	Locate system trouble	I. Diagnosis of trouble a. Make exterior checks b. Make interior checks c. Check all electrical controls d. Check other controls e. Check air cleaning devices	7 Pages 169-175, 218-248	I. The student will locate trouble in heating and cooling systems.
2.13	Correct problem	II. Installation and servicing a. Types of units b. Replacement and repair	2 Pages 737-754	II. The student will correct problems in air conditioning systems
2.20	ELECTRICAL DIAGNOSIS AND SERVICING			
2.21	Locate and repair defective components in control circuits.	I. Check and repair air conditioning controls a. Cooling controls b. Heating controls	2 Pages 308-310, 740,742	I. The student will service electric control circuits.
2.22	Locate and replace defective components in line voltage circuits.	II. Main Electrical circuit a. No power at compressor b. High voltage c. Low voltage d. Improper wiring e. Starting capacitor f. Starting relay g. Running capacitor h. Motor draws too much current i. Start winding stays in circuit	7 Pages 568-574	II. The student will service electric circuits.

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
3.70	COMMERCIAL REFRIGERATION SYSTEMS			
3.73	The student will use meters, schematics, and wiring diagrams to locate troubles.	I. Locating motor control and electrical troubles a. Visual inspection b. Electrical meters c. Electrical/electronic malfunctions d. Mechanical malfunctions e. Test of correction	1 Pages 234-238	I. Locate motor control and electrical troubles
3.74	The student will read analysis charts of different companys.	II. Reading trouble analysis charts a. Be knowledgeable of charts of all companies b. Keep a file on companies normally used	1 Pages 209-232 3 GTE-6A, 7A, 8A, and 9A - slides and cassettes	II. Read trouble analysis charts
3.75	The student will troubleshoot a complete system.	III. Recognizing and correcting compressor troubles, etc. a. Noisy,oil low, gas sludging b. Not pumping c. Low charge - by low head pressure, low back pressure d. Overcharge, high heat, high head pressure	1 Pages 367, 433-434 3 GTR-3A 2 Pages 755-765	III. Recognize and correct compressor troubles, low charge, overcharge, high heat, and high head pressure

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
3.80	REFRIGERATION SERVICING			
3.83	Be able to service or suitably replace refrigeration components.	I. Shop troubleshooting a. Compressor short cycles b. Compressor runs continuously c. Compressor is noisy d. Space temperature too high e. Evaporator coil freezes f. Heat pressure too low g. Suction pressure too low h. Liquid line hot i. Liquid line frosted	7 Pages 118-135 2 Pages 302-312	I. The student will service refrigeration systems.
3.85	Organize a systematic method of repair of malfunctioning components.	I. Develop a chart a. To check out systems b. To report repair	2 Pages 302-312	II. The student will learn systems of troubleshooting and repairing domestic and commercial units.
	AIR DISTRIBUTION			
4.20	DUCT SYSTEM			
4.27	Balance system for proper quantity and direction of air flow.	I. Air distribution system a. Diffusers, registers, and grilles b. Ductwork c. Dampers d. Blowers e. Filters	7 Pages 485-488 2 Page 743	I. The student will service and repair ductwork

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	CONTROLS			
6.20	TEST EQUIPMENT			
6.22	Diagnose problems in control circuits	I. Control Circuits a. Transformer and relay coil circuits b. Changeover relays c. Cooling circuits d. Damper circuits e. Fan circuits f. Heating circuits g. Humidification h. Reset circuits i. Pressure control circuits j. Reversing relay circuits k. Thermal delay relays	2 Pages 308-310 740; 742	I. The student will servic control circuits for various systems.
	ENERGY CONSERVATION			
9.10	MECHANICAL SYSTEMS			
9.11	Student will learn diagnosis techniques to evaluate system performance.	I. Peak operating efficiency a. Diagnosis techniques b. Heat loads of the system c. Oil and gas combustion efficiency tests d. Use of instruments to measure system dewpoint, temperature, air flow, pressure, carbon dioxide, and nitrogen e. Checking and repairing	7 Page 367-416	II. Use applicable equipmen to maintain operating efficiency

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		controls f. Troubleshooting mechanical components		
9.12	Student will use an approved detergent-air and water to facilitate cleaning of air cooled condensers.	II. Cleaning air cooled condenser a. Fin combs b. Chemical cleaners c. Compressed air	7 Page 302-319	II. Clean air cooled condenser
9.13	Student will follow manufacturer's directions for cleaning water cooled condensers.	III. Cleaning water cooled condenser a. Use of tube brusher b. Chemicals	7 Page 250-289	III. Clean water cooled condenser
9.14	Student will use manufacturer's recommended procedure for treating water.	IV. Treating circulating water a. Testing procedures b. Correction by chemical addition	7 Page 378, 382, and 383	IV. Treat circulating water
9.15	The student will disassemble and vacuum furnace unit and flue.	V. Cleaning furnace heat exchanges a. Air b. Forced hot water c. Steam	5	V. Clean furnace heat exchangers
9.16	The student will lubricate and practice safety in using all types of grease and oil.	VI. Lubricating moving parts a. Proper amount and type lubrication b. Lubrication methods	5	VI. Lubricate moving parts

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.17	The student will correctly use gauges and tools to adjust to specifications.	VII. Inspecting and replacing belts a. Check belt alignment, tension, condition b. Replace faulty belts	1 Pages 236-237	VII. Inspect and replace belts
9.18	The student will inspect, clean, test, and analyze boilers using appropriate pH testing and water level controls.	VIII. Cleaning boiler a. How to disassemble b. Proper cleaning methods c. How to purge and return to service	7 Pages 498-529	VIII. Clean boiler
139 9.19	The student will identify filter types and materials. a. Replacing filters using proper instrument to measure pressure drop b. Identify, remove, replace oil filter after cleaning filter retainer then purge air and start up	IX. Cleaning and replacing air/fuel filters a. Air 1. Measure pressure drop 2. Filter types 3. Obtain suitable replacement b. Fuel 1. Check pressure drop 2. Disassemble, clean, and replace 3. Bleed and return to service	7 Pages 530-538	IX. Clean and replace air/fuel filters

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.110	The student will identify, obtain and replace nozzle and orfice with appropriate units and determine operational efficiencies.	X. Cleaning and replacing fuel jets a. Oil nozzle 1. Identify malfunctioning nozzle 2. Select correct GPH, spray angle pattern 3. Use of nozzle wrench b. Gas orifice 1. Check for obstruction 2. Clean or replace 3. Size properly	7 Pages 319, 381, 392-395, 369	X. Clean and replace fuel jets and test performance
9.111	The student will know how to provide correct air intake area upon calculation per 1000 BTU.	XI. Evaluating air source for heating system a. Location of heating system b. Warmed air or outside air supply c. Infiltration d. Supplemental air supply e. Preheating techniques f. Improved efficiencies	7 Pages 37-61	XI. Evaluate source of air supply for heating system
9.112	The student will identify refrigerant pressures and correctly charge to proper condition or level.	XII. Charging air conditioning systems a. Use of gauges b. Charging methods c. Safety precautions d. How to determine proper charge	2 Pages 113-115, 296-300, 752	XII. Charge air conditioning systems

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.114	The student will make heat load calculations for heat recovery feasibility.	XIV. Heat recovery systems a. Knowledge of types b. Heat load calculations	8 5	XIV. Determine feasibility of adding heat recovery systems
9.115	The student will determine type and system for equipment location and set up and check performance.	XV. Locating equipment for maximum energy efficiency a. Orientation to run b. Orientation to prevailing winds c. Adjacent obstructions and shading	3 Program on oil burners, gas burners, and heat pumps	XV. Locate equipment for maximum energy efficiency
9.116	The student will use appropriate meters and obtain an analysis to get a higher efficiency.	XVI. Adjusting primary air a. Types of air adjustments b. Use of smoke tester, CO_2 gauge, and stack thermometer c. Use of draft gauge	7 Page 378-383 5 Instructors Notes	XVI. Adjust primary air for maximum CO_2, proper flue gas temperature, and draft
9.117	The student will use manometers and calculations to obtain desired CFM.	XVII. Adjusting blower a. Check temperature rise b. Adjustable pulleys c. Check meter current	1 Page 236-237	XVII. Adjust blower for proper CFM

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.20	ELECTRICAL SYSTEMS			
9.21	The student will identify and use approved cleaning and service procedure.	I. Cleaning controls a. Know of sensitive parts b. How to clean	1 Pages 837-868 10	I. Clean controls
9.22	The student will mount, level, wire, install and adjust thermostats and correctly set timers for appropriate demand.	II. Installing thermostats and timers a. Sizing wire b. Selecting suitable control to do the job c. Thermostat adjustment and calibration	1 Pages 837-868 4	II. Install thermostats and timers
9.23	The student will choose the correct meter or test equipment in order to evaluate maximum EER.	III. Explaining energy efficiency ratios a. Understand formula b. Types of equipment on which used	16 Publication of Equipment (EER)	III. Explain (EER) Energy Efficiency Ration
9.24	The student will know BTU/watt relationship.	IV. Computing power a. Use voltmeters, Ammeter, wattmeters, and power factors b. Computations	1 Pages 174-177	IV. Compute power used by system

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.25	The student by using amp, watt and volt meter will determine highest efficiency.	V. Measuring power a. Instruments b. Measurements		V. Measure power used by a system
9.26	Student will study energy efficient controls and devices.	VI. Benefits of additional controls a. Recognize energy losses b. Selection of remedial controls	1 5	VI. Advise owner of behefits of additional controls
9.30	RECORDS			
9.31	The student will by proper testing and calculation use degree days to determine the anticipated fuel consumption.	I. Performance records a. Compare performance to degree days b. Read temperature and humidity records and charts	1 Page 666 11	I. Maintain system performance records
9.32	Student will become familiar with manufacturers' forms and service forms as requested.	II. Maintenance records a. Model, serial, manufacturer b. Keep accurate log of all service rendered to equipment	5	II. Maintain system Maintain records
9.33	The student will record information and data required.	III. Manufacturer's charts and supplemental material	5	III. Record system variables for evaluating energy utilization

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.34	The student will, by recorded data, ascertain related equipment efficiencies.	IV. Read and analyze charts and compare to anticipated consumption	5	IV. Analyze charts to determine system efficiencies
9.4[illegible]	<u>PUBLIC RELATIONS</u>			
9.4[illegible]	The student will understand and know the merchandise along with the competition and then successfully justify his/her product.	I. Explaining energy conservation features	5	I. Explain energy conservation features of system to customer
9.4[illegible]	The student will know rates/million BTU and justify any recommendation over other systems in energy savings to owner.	II. Informing owners of saving methods a. Demonstrate techniques for maximizing system effectiveness to customer b. Provide data and alternatives	5 1 Pages 699-763	II. Informs owner of saving methods
9.4[illegible]	The student will be knowledgeable and conversant in energy required for a particular installation and upon evaluation make appropriate recommendations. Calculate estimated cost of updating a specific system and/or system replacement.	III. Alternative energy systems a. Knowledge of other systems b. Can list pros and cons c. Cost analysis d. Feasibility of updating existing system	15 1 13 7 Page 660	III. Discuss features of alternative energy systems

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
9.50	INSULATION MATERIALS			
9.51	The student will be able to calculate heat gain and loss for a building.	I. Evaluating insulation a. Calculate R factor b. Identification of types c. Methods of checking	9 Pages 16-54 12 6	I. Evaluate existing insulation
9.52	The student will be able to make appropriate recommendations meeting EES requirements for owner.	II. Requirements to meet EES a. Know EES standards b. Compare to results from 9.51	13 Current EES standards 14 Data and specifications from Corning Glass	II. Determine additional requirements to meet EES
9.53	The student from observation of building orientation and other factors will calculate best possible positioning of new construction to obtain maximum usage of environment.	III. Building orientation a. How to read compass b. Understands factors affecting heat transfer c. Locating heat pump or solar collector	12 Pages 16-54 6	III. Determine building orientation, shading, landscaping for new construction
9.54	The student will be knowledgeable about various insulation data and installation techniques and utilize knowledge in making best possible recommendation on insulation.	IV. Installation of insulation a. Know all available types of insulation b. Understand correct installation procedures c. Advantages of each type	9 12 Pages 16-54 6 5	IV. Evaluate new insulation and installation procedures

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SUGGESTED TEXTS AND REFERENCES

1. Modern Refrigeration and Air Conditioning
   Althouse, A.D., Turnquist, C.H., and Bracciano
   Chicago: Goodheart-Willcos Co., 1975

2. Refrigeration and Air Conditioning
   Air Conditioning and Refrigeration Institute
   Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979

3. 35mm Slides and Cassettes can be obtained from
   Carrier Air Conditioning Company
   Syracuse, NY

4. National Electric Code
   National Fire Protection Association
   Boston: 1978, No. 70-1978

5. Data from manufacturers

6. ASHRAE Guide and Data Books (Applications/Systems and Equipment)
   American Society of Heating, Refrigeration and Air Conditioning Engineers
   New York

7. Air Conditioning and Heating Practice
   Laub, Julian M.
   New York: Holt, Rinehart, and Winston, Inc., 1963

8. Refrigeration and Air Conditioning Service Application Manual
   Refrigeration Service Engineers Society
   Des Plaines, IL, Vol. 2

9. Manual "J" - Load Calculations
   Air Conditioning Contractors of America
   Arlington, VA

10. Honeywell Service Handbooks
    Honeywell, Inc.
    Minneapolis, MN

11. Institution's Reference Library or NOAA

12. Train Air Conditioning Manual
    Trane Co.
    La Crosse, WI

13. Current Energy Efficiency Standards (EES)

14. Data and specifications from Corning Glass Works

15. Periodicals and Service Manuals

16. Publication of Equipment (EER)
    Air Conditioning and Refrigeration Institute
    Arlington, VA

NOTE: Number beside resource agrees with numbering system used in Activity Experience column.

OTHER RESOURCES

ARI Standards
Air Conditioning and Refrigeration Institute
Arlington, VA

Modern Air Conditioning Practice
Harris, Norman C., and Cande, D.F.
New York: McGraw-Hill, 1974

NC State Boiler Code
NC Building Code Council and NC Department of Insurance
Raleigh, NC

NC State Building Code
NC Building Code Council and NC Department of Insurance
Raleigh, NC: Vol. III

National Fire Protection Association Manuals
Boston

Refrigeration Servicing
Goliber, Paul F.
Albany, NY: Delmar, 1976

Sheet Metal and AC Contractors National Association Manuals
Vienna, VA

COURSE OUTLINE

AHR 1126 ALL YEAR COMFORT SYSTEMS

Developed By

Air Conditioning and Refrigeration

Competency Curriculum Committee

October, 1979

PROGRAM DEVELOPMENT
DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

AHR 1126 - ALL YEAR COMFORT SYSTEMS

DESCRIPTION OF COURSE:

Equipment used to provide heating and cooling for "all year" comfort will be studied. Included will be heat pumps, oil fired, gas fired, water circulating, electric-resistance and an introduction to solar heating and cooling systems. Specialized controls required for all year comfort systems, preventive maintenance, and balancing are included in the course.

Course Hours Per Week:	Classroom, 3; Laboratory, 6.
Quarter Hours Credit:	5.
Prerequisites:	AHR 1123, AHR 1128
Course Objectives:	Specific objectives are included in the outline of instructions.
Course Outcome:	The student will follow safety rules, and skills learned in proceeding courses to establish correct work habits in troubleshooting, installation of components adjusting-wiring-evacuating, charging. Testing with gauges, meters, or instruments. Problems or conditions related to refrigeration, heating, and air handling equipment including heat pumps for all year comfort.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	HEATING			
1.30	**HEAT PUMPS AND ELECTRIC HEAT**			
1.31	Student will select conductor from charts included in code book.	I. Conductors a. Size b. Code requirements	6* Chapters 3 and 4 7 Pages 1-5	I. Size conductors
1.32	Student will install disconnect in view of equipment for safety.	II. Service from disconnect to equipment a. Disconnects b. Conduits c. Conductors	6 Chapters 2 and 3 7 Pages 1-15 4 Applicable	II. Run conduit from disconnect to equipment
1.33	Show student how to select equipment from heat loss-heat gain calculations and to determine supplemental heat from heat pump balance point. Also, student will be taught to select type or style of equipment to use by reading blueprints of project. Know factors involved in proper location and placement.	III. Equipment selection a. Manufacturers specifications b. Size requirements c. Style d. Location e. Placement	5 Use for particular unit being considered	III. Select equipment
1.34	Student will be instructed on use of state code book in section for "clearances" and install unit, or units, using correct materials.	IV. Equipment installation a. Handling during delivery b. Code requirements 1. Clearances 2. Location 3. Materials	6 Chapter 10 Omnidata Heat Pump Trainer 4 Chapter 7	IV. Install equipment

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* Number refers to source listed in Suggested Texts and References section.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
1.35	Student will be instructed to use electrical test instruments to check voltage, current, and resistance on both heat pumps and electric forced air systems. Show how electric supplemental heat (electric furnace) may be applied as stage heat for heat pump. Gauge pressures may be read according to comfort cooling units. Also, student will be instructed in sequence of operation for electric furnace and in how to use electric meters to troubleshoot heating elements, relays, and sequences.	V. Servicing equipment a. Heat pump 1. Voltmeter 2. Clamp-on ammeter 3. Ohmmeter 4. Compound gauges with manifold and service hoses b. Electric forced air furnace 1. Voltmeter 2. Clamp-on ammeter 3. Ohmmeter	6 Chapters 5, 6, and 7 8 Data on test instruments 4 Chapters 7 and 9	V. Service equipment
	AIR CONDITIONING AND HEAT PUMPS			
2.10	MECHANICAL DIAGNOSIS AND SERVICING			
2.11	Student should have available and know how to read a road map in order to locate job site.	I. Getting to job location a. Knowledge of streets in location of work b. Read maps	9 For designated area 2 Pages 755-765	I. Locate job site

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
2.12	Student will be instructed in procedures for asking questions of user in order to help determine trouble area. Start equipment with power source, then "hop scotch" circuits.	II. Finding problem area a. Good communication skills b. Know the type of questions to ask the customer c. From information supplied, be able to determine general trouble area d. Use test procedures of elimination to pinpoint trouble spot	6 Chapters 3, 4, 5, 6, and 7 3 Carrier heat pump audiovisual 11 Westinghouse audio-visual	II. Locate system trouble
2.13	Student should be taught to carry complete supply of replacement parts and how to repair an existing part. Operate system through one or two complete cycles before leaving job.	III. Correcting problem a. Repair part if practical b. Replace part c. Test for proper operation	6 Chapters 3, 4, 5, 6, and 7 5 Omnidata Heat Pump Trainer	III. Correct problem
2.20	<u>ELECTRICAL DIAGNOSIS AND SERVICING</u>			
2.21	Student will be taught sequence of operation from electrical schematic diagram. He will be instructed to determine low voltage loads and load controls. Use "hop scotch" method to locate defective controls. Line voltage	I. Low voltage control circuits a. Have basic knowledge of electricity b. General knowledge of all types of controls how and what they operate c. Use test equipment to trace out trouble	6 Chapter 3 10 Select those which explain a particular facet	I. Locate and repair or replace defective components in low voltage control circuits

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	controls will be traced out by same method.	d. Repair or replace control or wiring e. Test for proper operation		
2.22	The student will determine line voltage loads and locate and replace defective components.	II. Line voltage circuits (Same as a-e above)		II. Locate and repair or replace defective components in line voltage circuits.
2.60	<u>HEAT PUMPS</u>			
2.61	Student will learn to install and level concrete pad, attach unit to pad, install roof brackets and install unit.	I. Installing outdoor unit on concrete pad a. Economy considerations b. Orientation in relation to sun and wind directions c. Roof overhang	2 Pages 321, 585, 586-593 3 Carrier GTA-HA slides and cassettes	I. Install outdoor unit on concrete pad with consideration given for snow and ice accumulation
2.62	The student will install indoor unit, attach noise vibrators, ducts, and drain pipe or pump.	II. Installing indoor unit a. Use of insolation noise vibrators b. Sound control by use of duct liner on return duct c. Make condensation drain accessible	1 Pages 690-694	II. Install indoor unit with proper sound baffling
2.63	Student will make opening in duct and install heat section.	III. Installing supplemental heat section a. Proper location in downstream air section of duct or air handler b. Sizing unit	1 Pages 840-850	III. Install supplemental heat section in indoor unit

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
2.64	Student will learn to install thermostats to achieve desired comfort from systems.	IV. Installing indoor thermostats a. Where to install to sense average return air temperatures b. Special situations	1 Chapter 24	IV. Install indoor thermostat
2.65	Student will install outdoor thermostat and attach to control circuit.	V. Installing outdoor thermostat a. Where and how to install so that control will not be affected by sun and weather conditions b. Purpose	11 Westinghouse audio-visual	V. Install outdoor thermostat (if used)
2.66	Student will drill holes in wall and floor, install, and connect wire.	VI. Installing all low voltage wiring a. Make lines as short as possible and isolated from rattles and pulsating sounds b. Proper installation	1 Chapter 24	VI. Install all low voltage wiring from schematic wiring diagram
2.67	Install tubing and check for rattles and oil traps.	VII. Installing refrigeration lines a. Makes lines as short as possible and isolated from rattles and pulsating sounds b. Proper installation	1 Pages 819-821	VII. Install refrigeration lines
2.68	Check temperature of normal valve and compare with defective valve with	VIII. Using pressure-temperature methods a. One method of determining if a valve is	1 Page 826	VIII. Use pressure-temperatu methods to check out reversing valve

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		b. Test procedures		
2.69	Check strength of coil with soft iron tool	IX. Using steel tool to check magnetism a. Steel tool will react to electrical magnetism of solenoid b. Test and replace procedure	3 11	IX. Use steel tool to check magnetism of reversing valve solenoid
2.610	Check timer contacts with ohmmeter and visually check motor to see if running	X. Checking defrost timer clock a. Use of ohmmeter to see if timer motor is open b. Test procedures	1 Pages 178-179 3 11	X. Check defrost timer clock for operation
2.611	Check sensing bulb for thermal contact	XI. Checking defrost control sensing bulb a. Visually check copper strap to see if it has worked loose due to vibration b. Correction procedures	3 11	XI. Check defrost control sensing bulb for good contact with outdoor coil
2.612	Move strong magnet across check valve and check sound	XII. Testing check valves with magnet (unit off) a. Method of determining position of check valve b. Check valve function	1 Page 184	XII. Test check valves with magnet (unit off)
2.613	Look for temperature difference in leaking valve.	XIII. Testing for temperature difference a. How to test for leaky valve	1 Page 447	XIII. Test for temperature difference across check valve (unit on)

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		b. Replacing defective components		
2.614	Install gauges check high and low side pressures on normal and defective system	XIV. Checking refrigerant pressures a. How to install and read gauges b. Determine proper operation from gauge readings	1 Pages 493-495	XIV. Check refrigerant pressures
2.615	With power off check elements with ohmmeter	XV. Checking electric resistance elements a. How to check continuity. b. Ohmmeter	1 Pages 178-179	XV. Check electric resistance elements for proper operation
2.616	Check unit for leaks with a. Soap solution b. Halide torch c. Electronic leak detector	XVI. Testing complete system for refrigerant leaks a. Methods of leak check b. When to use which	1 Page 496	XVI. Test complete system for refrigerant leaks
	AIR TREATMENT			
5.10	CHECKING CONDITION OF AIR			
5.13	Student will demonstrate use of psychrometers and charts to obtain appropriate air changes.	I. Checking volume of air a. Determine amount of ventilation needed. b. Determine proper method of make-up air and duct size	1 Pages 766-767	I. Check volume of air (to achieve air balance

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SUGGESTED TEXTS AND REFERENCES

1. Modern Refrigeration and Air Conditioning
   Althouse, A.D., Turnquist, C.H., and Bracciano
   Chicago: Goodhart-Willcox Co.

2. Refrigeration and Air Conditioning
   Air Conditioning and Refrigeration Institute
   Englewood Cliffs, NJ: Prnetice-Hall, Inc, 1979

3. 35mm Slides and Cassettes can be obtained from
   Carrier Air Conditioning Company
   Syracuse, NY

4. National Electric Code
   National Fire Protection Association
   Boston: 1978, No. 70-1978

5. Manufacturers' Specification Sheets

6. Servicing Comfort Cooling Systems
   North American Heating and Air Conditioning Wholesalers Association
   Columbus, OH

7. North Carolina State Building Code
   NC Building Code Council and NC Department of Insurance
   Raleigh, NC

8. Servicing information furnished by manufacturers' of instruments such as Amprobe, Robinair, Simpson, etc.

9. City, county, and state maps

10. Control manufacturers service guides: Honeywell, White Rogers, General Electric, Robert Shaw, etc., as well as audiovisual materials from the same sources

11. Audiovisuals
    Westinghouse Electric Corporation, Central Residential Air Conditioning Division
    Norman, OK

NOTE: Number beside source agrees with numbering system used in Activity Experience column.

OTHER RESOURCES

A Guide for Residential Heat Pumps
Campbell, Stuart, and Taff, Douglas
Charlotte, VT: Gardenway Publishers

Ductulator English and SI Metric Units
Trane Corporation
La Crosse, WI

COURSE OUTLINE

MEC 1120 DUCT CONSTRUCTION AND INSTALLATION

Developed By

Air Conditioning and Refrigeration

Competency Curriculum Committee

October, 1979

PROGRAM DEVELOPMENT
DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

MEC 1120 - DUCT CONSTRUCTION AND INSTALLATION

DESCRIPTION OF COURSE:

Study of fabrication, installation, and maintenance of ducts using various materials and fittings to achieve correct air flow. Course covers safety, fabrication, tools and equipment, cutting and shaping, fasteners and fabrication practices, fans, insulation, ventilating hoods, layout methods, and development of duct systems. The student will study the installation of various duct systems and perform on-the-site modifications.

Course Hours Per Week:	Class, 3; Laboratory, 6.
Quarter Hours Credit:	5.
Prerequisite:	None
Course Objectives:	Specific objectives are included in the outline of instructions.
Course Outcomes:	The student will use earlier skills learned in Air Conditioning, Heating, and Refrigeration. Additional skills and study will be given as related to tools and fabricating machinery for ducting and insulation from working drawings and layouts. Hang ducts using appropriate fastening and joining material. Seal and insulate ducts then install duct accessories.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	DUCT FABRICATION AND INSTALLATION			
7.10	FABRICATION			
7.11	Student should be able to use drafting tools, duct charts, and tables, convert from round to rectangular duct, and calculate air requirements.	I. Interpreting plans and drawings a. Basic blueprint reading b. Duct symbols c. Duct sizing methods and guidelines d. Use of different scales e. Determine when prefab duct will be cheaper.	2* Pages 423-497 Pages 602-607	I. Interpret duct work on plans and working drawings
7.12	Student will know capacity of each machine, the safe and unsafe features of each machine, what performance can be accomplished with a machine and make a duct section which will require the use of the fabricating tools and machinery	II. Using fabricating tools and machinery a. Duct board cutters and techniques b. Cornice brake c. Press brake d. Bar folder e. Shear f. Pittsburg lock machine g. Forming machine h. Electric shears i. Aviation snips j. Notcher k. Hand seamer l. Hand benders m. Pin spotter	3 Pages 1-194	II. Use fabricating tools and machinery

ber refers to source listed in Suggested Texts and References section.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
7.13	Student should be able to develop a template by the use of triangulation, slip and drive joints, and make various types of seams.	III. Layout a. Know no. I and II b. Templates, know how to make them c. Overhead projector layout d. Use of square, scriber, compass, trammel points e. Make maximum use of metal (scraps) f. Joint techniques g. Seams	3 Pages 223-257 4 Pages 41-107 5 Pages 27-188	III. Lay out and make square and round fittings.
7.14	Know the types of insulation, the thickness of insulation to use, the different methods of fasting insulation to ducts, when insulation can be inside or outside of ducts, the manner in which insulation seams are sealed and the importance of the vapor barrier.	IV. Insulating ducts a. Duct lines attachment techniques b. Duct board, proper grooving c. Thermaflex d. 2" foil duct wrap now required e. Use of outward clinch stapler f. Taping joints g. Importance of complete vapor barrier h. Proper adhesive technique for duct liner and knowledge of code requirement for interior fasteners	2 Pages 482-485	IV. Insulate ducts interior-exterior

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
7.20	INSTALLATION			
7.21	The student will be able to relate to code, why and how ducts are supported.	I. Hanging ducts a. Duct holders (tool) b. Duct hangers (different types) c. Hanger spacing d. Importance of keeping square and level	2 Page 265 5 Page 276	I. Hang ducts
7.22	Student will know the different types of duct seams and joints, and size metal required.	II. Fastening and joining ducts a. "S" and drive locks b. Snap locks c. Drill-in screws d. Pop rivets e. Round pipe crimping f. Cutting take off holes	3 Pages 75-90 Pages 125-159	II. Use devices for fastening and joining ducts
7.23	Student will know the advantages of the vinyl, pressure, and heat sensitive tapes and proper use of each.	III. Sealing and insulating joints and seams a. Vinyl duct tape (not approved) b. Foil duct tape 1. Pressure sensitive 2. Heat sensitive	5 Use manufacturers information	III. Seal and insulate joints and seams
7.24	Student will know how duct fittings are properly installed, and where and why they are used.	IV. Installing duct accessories a. Location for dampers, per plan b. Turning vanes	2 Pages 433-447 5 Pages 189-240	IV. Install duct accessories, grills, registers, dampers, boots and takeoffs

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		c. Cutting methods for holes in ceiling, walls, floors d. How to box in closets e. Selection and location of grills and registers (as per plan) f. Checking for hidden obstruction before cutting holes g. Tools, drop cords, etc.		

SUGGESTED TEXTS AND REFERENCES

1. Principles of Air Conditioning
   Lang, V. Paul
   New York: Delmar Publishing Co., 1979, 3rd ed.

2. Air Conditioning and Heating Practice
   Laub, Julian M.
   New York: Holt, Rinehart, and Winston, Inc., 1963

3. Sheet Metal Shop Practice
   Myers, Leo A.
   Chicago: American Technical Society, 1976, 4th ed.

4. Triangulation Short-Cut Layouts
   Kaberlein, J.J.
   Riverside, NJ: Glencoe Publishing Co., 1973, 3rd ed.

5. Air Conditioning Cutter's Ready Reference
   Morris, Ralph C.
   Birmingham, MI: Business News Publishing Co

6. Manufacturer's Specification Sheets

OTHER RESOURCES

Air Conditioning Metal Layout
Kaberlein, J.J.
Riverside, NJ: Glencoe Publishing Company, 1973, 3rd ed.

Sheet Metal Blueprint Reading for the Building Trades
Zihngrabe, Claude J.
Albany, NY: Delmar Publishing Co.

Sheet Metal Layout
Meyer, Leo A.
New York: McGraw-Hill, 1979, 2nd ed.

Sheet Metal Shop Practice Study Guide
Meyer, Leo A.
Chicago: American Technical Society

Short Cuts for Round Layouts
Kaberlein, J.J.
Riverside, NJ: Glencoe Publishing Co., 1973

NOTE: Number beside resource agrees with numbering system used in Activity Experience column.

INDUSTRIAL ORGANIZATIONS - methods, techniques, and practices of modern management in planning, organizing and controlling operations of a manufacturing concern. Introduction to the competitive system and the factors constituting product cost.

PREREQUISITE: None

	Class Hours	Lab Hours	Credit Hours
MAJOR DIVISIONS	3	0	3

I. The industrial organization--its nature and structure

II. Industrial ownership

III. Industrial finance: Capitalization of the enterprise

IV. Physical facilities

V. Materials control

VI. Production control

VII. Quality control from the management's viewpoint

VIII. Administration of wage and salary

IX. Sales and advertising

X. Financial controls

SUGGESTED TEXT:

Bethel, Lawrence L.; Atwater, Franklin S.; Smith, George, H.E.; and Stackman, Harvey A., Jr., Essentials of Industrial Management; Latest Edition. New York: McGraw-Hill Book Company, Inc.

SUGGESTED REFERENCES:

Bethel, LawrenceL.; Atwater, Franklin S.; Smith, George H.E.; Stackman, Harvey A., Jr; and Riggs, James L.; Industrial Organization and Management; Latest Edition. New York: McGraw-Hill Book Company, Inc.

INDUSTRIAL SAFETY, a study of the development of Industrial Safety; accident occurrence and prevention; analysis of accident causes and costs; basic factors of accident control; safety education and training; accident reporting and records; employer and employee responsibility; safety organizations; first aid; mechanical safeguards; personal protective equipment use; materials handling; fire prevention and protection; safety codes; and accident statistics.

PREREQUISITE: None

	Class Hours	Lab Hours	Credit Hours
MAJOR DIVISIONS	3	0	3

I. Accident Toll in the United States

II. Basis of industrial accident prevention

III. Basic philosophy of accident occurrence and prevention

IV. Facts and fact finding - accident causes

V. Application of remedial action

VI. Creating and maintaining interest in accident prevention

VII. Safety education and training

VIII. Safety and health standards - rules

IX. Accident records and reports

X. Industrial first aid

XI. Personal protective equipment

XII. Fire prevention and protection

XIII. Handling Materials

XIV. Accident statistics

SUGGESTED TEXTS AND REFERENCES:

Heinrich, H.W. Industrial Accident Prevention, New York: McGraw Hill Book Company, 1959.

Blake, Roland P., Industrial Safety, Third edition, New Jersey: Prentice Hall, Inc., 1963.

The American Red Cross Textbook, Fourth edition.

Safety Precautions for Shore Activities, NAVSO P-2455, Office of Industrial Relations, Department of the Navy, Washington, DC, April 1965.

Industrial Safety Leader's Guide, Series A, Technical Aids Branch, Office of Industrial Resources, International Cooperation Administration, Washington, DC, 1960.

DuPont Library of Industrial Training, Administrative Materials only for Safety Training Observation Program (S-T-O-P) - AA - 522- Price $5.00; All 8 Programmed Instruction courses for Safety Training Observation Program (S-T-O-P) - AA 523 - Price $10.00; For Wage Roll Employees - "Safe Practices Series" - AA 550 thru AA 592 - Price - $1.25 each.

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SMALL BUSINESS OPERATIONS - an introduction to the business world, problems of small business operation, basic business law, business forms and records, financial problems, ordering and inventorying, layout of equipment and offices, methods of improving business, and employer-employee relations.

PREREQUISITE: None

	Class Hours	Lab Hours	Credit Hours
MAJOR DIVISIONS	3	0	3

I. Introduction

II. Problems of small business operation

III. Basic business law

IV. Business forms and records

V. Financial problems

VI. Location problems

VII. Ordering and inventorying

VIII. Layout

IX. Improving your business

X. Employer-employee relations

SUGGESTED TEXT:

New York State Vocational and Practical Arts Association Publication. Small Business Management. Albany: Delmar Publishers, Inc., 1952.

Related Instructional and Performance Objectives

An auxiliary set of related instructional and performance objectives has been written by the Air Conditioning, Heating, and Refrigeration Competency Committee. These concepts are suggested as a resource to use in teaching specialty courses or in working with related and general education instructors to help identify skills that may be developed in supporting courses of instruction. This list has been prepared in the format of the course outlines for the specialty courses.

Major topics included are Applied Science, Professional Practice, Cultural Attributes, Interpersonal-Interactive Skills, Information Retrieval, and Personal Skills and Traits. These topics may be taught where most suitable to the individual institution. In some institutions, the topics may be taught in the specialty courses, in others the topics may be taught in related courses such as Applied Science, Human Relations, and/or Small Business Operations. Texts and references should be identified with the help of the appropriate instructors in the institution.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE
15.00	SCIENCE		
15.10	UNITS AND MEASUREMENTS		
15.11	Practice the measurement of various articles	I. Identifying units of length, weight, and volume a. Linear measurement b. Mass measurement c. Area measurement d. Cubic measurement	
15.12	Use various measuring instruments	II. Estimating length and weight in metric units a. Use of millimeter centimeter, meter, and kilometer b. Use of gram and kilogram	
15.13	Convert units of linear measurement from English standard to metric	III. Conversion of inches to mm and cm and lb. to kg. a. Convert inches to millimeter b. Convert millimeter to inches c. Convert inches to centimeters d. Convert centimeters to inches e. Pounds to kilograms f. Kilograms to pounds	
15.14	Convert units of cubic measure from English to metric	IV. Conversion of cubic inches to cubic centimeters a. Convert cubic inches to cubic centimeters b. Convert cubic centimeters to cubic inches	

* Number refers to source listed in Suggested Texts and References section.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.15	Use metric measurement rules.	V. Performing measurements using English and metric rules a. Use an English unit rule b. Use a metric unit rule		V. Perform measurements using English or metric machinist rules
15.16	Use metric micrometer calipers	VI. Performing operations using English or metric micrometer calipers a. Measure some parts and b. Record results		VI. Perform measurements using English or metric micrometer calipers
15.17	Use metric vernier calipers	VII. Performing operations using English or metric vernier calipers a. Measure parts with a vernier caliper b. Record results		VII. Perform measurements using English or metric vernier calipers
15.18	Use scientific notation and significant figures in calculations	VIII. Estimating calculations a. Significant figures b. Scientific notation		VIII. Use the correct number of significant figures
15.19	Perform repeated precise measurements and determine range of error	IX. Estimating error in measurements and calculations a. Make repeated measurements b. Calculate error in measurements		IX. Estimate error in measurements and calculations

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.20	PROPERTIES OF MATERIALS			
15.21	Compare density of propane gas to density of air	I. Using tables		I. Use tables of density and specific gravity
15.22	Identify and compare density to specific gravity PSIG vs. PSIA	II. Reading gauges and meters		II. Read gauges and meters
15.23	Determine density or specific gravity of fluids using a hydrometer	III. Making hydrometer measurements		III. Make measurements to determine density or specific gravity
15.24	Test tensile strength of solder, sheet metal, wleded metal, etc.	IV. Tensile strength		IV. Make measurements to determine tensile strength
15.25	The student will list properties of material samples	V. Properties of materials a. Terminology b. Use of lab instruments c. Visible properties d. Characteristic properties		V. Apply terms relating to properties of materials
15.26	Calculate experiemntally the specific gravity or density of liquid or solids	VI. Specific gravity/density		VI. Calculate density and specific gravity
15.27	Determine new volume and pressure when the temperature of a gas changes	VII. Calculating changes in a gas		VII. Calculate temperature, volume and pressure changes in a gas

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.28	Compare the buoyancy of various materials	VIII. Buoyancy and flotation		VIII. Relate densities to buoyancy and flotation
15.29	Analyze information collected from a lab project	IX. Following directions		IX. Follow directions, oral and written, from lab experiences
15.210	Plot a graph of changes in volume, pressure, and temperature of a gas sample	X. Graphs		X. Graph and interpret graphs
15.30	<u>MECHANICS</u>			
15.31	Determine power output of a motor using a prony break record RPM, and calculate efficiency of a motor. Have a knowledge of source of energy loss.	I. Power a. Use of prony brake b. Use a tachometer c. Use of dynomometer		I. Measure the power output of a rotating shaft.
15.32	Take measurements of input and output of machines and compute the efficiency	II. Efficiency a. Be able to measure power input and output b. Understand efficiency formula c. Understand sources of of energy losses		II. Determine the efficiency of a machine
15.33	Calculate the energy required to move an object moved a specific distance in a stated time	III. Energy a. Be able to measure and apply distance, time weight, force, friction, inertia to determine energy required		III. Determine the energy required to do a given job

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		b. Forms of energy		
15.34	Know how to calculate velocity and acceleration of an object	IV. Velocity a. Be able to use and apply velocity formula b. Solve for any of the variables		IV. Calculate velocity, distance, or time
15.35	Have knowledge of the forces acting on an object while moving and at rest.	V. Acceleration a. Be able to use and apply the acceleration formula and solve for any of the variables b. Know the acceleration of gravity constant		V. Calculate acceleration, change in velocity or time
15.36	Draw free body diagrams and identify forces acting on bodies	VI. Forces a. Understand forces of gravity, centifugal, centripetal friction, air pressure, acceleration, action and reaction. b. Analyzing forces		VI. Identify all forces acting on a body
15.37	Calculate the effects of friction and inertia of a body in motion	VII. Friction a. Causes of friction b Inertia		VII. Determine force required to start or stop a body
15.38	Know the relationship of friction, tolerance and lubrication	VIII. Inefficiency a. Friction b. Tolerances c. Lubrication d. Number of energy conversions		VIII. Identify causes of inefficiency in a machine

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.40	HEAT			
15.41	Understand capability of various thermetic devices. Apply depending upon use and accuracy required.	I. Thermetric devices a. Thermometers, pyrometers, thermistors, thermocouples b. Temperature ranges c. Temperature source		I. Select correct thermetric device
15.42	Calibrate a thermetic device using a known reference	II. Temperature a. Be able to use all instruments in No. 1		II. Use a metric device to determine temperature
15.43	Measure various temperature ranges and sources	III. Calibrating thermometers a. Compare reading when in distilled ice water b. Adjustment techniques		III. Calibrate thermometer
15.44	Calculate expansion of an object when heated to a specified temperature	IV. Linear expansion a. Use co-efficient of expansion and temp. difference for prediction b. Selection of materials for application		IV. Calculate linear expansion and apply to job at hand
15.45	Determine the increase in volume of a substance when heated to a specific temperature	V. Volume expansion (Same as No. 4)		V. Calculate volume expansion
15.46	Know how to determine quantity of heat absorbed and given up because of a tempera-	VI. Heat absorption a. Understand sensible heat and latent heat b. Understand specific heat		VI. Calculate or estimate heat absorbed and given up due to a temperature change

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	ture change of a given substance	c. Know how to use basic formula (Q=WCST)		
15.47	Know the loss of mechanical devices due to friction expressed in BTU's and determine overall efficiencies from the data	VII. Heat production a. Use friction formula b. Conversion of energy losses converted to BTU		VII. Calculate or estimate heat produced in a mechanical operation.
15.50	<u>LIGHT AND SOUND</u>			
15.51	Know those materials which will reduce noise to acceptable levels and how to utilize and apply these materials	I. Noise a. Sources of noise b. Damping noise c. Acceptable noise levels		I. Calculate and evaluate noise levels
15.52	To include and add to other factors having a bearing on loss or gain internal heat radiant rays from sun and etc.	II. Sunlight a. Structure orientation and construction characteristics b. Heat gain/loss of structure		II. Be familiar with and able to calculate BTU gain or loss from a structure
15.53	Determine the amount of heat added to a room as a result of the type of lighting used.	III. Lighting efficiency		III. Determine the efficiency of a light fixture
15.54	Calculate watt-BTU in and determine rrect placement	IV. Electrical layout		IV. Lay out a simple lighting system.

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
	of lighting to utilize heat gain			
15.55	Determine heat gain/loss resulting from choice of various colors and surfaces.	V. Radiation a. Reflective objects b. Absorbing objects		V. Predict the results of additive color mixing
15.56	Identify solar screening techniques for reducing heat gain	VI. Solar screening		VI. Predict the results of subtractive color mixing
15.57	Assess the effect of motors and air handling units on the noise level in a room	VII. Reverbation a. Factors affecting sound propogation b. Damping		VII. Determine the reverberation time of a room
15.58	Identify sound amplifiers and sound reducers	VIII. Vibration a. Input energy b. Output energy c. Amplifiers d. Dampers		VIII. Analyze the performance of a loud speaker
15.60	ELECTRICITY AND MAGNETISM			
15.61	Knowledge of proper motor connection	I. Meters a. Understand operational methods and procedures of volt meters, ampmeters, and ohm meters. b. Use these to determine correct values		I. Install meters and take readings

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.62	Ohm's law and related computed data	II. Circuits a. Use lab equipment to show circuits including power source, conductor, loads, and switches b. Formulas		II. Set up simple circuits
15.63	The student will know how to use an appropriate scale to measure resistance valves	III. Ohmmeter a. Understand correct sequence and rules pertaining to checking for continuity with an ohmmeter b. Scales		III. Test with an ohmmeter
15.64	The student will know basic applied math as related to English and metric conversions	IV. Joules to calories a. Formula to convert to English b. Formula to convert to metric		IV. Convert joules to calories
15.65	The student will be familiar with the relationship of various units of heat	V. Units of heat		V. Convert calories to joules
15.66	The student, from memory, will compute the BTU's from hp related activities	VI. Watts to hp a. Understand relationship and reason for converting watts to hp and back b. Formula to convert		VI. Convert watts to hp

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.67	The student will know how to convert to BTU/watt and pricing	VII. Cost of electrical energy a. Calculating energy cost b. Calculating energy usage		VII. Determine cost of electrical energy used
15.68	Check continuity of a fuse-use various instruments. Check continuity by disassembly and/or observation	VIII. Fuses a. Is able to recognize a blown fuse b. Replacing blown fuses		VIII. Replace blown fuse
15.69	Knowledge of electrical tables and data and use these to select wire size dependent on load	IX. Wire sizes a. Read charts pertaining to amperage and conductor b. Compute load on line		IX. Determine wire size
15.610	Construct electromagnet from basic materials in order to understand how solenoids function	X. Electromagnetism a. Ampere turns as applicable to electrical magnetism-for AC and DC b. Applications of electromagnets		X. Build an electromagnet
15.611	The student will know how to build a transformer.	XI. Induction coils a. Winding relationship b. Uses		XI. Build an induction coil
15.612	The student will be aware of chemical action as a source of electricity.	XII. Lead storage battery a. Connects proper terminals and set amperage and		XII. Charge a lead storage battery

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMAN- OBJECTIVE
		time controls to completely charge battery b. Uses of batteries		
15.613	The student, from an electrical diagram, can identify the three basic uses of transformers.	XIII. Transformers a. Understand principle b. Uses of transformer for voltage changes and isolation		XIII. Use a transformer
15.614	Use an induction heater to heat a fluid.	XIV. Induction heater		XIV. Build an induction heater
15.615	The student will be able to identify AC equipment as compared to DC and what is required to apply appropriate rectifying equipment.	XV. Rectifying A. C. current a. Understand and apply knowledge of motor generators and solid state rectifier b. Current output from rectifier		XV. Rectify A. C.
15.616	The student will identify running and starting capacitors and where used.	XVI. Capacitors a. Phase shift to accomplish motor starting at greater efficiency b. Running efficiency		XVI. Use a capacitor to control current
15.617	Demonstrate ability to raise or lower current by use of a variable resistor	XVII. Variable resistors a. Types b. Uses		XVII. Use a variable resistor to control current

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.618	Use an oscilloscope to show current demand of various electrical devices under load	XVIII. Oscilloscope a. Uses b. Circuit characteristics		XVIII. Use an oscilloscope
15.619	Check the specific gravity of a wet cell battery to determine charge	XIX. Determining charge of batteries a. Understand specific gravity and its relationship to electrical conductivity and particle contest b. Using hydrometer to determine charge		XIX. Determine charge of lead battery with hydrometer
15.620	The student will know how to solve applied math in order to calculate E-I-R and watts from the triangle or instrument measurements.	XX. Ohm's Law a. Can define and manipulate the formula from the triangle b. Verify Ohm's Law calculations		XX. Use Ohm's Law to find resistance
15.621	Use a relay	XXI. Relays		XXI. Build and use a relay
15.622	Use an A.C. generator	XXII. A.C. Generator a. Uses b. Types		XXII. Build an A.C. generator
15.623	The student will know and be able to identify load components from a power source	XXIII. Relays, generators, and motors a. Understand electromechanical principle and how it can be applied and converted		XXIII. Understand and use a relay generator and electric motor in sequence or relationship

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
		from one form of energy to another b. Using relays, generators and motors		
15.624	The student will know principle of thermal potential generation	XXIV. Copper wire cells a. Construct a simple voltaic cell to understand different potential of dissimilar metals b. Thermocouple c. Thermopile		XXIV. Build a copper wire cell
15.625	Knowledge of electrical safety	XXV. Grounding electrical devices a. Understands the necessity of a ground and its purpose as far as safety is concerned b. Grounding electrical devices		XXV. Ground an electrical device
15.626	The student will, by use of appropriate instruments, calculate impedance.	XXVI. Impedance a. Uses meters to find impedance of different coils b. Factors influencing		XXVI. Determine impedance of a coil
15.627	The student will demonstrate magnetic lines and polarities.	XXVII. Lines of force a. Use iron fillings to prove the existance of lines of force b. Field of force		XXVII. Show lines of force of a magnet

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.628	The student will demonstrate the ability to identify common start and running terminals of a Hermetic Single Phase Compressor and make a final resistance reading to ground.	XVIII. Compound resistance a. Identify run, common, and start leads of a motor b. Formula for compound resistance		XXVIII. Determine compound resistance
15.629	Know how to use test instruments	XXIX. Combining voltages a. Use voltmeter to find the potential between two phases of electricity b. Formula		XXIX. Determine how voltages combine
15.630	Knowledge of electrical behavior	XXX. Combining current a. Use an ammeter to find each current and total current in a unit b. Formula		XXX. Determine how current combines
15.631	Show uses of charge for electronic air cleaners, solenoids, etc.	XXXI. Charge a. Use magnets to prove the repulsion attraction theory b. Styrofoam beads		XXXI. Determine that like charges repel

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.632	Use electric meter and watt meter to measure power	XXXII. Power a. Use and understand the function of a watt meter b. Measure total power consumption		XXXII. Determine the power used by a lamp, etc.
15.633	Be able to use Ohm meter to determine electrical resistance, open circuits, shorted or grounded circuits	XXXIII. Resistance a. Use and understand principles behind an ohm meter b. Conductivity of various metals		XXXIII. Find the resistivity of a metal
15.634		XXXIV. Convert watts to BTU		XXXIV. Determine the electrical equivalent of heat
15.635	Calculate the horsepower of a motor using various methods	XXXV. Horsepower a. Understand the meaning of horsepower and its computation b. Read motor plate data		XXXV. Find the horsepower of a motor
15.636	Explain and connect transformer to produce specific voltages and currents	XXXVI. Transformers a. Knowledge of transformers effect in a circuit		XXXVI. Use the laws of transformers
15.637	The student will know where and how to use a voltmeter and ampmeter	XXXVII. Voltmeters and Ammeters a. D'arsonal movement and factor that influence it b. Connecting meters c. Protecting meters d. Digital meters		XXXVII. Explain operation of a voltmeter and ammeter

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.638	Use various instruments to detect lines of force around a coil of wire	XXXVIII. Field of force a. Use meters to prove the existence of lines of force b. Uses of field of force		XXXVIII. Find the field lines around a current-carrying wire
15.639	Knowledge of the NEC	XXXIX. National Electric Code a. Conductor sizing b. Disconnects c. Fuse and circuit breakers sizes d. Grounding of motors and equipment		XXXIX. Be familiar with chapters and articles in the National Electric Code and use of it to find pertinent information
15.70	AUXILIARY			
15.71	The student will demonstrate the development of a graph as related to the plotted information.	I. Plotting graphs a. Explain value of a position through the use of dots or lines on graph paper b. Scales c. Types		I. Plot a graph
15.72	The student will interpret information as given from graphs.	II. Reading graphs a. Type information passed through the use of a graph b. Application to trade		II. Read a graph
15.73	The student will demonstrate reading of diagrams and charts.	III. Diagrams and charts a. Interpret information on lines or graph paper b. Types c. Applications		III. Read diagrams and charts

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE	PERFORMANCE OBJECTIVES
15.74	The student will apply the four basic mathematics as applicable to HVAC.	IV. Basic arithmetic a. Use basic mathematics to solve problems involving figures b. Applications		IV. Perform the four basic arithmetic functions
15.75	The student will by appropriate math (calculator) calculate roots and square roots.	V. Square roots		V. Extract a square root
15.76	The student will develop the principle of calculations when reciprocals are given.	VI. Inverses		VI. Add inverses

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
6.00	COMMUNICATIONS			
6.10	READING			
6.11	The student should be familiar with and know approved reference manuals and text as job related.	I. Manuals, workbooks, work orders, and memos should be read to understand technical information related to the job.		I. Read manuals, workbooks, work orders and memos
6.12	The student should read and study job related publications	II. Reading books in field would be required by a technician or foreman and normally would be highly technical for the purpose of making on the job decisions.		II. Read books in the field
6.13	The student should keep abreast of work assignments from day to day.	III. Reading bulletin boards and company publications is one of several ways of being informed. Everyone in every organization should be encouraged to make reading a habit		III. Read bulletin boards and company publications
6.14	The student should be able to use the dictionary	IV. Use of dictionary a. In reading the materials available it is important to understand the words. A dictionary should be considered as an important tool for understanding b. It should also be used to verify spelling if there is any doubt		IV. Look up words in dictionary

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
16.15	The student should study and obtain new data as field related	V. Reading trade journals is important to being able to keep up with industry developments and equipment changes		V. Read articles in trade journals
16.16	Interpret written directions and instructions	VI. Written instructions are used in everyday communication and are vital in service work		VI. Read and interpret written instructions
16.20	WRITING			
16.21	The student will be able to write reports, work orders, memos, and instructions to relay important information to appropriate persons.	I. Forms a. Work progress b. Work orders c. Form d. Directions		I. Write reports, work orders, memos, and instructions
16.22	The student will give appropriate answers on form questions.	II. Application forms		II. Application for employment
16.23	The student should be able to write both formal and informal job applications.	III. Formal and hand-written		III. Job application form
16.24	The student will select and write a rough draft of a business letter ...ng appropriate	IV. Select information necessary a. Inquiry b. Explanation c. Order		IV. Business letters

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
	form for the type of communication desired.	d. Reference		
5.25	The student should know the language of industry.	V. Terminology		V. Spell job related terms
5.26	The student should know the process of developing a formal hand-written letter.	VI. Writing legibly a. Typed b. Written		VI. Write legibly
5.27	The student should be familiar with fundamentals of purchase orders and purchase order numbers.	VII. Objectives of purchase orders and requisitions		VII. Requisitions and purchase orders
5.28	The student should develop a bill of material from a blueprint.	VIII. Blueprint take off (Bill of Materials)		VIII. Make out a bill of goods
5.30	<u>TALKING</u>			
5.31	The student should demonstrate the ability to give directions understandably	I. Oral directions a. Know what message to convey and be specific b. Make certain the message is understood		I. Give oral directions

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
16.32	The student should be able to present general information on a topic with which he is familiar to a small group of peers.	II. Speaking to a small group.		II. Speak to a small group
16.33	The student should ask leading, pertinent questions.	III. Be attentative to answers a. Ask leading questions b. Understand answers		III. Solve problems by asking questions
16.34	The student should demonstrate the ability and knowledge of subject matter to substantiate suggestions.	IV. Agree if applicable a. Substantiate answer b. Use "Yes-But" tactic		IV. Making suggestions to superiors
16.35	The student should demonstrate the ability to "keep his cool" under all conditions, when using the telephone or other public communication systems.	V. Talking on the telephone a. Be pleasant, plain and brief b. Use notes on communication in order to repeat if necessary		V. Talking on telephone
16.36	The student should participate in discussion of a specific [illegible]pic and develop skills [illegible]d diplomacy in discussion.	VI. Be able to stick to subject.		VI. Participating in discussions

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
6.37	The student should be able to evaluate and orally convey required job reports or request to personnel involved.	VII. Oral reports and requests pertinent to the job		VII. Report orally on work
6.38	The student should present his/her side of a controversy in order to amicably make his/her point.	VIII. Be sincere and know topic presented in order to maintain interest		VIII. Show conversational courtesy to others
6.40	LISTENING			
6.41	The student should listen objectively to obtain meaning.	I. Meaning		I. Listening for meaning
6.42	The student should be able to listen critically for information.	II. Information		II. Listening for information
6.43	The student should be able to listen conceptually for understanding.	III. Clarifying		III. Listening for understanding
6.44	The student should be able to listen sensitively to share feelings.	IV. Empathy		IV. Listen to share feelings

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
6.50	VISUAL INTERPRETATION			
6.51	The student should demonstrate an ability to describe surroundings from sight and memory.	I. Describe surroundings		I. Be aware of surroundings
16.52	The student should be aware of hazards, safety violations, and general physical dangers on the job.	II. Recognizing problems and dangers		II. Recognize problems and dangers
16.53	The student should be able to interpret informational and warning signs, symbols, and posters.	III. Being attentive and knowledgeable of sign information		III. Interpret signs, symbols, posters, and other visual
16.54	The student should be able to interpret simple freehand drawings.	IV. Sketching and interpreting charts and diagrams		IV. Interpret freehand sketches and diagrams
16.55	The student should interpret graphs and maps as related to both indoor and outdoor signs and information.	V. Interpreting graphs and maps		V. Interpret graphs and maps

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
	PROFESSIONAL PRACTICE			
17.10	BUSINESS MANAGEMENT			
17.11	Student maintains good relations with instructor.	I. Know the employer and how he will react to different words and emotions. Develop personal skills and traits.		I. Maintains good human relations with employer
17.12	Will show student system of filing so service personnel can find history of customer equipment.	II. Knows a system so that a customer's equipment can be found quickly, also records repairs done on equipment. Knows age of equipment and case history.		II. Keeps records of customer on file
17.13	The student will maintain good relations with classmates.	III. Set up a system which will bring business to the attention of the general public in an acceptable manner.		III. Maintains good public relations with general public
17.14	Student will be taught method of planning and specifying work for bid purposes.	IV. Be able to figure material, labor, hidden cost, tax, and other things which might influence the cost and profit before the job is finished.		IV. Can compute overhead cost of each job as well as other costs
17.15	Reasons for enforcement of codes will be explained to student.	V. Have on hand and a knowledge of all codes and laws which say what can and must be done related to the installation, maintenance, operation, and servicing of equipment.		V. Knows locals, state, and federal regulations pertaining to equipment to be used

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
17.20	ETHICS			
17.21	Students will be taught to exchange ideas at group meetings.	I. Know how other businesses do their job. Be able to be their friend instead of their competitor. Know how to respect what they do.		I. Respects competitors in same field
17.22	Teach the importance of doing quality work.	II. Perform satisfactory competency work for reasonable fee.		II. Feels obligation to public to do a good job
17.23	Student will be instructed in incentive procedures.	III. Compensations for good work and proper attitude to company.		III. Has obligation to employee to give fair treatment
17.24	Will teach pride in workmanship.	IV. Appreciate and comment on excellence of work done by employee.		IV. Knows the value of work competently done
17.25	Student will be taught minimum requirements.	V. Perform to standards even when able to get by with less.		V. Respects laws, rules, and regulations which must be observed
17.30	STANDARDS			
17.31	Will teach students on value of retrofits to save energy.	I. Understanding the value of current information pertaining to individual's equipment.		I. Keeps up-to-date records of changes
17.32	Get student interested in reading trade manuals regularly.	II. Read latest brochures, magazines, journals, etc.		II. Keeps in touch with manufacturer's recommendations

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
17.33	Code book will be emphasized.	III. Read and understand building, fire, and electrical codes.		III. Knows laws pertaining to equipment
17.34	Students will learn to assume an "informed attitude"	IV. Sources of information		IV. Keeps informed
17.35	Student is careful to do quality work.	V. Recognize craftsmanship.		V. Does those "plus" jobs
17.40	MARKETING			
17.41	Teach student to use competitive bidding.	I. Make student aware of general cost so that he does nothing impulsive to cost equipment owner or service contractor a lot of money.		I. Aware of total cost of equipment
17.42	Student will be taught methods of determining overhead.	II. Determining overhead.		II. Knows overhead cost to deliver and/or install material
17.43	Student has filing system for supplies.	III. Keep up-to-date costs.		III. Maintains list of available supplies to choose from
17.44	Student will be taught methods of design.	IV. Be aware of all types of systems and the many available applications and methods.		IV. Aware of alternate systems to be used

TASK CODE	INSTRUCTIONAL OBJECTIVES		CONTENT OUTLINE	ACTIVITY EXPERIENCE*		PERFORMANCE OBJECTIVES
17.45	Explain health benefits vs. costs of a system to customer.	V.	Have working/practical knowledge of physical, health, and pleasure-giving aspects of the operating system.		V.	Can explain health benefits related to installation of job
17.46	Teach methods of retrofit for existing jobs.	VI.	Have thorough knowledge of installation techniques as well as energy conservation methods and cost-cutting (approved) techniques.		VI.	Analyzes what could be done to decrease cost of installation and operation
17.47	Student can determine payback on investment.	VII.	This topic not of value to student--perhaps in an advanced or upgrading course.		VII.	Can compute first cost of job relative to annual operational cost
	CULTURAL ATTRIBUTES					
18.10	VALUES					
18.11	The student will keep abrease of research and development from periodicals.	I.	Keeps up with changes and improvements in the air conditioning and refrigeration equipment.		I.	Interested in being informed
18.12	The student will demonstrate ability and personal involvements involving call backs and customer complaints.	II.	Does neat work and shows personal involvement in what is being done.		II.	Interested in becoming a better employee
18.13	The student must be job and work dedicated.	III.	Does quality work which will help build the business.		III.	Interested in concerns of employer

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
18.14	The student will demonstrate personal integrity and meet monetary obligations.	IV. Shows conservative traits in personal finances.		IV. Careful in use of salary
18.15	The student will demonstrate personal pride in his work.	V. Knows that professional manners with a personal touch impress the public.		V. Committed to personal and professional goals
18.16	Maintain price and personal community respect.	VI. Knows that a person's standard of living reflects his attitudes of others standards.		VI. Concerned for standard of living.
18.17	Attend manufacturer's trade related seminars.	VII. Knows that an employer will respond to the person who is willing to learn.		VII. Has desire to learn
18.20	ATTITUDES			
18.21	The student will demonstrate psychological attitudes in customer building and relationships.	I. Knows a pleased customer is a good customer.		I. Has desire to please
18.22	The student should develop customer empathy.	II. Knows other people do not understand his line of work and that there is usually reason for having problems.		II. Understands others problems
18.23	The student will be aware of the promotional ladder and serve as a team leader in complying with the employer's requests.	III. Knows that through hard work both quality and proficiency can be improved.		III. Is willing to work hard to improve

TASK CODE	INSTRUCTIONAL OBJECTIVES		CONTENT OUTLINE	ACTIVITY EXPERIENCE*		PERFORMANCE OBJECTIVES
18.24	Student adapts to classroom situation.	IV.	Knows work and life will be much more productive when one is able to work his ideas and objectives along with those of the employer and the other employees.		IV.	Wants to fit into scheme of things
18.30	PHILOSOPHY					
18.31	Student will be assigned to develop and provide performance and efficiency.	I.	Satisfaction on the job can be attained by putting value on pride of work well done.		I.	Interested in benefitting from better working conditions by performing quality work at better efficiency
18.32	Student will be assigned leadership of groups in class.	II.	Attitude toward customers, fellow employees, and management is a training process which takes a period of time to attain and requires leadership.		II.	Consistent attitude toward all phases of work and private life
18.33	The student will be given responsibilities of work with a definite purpose.	III.	Understanding one's responsibilities fully will create a definite purpose of work.		III.	Has a definite purpose to work
18.40	HUMANISTIC AND SOCIAL SKILLS					
18.41	Require student to be prompt and to utilize time for work.	I.	Be on time, respond to requests promptly, utilize time for profit.		I.	Is dependable

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
18.42	Promote teamwork in classroom and labs.	II. Respect for viewpoints of others is necessary.		II. Understands all people
18.43	Group students to take advantage of aggressive students.	III. Controlled agressiveness which works for the benefit of a group.		III. Has aggressiveness to get job done
18.44	Require student to think to complete job.	IV. This can be accomplished through education.		IV. Is thorough in work habits
18.45	Encourage students to share thoughts.	V. Understanding through sharing experiences and concerns.		V. Is thoughtful of others problems
	INTERPERSONAL-INTERACTIVE SKILLS			
19.10	LEADERSHIP			
19.11	Student will arrange tools in correct order for job to be done.	I. Coordinate tools, equipment, supplies, and personnel to effect smooth and orderly operation.		I. Is able to coordinate different phases of jobs
19.12	Student will write instructions so that others may do a job. Jobs must be completed from instructions given him by other students. Teach teamwork. Student will ask questions and make sure he understands instructions before doing job.	II. Instructions (a) Give comprehensible instructions in manner acceptable to others (b) Understands instructions given to him (c) Never petty or unfair (d) Encourages questions if instructions are not clearly understood		II. Is able to take as well as give clear concise instructions in a businesslike manner

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
19.13	Students are trained to realize their strengths and weaknesses from encouragement and constructive criticism of other students.	III. Knowledge of fellow employees (a) Encouragement (b) Constructive criticism (c) Strengths and weaknesses of employees		III. Completes job performed in professional manner so company is complimented
19.14	Instill in student the importance of quality workmanship and time conserved is profit for the company.	IV. Efficiency (a) Quality workmanship (b) Time conserved (c) Profit for the company		IV. Motivates co-workers and helpers to accomplish objective in least amount of time with quality retained
19.15	Student trained to use tools properly, use correct tools for job.	V. Tools and equipment (a) Knowledge and use of proper tool for the proper job (b) Knowledgeable and respectful use of company equipment		V. Insures company equipment and supplies are not misused
19.20	TEAMSMANSHIP			
19.21	Arrange students in teams.	I. Compatibility increases work output.		I. Works well with other employees
19.22	Promote student discussions of work being done.	II. Understands and appreciates views of others even if disagreement exists.		II. Respects views and opinions of others
19.23	Promote teamwork between sex and race.	III. Discrimination is undesirable in any form.		III. Does not discriminate

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
19.24	Set goals for students and require that they achieve at their best pace.	IV. Goals are necessary.		IV. Is concerned with total company objectives
19.30	PERSONNEL MANAGEMENT			
19.31	Develop a good management program have students do research.	I. Cooperation with management planning.		I. Understands and appreciates need for rules and regulations that are a function of good management practices
19.32	Set up lab groups with one student in charge change leaders with each job.	II. Knows who is his immediate superior and shows a willingness to respond.		II. Understands and follows chain of command
19.33	Train students to recognize talents of others.	III. Recognizes the talents of individuals on an individual basis and assigns work accordingly.		III. Decides who is to be assigned to job and how to best effect completion
19.40	GROUP INTERACTION			
19.41	Have student obtain information and share with others.	I. Is knowledgeable and in general keeps up with timely information. Has an interest in other people.		I. Enjoys participation in group activities
19.42	Presents relevant information in group discussions.	II. Student is in the "present" in conversations.		II. Has something to contribute to group

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
19.43	Instruction instills motivation in students and requests that all students help others to become involved.	III. Knows how to be flexible "give and take"		III. Understands that the good of the group should come first
19.44	Explains unclear items to others.	IV. Knows or understands personal circumstances in various situations.		IV. Aware of responsibilities of relating to individuals who are not as involved as they may be
19.50	SALESMANSHIP			
19.51	Requires students to study manufacturer's data sheets.	I. Know what the product can do to meet the needs of the user.		I. Understands and has knowledge of product and services to be sold
19.52	Student enjoys talking with people about the field.	II. Develop and maintain interest in the discussion of the product.		II. Attentive to customers' "signals," moods, etc. Analyzes these and adjusts sales pitch to benefit sale
19.53	Have student groups discuss and analyze various products as to quality and price.	III. Know the quality of other like (brands) products and their prices.		III. Attempts to get most reasonable price for company

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
19.54	Train student as a sales person to always protect his company financial condition.	IV. Has knowledge that his financial condition can never be better than the company he works for.		IV. Understands and appreciates fact that the better financial condition company is in, the better his position
	INFORMATION RETRIEVAL			
20.10	RECALL			
20.11	Teach association of ideas.	I. Make use of old ideas to recall new ideas.		I. The recall of basic ideas by memory games. Word/object associations.
20.12	Student must first think, function, and relate to technical facts.	II. Know how to use technical facts to solve new problems.		II. The use of job or inside information taken from notes that were kept to help recall technical facts
20.13	Require students to keep a log of each job.	III. Know when to recognize a job that is not of the ordinary design and log same.		III. Keep log book for all jobs or installations that are not of the ordinary design

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
20.20	DATA COLLECTING			
20.21	Require students read trade journals.	I. Providing the necessary knowledge is a personal responsibility.		I. Reads technical manuals and trade journals, then files according to pre-determined system
20.22	Stress importance of personal library.	II. Obtaining knowledge from personal library is quicker and more efficient.		II. Buys textbooks and starts personal technical library
20.23	Inform student how to obtain use of material from manufacturers.	III. Pertinent information must be kept selectively for anticipated needs.		III. Collects manufacturers' releases and files in library
20.24	Student must know the importance of installation sheets.	IV. Engineering data (a) Installation sheets (b) Service information		IV. Requests engineerin data from related manufacturers and files for future use.
20.25	Student must know the importance of reference information.	V. Filing system		V. Removes installer's information sheets from new equipment and files under area and customer
20.30	SELF INSTRUCTION			
20.31	Explain use of trade journals.	I. Provides up-to-date knowledge of new equipment and processes used in the trade.		I. Obtains subscriptions to trade journals

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
20.32	Ask student to start new product file.	II. New ideas are available in a fast changing market.		II. Collects and files trade releases for new products for study and evaluation
20.33	Ask student to meet with trade people.	III. New service techniques are available where people meet and exchange ideas.		III. Attends service schools sponsored by both industry and educational institutions
20.34	Get "junk mail" file, useful material discard remainder, and do not clutter files.	IV. Checking "junk mail" not only puts a person on a mailing list, but also provides the newest information on competitive products		IV. Checks "junk mail" sent by manufacturing companies for new or improved products or designs or performance changes
	PERSONAL SKILLS AND TRAITS			
21.10	RELIABILITY			
21.11	Practice punctuality at all times in all things.	I. Know what is expected and live up to it.		I. Arrives on time
21.12	If employer is to be informed on any matter, be sure that the information is accurate. Never resort to gossip and discuss only items affecting the company.	II. Make employer aware of things which might interfere with performance.		II. Keeps promises.

TASK CODE	INSTRUCTIONAL OBJECTIVES		CONTENT OUTLINE	ACTIVITY EXPERIENCE*		PERFORMANCE OBJECTIVES
21.13	Make every effort to understand instructions, listen intently to oral instructions and study written instruction diligently.	III.	Understands place instructions have in effective communication.		III.	Follows orders intelligently.
21.20	THOROUGHNESS					
21.21	Evaluate what is needed on job prior to start and be prepared. Have everything on hand and ready.	I.	Understands job needs.		I.	Willing to finish job
21.22	Follow instructions to the letter and if anything is not clear, get the answers before beginning.	II.	Understands need for accuracy.		II.	Listens carefully for complete instructions
21.23	Recognize which tools are the most effective for given applications.	III.	Labor-saving tool knowledge useful.		III.	Uses best information and tools available for job
21.30	NEATNESS					
21.31	Make an effort to conduct oneself on the job so as to never offend the customer. Respect customer's questions and comments.	I.	Makes a good impression on a customer and increases company good will.		I.	Always cleans up after job is done
21.32	Maintains trucks, tools, and instruments, and stores them in an organized fashion.	II.	Understands corract shape for safety of tools.		II.	Keeps tools in proper shape

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TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
21.33	Recognize and wear proper dress to avoid possible injury.	III. Knows safety and unsafe clothing characteristics.		III. Dresses appropriately for the job
21.34	Recognize that certain hair styles can be extremely dangerous around mechanical devices.	IV. Hair styles can cause safety problems.		IV. Keeps hair well groomed and uniform clean
21.40	EFFICIENCY			
21.41	Student is instructed in labor-saving methods.	I. Knowledge of time and labor-saving devices and information.		I. Looks for ways to save time and labor
21.42	Instruction pertains to good work habits.	II. Completing tasks efficiently (a) Standard (b) Practice and familiarization (c) Resources (d) Work habits and techniques (e) Maintenance of tools		II. Completes tasks in appropriate period of time
21.43	Student learns to use materials wisely.	III. Evaluates different concepts and methods.		III. Looks for ways to save materials, use less expensive materials, and not waste materials
21.44	Analyzes comparative methods and evaluates all tasks toward job completion.	IV. Use of suggestion box and evaluates lost motions to avoid future problems.		IV. Looks for ways to decrease non-productive work

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
21.50	INTEGRITY			
21.51	Beware and accept that trustworthiness is one of the stepping stones in advancement.	I. Must report accurate conditions.		I. Can be trusted at all times
21.52	Be aware that truthfulness is the foundation for mutual trusts.	II. Understands truthfulness.		II. Provides accurate information about the job
21.60	HONESTY			
21.61	Recognize that time materials and equipment and property represent money.	I. Knows value of money.		I. Can handle money safely
21.62	Practice the art of time utilization and the careful and accurate use of any parts.	II. Understands value of time and does not use parts unnecessarily.		II. Is careful and honest with time allotted
21.70	RECEPTIVITY			
21.71	Recognize that authority is necessary to all well run organizations.	I. Understands need for authority.		I. Accepts authority easily
21.72	Recognize that job descriptions assist both management and employees.	II. Understands need for varied job assignments.		II. Accepts job assignments willingly

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TASK CODE	INSTRUCTIONAL OBJECTIVES		CONTENT OUTLINE	ACTIVITY EXPERIENCE*		PERFORMANCE OBJECTIVES
21.73	Develop the trait of asking for direction when in doubt and then proceeding promptly and automatically.	III.	Understands that there is a balance between "lack of self initiative" and having too much "self initiative."		III.	Tries to understand reason for job
21.74	After proper planning and direction, be able to follow plan.	IV.	Understands the value of proper planning.		IV.	Takes time to get proper instructions and asks when there is doubt
21.80	SENSITIVITY					
21.81	Accept and apply rules governing individual and company behavior.	I.	Understands basic psychology.		I.	Has a feel for human relations
21.82	Be aware that other persons have feelings and endeavor to satisfy the desires of others.	II.	Application of "Golden Rule" principle.		II.	Responds to others' feelings constructively
21.83	Recognize that cooperation and compromise are necessary to remove dissatisfactions brought on by agitation.	III.	Areas of agreement must be found rather than stressing disagreement and relief must be provided where there is serious agitation.		III.	Explains that overall needs must be met despite some different of opinion
21.90	PRACTICABILITY					
21.91	Establish priorities for work progression and cooperate with other trades and workers.	I.	Know what the job consists of and the order of progression.		I.	Has ability to keep proper perspective of job relations

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
21.92	Be aware of the "game plan" and be on constant lookout for possible problems.	II. Know what is expected and/or required. Have knowledge of good safety practices.		II. Uses good judgement in work decisions.
21.100	FRIENDLINESS			
21.101	Listen to the ideas and explanations of others.	I. Be openminded but also knowledgeable and diplomatic in following and giving information to co-workers.		I. Willing to accept others' viewpoints.
21.102	Is open to newcomers and willing to make an effort to find areas of common interest.	II. Be attentive to co-workers and recognize need for communication on topics of common interest so that co-workers feel at ease.		II. Meets new people easily
21.103	Remember that all employees make the whole company what it is and be prepared to assist and cooperate with newly acquired personnel.	III. Be receptive to new employees and don't require them to prove themselves.		III. Helps new personnel become productive
21.110	ALTRUISM			
21.111	Be able and willing to explain to others' skills or knowledge which have already been acquired.	I. Know the operation and function of the equipment.		I. Can place himself in the other man's shoes

TASK CODE	INSTRUCTIONAL OBJECTIVES	CONTENT OUTLINE	ACTIVITY EXPERIENCE*	PERFORMANCE OBJECTIVES
21.112	Represent the company and the customer as though the success of both depend on you individually. If criticizing appears to be necessary, think through the course of action thoroughly before acting and be absolutely sure you are not expressing a personal preference.	II. Be honest and render a fair day's work for an honest day's pay.		II. Interested in employer, employee, and customer concerns

*Activity Experiences will vary depending on how these objectives are used in the curriculum. The AHR instructor should work with related instructors to identify appropriate content and resource materials to use in teaching these concepts.

Chapter V

EQUIPMENT

The equipment listed has been identified as being necessary to start an air conditioning, heating, and refrigeration mechanic program for 18 students. As additional funds and space become available or if the institution offers an advanced level program other items of equipment can be added to provide exposure to more specialized applications and skill development. While requisition of equipment is now a local concern, the high cost of new equipment and limited equipment funds suggest utilizing whatever resources might be available to acquire used equipment that can be used for demonstrating, troubleshooting, servicing, and cannibalization. Often local air conditioning, heating, and refrigeration contractors have second hand air conditioners, furnaces, and refrigeration units that they will give to the institution for educational purposes. Also, maintenance and replacement of equipment and availability of supplies are concerns that require a continuing budget and the attention of the institution.

Basic Air Conditioning, Heating, and Refrigeration Equipment

ITEM NO.	QUANTITY	DESCRIPTION
TEACHING SYSTEMS (STATIONS, DISPLAYS AND MOCK-UPS)		
1		The institution may choose to use laboratory teaching systems to provide basic training on air conditioning, heating, and refrigeration concepts. A variety of trainers are available or may be built from standard systems.
AUXILIARY EQUIPMENT		
2	1	Portable vacuum pump
3	1	High vacuum gauge
4	1	Hermetic valve kit
5	3	Tube bender, 3/8", 1/2", 5/8"
6	2	Swaging tool sets
7	1	Nitrogen regulator
8	1	Appliance truck
9	10	MAPP gas torch kits, with adapter
10	1	Bench chain vise
11	1	Arc welder A.C. type, shielded arc (Argon or CO_2) accessories
12	1	Oxygen and acetylene combination welding and cutting outfit (to be portable)
13	1	Cylinder truck, rubber tired welding hand truck
14	2	Flaring and cutting tool kit (45^0)
15	1	Pipe threader, 1/8" - 1", (ratchet drop head)

ITEM NO.	QUANTITY	DESCRIPTION
16	1	Service valve kit for hermetic compressors
TESTING EQUIPMENT (INSTRUMENTS, METERS, ETC.)		
17	1	Humidity and temperature recorder
18	1	Gas pressure manometer
19	2	Hermetic unit test cond.
20	1	Relay tester
21	1	Capacitor analyzer
22	1	Manometer
23	1	Test manifold
24	1	Relative humidity indicator
25	5	Sling psychrometer
26	1	Monoxor CO indicator
27	2	Anemometer 8 blade vane, low speed
28	2	Leak detectors (electronic and halide)
29	1	Thermostat
30	2	Charging and testing units with gauges and hoses
31	1	Velocity meter
32	1	Recording amperage meter A/C 0-5/25/100/250
33	1	Vortex tube
34	3	Heating and cooling thermostat, with sub-base
35	2	Digital power probe
36	4	Superheat thermometer set-electronic
37	3	Voltohmmeter, 0-25/100/1000/10,000 ohms and 0-50/215/250/500/ and 1000 volts AC-DC

ITEM NO.	QUANTITY	DESCRIPTION
38	4	Gas pressure test set
39	4	Two-cappy-pocket size capacitor tester
40	1	Hermatic compressor analyzer and electric tester
41	1	Gas furnace combustion efficiency tester
42	3	Volt-ohm-snap-on ammeter
43	2	Three-lead dual range, electronic thermometer
44	3	Volt-ohm-ammeter with temerature scale
45	1	Millivolt millamp meter
46	2	Sling psychrometer
47	1	Hygrometer
COMMERCIAL AND ELECTRICAL TOOLS		
48	1	Electric drill - 1/2" portable, reversing with hammer chuck
49	1	Electric soldering gun
50	1	Bench grinder 7", 1/2 H.P. with 60 grit and 40 grit wheels and 6" X 3/4" wire brush wheel
51	1	Drill press 15" floor type full tilting table
52	1	Jacobs chuck 0-1/2"
53	1	36" sheet metal brake with stand
54	2	4 1/2" bench vise, swivel base
MISCELLANEOUS HAND TOOLS		
55	2	Ball pein hammers, 2 lb.
56	2	Soft face hammers, 1 lb.
57	1	Socket Set 3/8" sq. dr. - ratchet wrench (10 pc. basic set in steel box)

ITEM NO.	QUANTITY	DESCRIPTION
58	1	Socket set 1/2" sq. dr. (11 pc. basic set in steel box)
59	1	1/2" Drive torque wrench
60	2	Hacksaw frames with sawblade
61	2	Adjustable wrench, 12"
62	2	Adjustable wrench, 10"
63	2	Lineman's pliers, 7"
64	2	Long nose pliers, 6"
65	2	Locking pliers, 10"
66	2	Ball pein hammer 8 oz.
67	1	Drill set by 64th, 21 pc. to 1/2"
68	2	Carpenter's steel square
69	1	Machinist Level
70	1	Plumb bob
71	1	Carpenter's level, 24" minimum
72	1	Pipe wrench 24"
73	1	Pipe wrench 14"
74	2	Box and open end wrench set, 7/16" - 3/4"
75	2	Offset box-end wrench set, 3/8" - 3/4"
76	1	Socket set 45pc., 1/4" and 1/2" drive
77	2	Phillips stubby screwdriver
78	1	Punch and chisel set, 12 pcs.
79	2	Stub screwdriver
80	2	Screwdriver, 4"
81	2	Screwdriver, 6"
82	2	Screwdriver, 8"
83	2	Phillips screwdriver, 6"

ITEM NO.	QUANTITY	DESCRIPTION
BENCHES, VISES AND SHOP FURNITURE		
84	1	Swivel base vise-4"
85	2	Oil waste cans - 10 gal.
86	8	Wood top work benches with metal legs (72" X 34" X 34")
87	2	Cubbyhole storage unit 87" X 36" X 12" 104 openings
88	1	Heat pump condensing unit, 1-phase 208-230V
89	1	Air handler with 4.7 KW heatstrips
90	1	1 stage cool and 2 stage heat thermostat
91	1	Electric boiler including circulator and controls. 2 KW elements, 34130 BTU/hr. capacity
92	1	Electric furnace - 3 heating elements-500 watts each 208/60/1 power - 1200 C fan 1/3 HP belt drive blower
93	1	Gas furnace - solid state controls 80,000 input-64,000 output belt drive - 1/3 HP
94	1	Lubricating oil protection control
95	1	Oil burner control
96	1	Combination fan and limit control
97	1	Delayed oil valve
98	1	Indoor-outdoor control system
99	1	Heat pump control panel
100	1	Surface temp. probe
101	1	Free air temp. probe
102	1	Additional themistor lead
103	1	Thermistor lead, 30 ft.
104	1	Carrying case for temperature probes

ITEM NO.	QUANTITY	DESCRIPTION
105	1	Oil fired basement furnace, 1/3 HP blower belt drive, 1130 CFM at .40 ESP
106	1	Gas-fired, low-boy, vertical furnace with all necessary control. 105,000 BTUH input, 84,000 BTUH output, 900 CFM
107	1	Electric low-boy, vertical furnace with all necessary controls, 83,738 BTUH output, 1360 CFM
108	1	Air conditioner, condensing units, air cooled, 220 volt, single phase, 24,000 BTUH output
109	1	Up flow, A-type evaporator coil for above air conditioner
110	1	Electric home air conditioner simulator with printer driver interface, locking cover, and sonic alarm
111	1	Refrigerator/freezer simulator with printer driver interface, locking cover and sonic alarm
112	1	Student tracking printer
113	1	Power humidifier for forced air furnace
114	1	Electric air cleaner for forced air furnace
115	2	Semi-hermetic compressor, medium temp., refrigerator 12, 1/4 HP
116	2	Semi-hermetic compressor, medium temp., refrigerator 12, 1/3 HP
117	1	Solar heating demonstration system
118	1	Solar heat collector
HEATING CONTROLS		
119	1	Heating relay
120	1	Cadimum cell for heating relay
121	1	Fan and limit control

ITEM NO.	QUANTITY	DESCRIPTION
122	1	Fan relay and transformer
123	1	Fan relay
124	1	Transformer (24V.) for fan relay 40 V.A.
125	1	Chronotherm (night-day thermostat)
126	1	Fan center
127	1	Fan limit control, close rise
128	1	Fan limit control, open on rise
129	1	Model control system to include electric controls
130	1	Differential solar thermostat
SAFETY ITEMS		
131	1	Cabinet, safety glass monitor

Chapter VI

RESOURCES

Selected resources for the Air Conditioning, Heating, and Refrigeration curriculum are listed as books in print and training aids.

The books in print are listed by subject area, title and publisher. These books have been extracted from the Subject Guide to Books in Print, 1978-79, R R Bowker Company, New York, NY, 10036. They should be reviewed to determine their appropriateness to the intent and level of the mechanic curriculum.

Training aids are listed also by subject area and include information on type training aid, title, code, and source. This information was extracted from Bibliography of Training Aids compiled by the Air Conditioning and Refrigeration Institute, 1815 N. Fort Myer Drive, Arlington, VA 22209.

Orders for books and materials listed in this section should be sent to the appropriate publisher or source. Prices and other information may have changed. Sources should be contacted for additional information on training aids if individuals ordering the material have questions.

The listing of materials in this section is a partial one and should not be construed as an endorsement by the Department of Community Colleges or the Air Conditioning and Refrigeration Competency Curriculum Committee.

BOOKS IN PRINT

Air Conditioning

	Title	Source
1.	Heating, Ventilating and Air Conditioning Estimating Manual	McGraw
2.	Refrigeration and Air Conditioning	AHR Inst.
3.	Air Conditioning and Ventilating Systems	Natl. Fire Prot.
4.	Modern Refrigeration and Air Conditioning	Goodheart
5.	Heat Pumps and Electric Heating: Residential, Commercial, Industrial Year-Round Air Conditioning	Wiley
6.	Efficient Comfort Conditioning	Westview
7.	Dictionary of Refrigeration and Air Conditioning	Intl. Ideas
8.	Heating, Ventilating and Air Conditioning Library	Audel
9.	Handbook of Air Conditioning System Design	McGraw
10.	Airconditioning and Ventilation in Buildings	Pergamon
11.	Aim for a Job in Air Conditioning and Refrigeration	Arco
12.	Aim for a Job in Air Conditioning and Refrigeration	Rosen
13.	Doolin's Trouble Shooters Bible	Doolco Inc.
14.	Trouble Shooters Bible for Refrigeration and Air Conditioning	Wehman
15.	Heating and Cooling Load Calculations	Pergamon
16.	Basic Air Conditioning	Hayden
17.	Standard Refrigeration and Air Conditioning: Questions and Answers	McGraw
18.	Heating and Air Conditioning Ducts Encased in and Under Concrete Slabs-On-Ground	Natl. Acad. Sci.
19.	Air Conditioning and Mechanical Trades: Preparing for the Contractor's license Examination	Van Nos Reinhold
20.	Applied Air Conditioning and Refrigeration	Intl. Ideas

	Title	Source
21.	Air Conditioning and Cold Storage	Chilton
22.	Automatic Control of Heating and Air Conditioning	McGraw
23.	Control Systems for Heating, Ventilating and Air Conditioning	Van Nos Reinhold
24.	Modern Air Conditioning Practice	McGraw
25.	Willis Haviland Carrier, Father of Air Conditioning	Arno
26.	Heat Transfer-Current Application of Air Conditioning: International Institute of Refrigeration	Pergamon
27.	Environmental Engineering: Analysis and Practice	Har-Row
28.	Air Conditioning Engineering	Crane-Russak Co.
29.	Scientific Basis of Air Conditioning	Intl. Ideas
30.	Solar Heating and Cooling Systems: Engineering, Practical Design and Economics	McGraw
31.	Guide to Home Air Conditioners and Refrigeration Equipment	Hayden
32.	Principles of Air Conditioning	Delmar
33.	Heating and Cooling Safety	Delmar
34.	Principles of Air Conditioning	Delmar
35.	Refrigeration and Air Conditioning	Reston
36.	Electric Controls for Refrigeration and Air Conditioning	P-H
37.	Air Conditioning and Heating Practice	HR&W
38.	How to Have Air Conditioning and Still Be Comfortable	Busn News
39.	Air Conditioning	LeFax
40.	How to Repair Home and Auto Air Conditioners	Tab Bks.
41.	Heating, Ventilating, and Air Conditioning: Analysis and Design	Wiley
42.	Power Plants with Air-Cooled Condensing Systems	MIT
43.	Air Conditioning Cutter's Ready Reference	Busn News
44.	How to Design Heating-Cooling Comfort Systems	Busn News

Title	Source
45. Estimator's Man-Hour Manual on Heating, Air Conditioning, Ventilating and Plumbing	Gulf Pub.
46. Air Conditioning: Home and Commercial	Audel
47. Handbook of Heating, Ventilating and Air Conditioning	Transatlantic
48. Air Conditioning for Building Engineers and Managers	Indus Pr.
49. Air Conditioning and Refrigeration	Natl. Learning
50. Getting Stared in Heating and Air Conditioning Service	Busn News
51. How to Make It in the Service Business	Busn News
52. Air Conditioning and Refrigeration	Wiley
53. Air Conditioning: A Guide for Architects, Engineers, and Prospective Purchasers	Queensland
54. Solar Cooling and Heating: Architectural, Engineering and Legal Aspects, Proceedings	Hemisphere
55. Principles for Air Conditioning Practice	Indus
56. Refrigeration and Air Conditioning	McGraw
57. Using SI Units (Standard International Metric) in Heating, Air Conditioning and Refrigeration	Busn News
58. Handbook of Air Conditioning, Heating, and Ventilating	Indus
59. Practical Drafting for the HVAC Traces	Sams
60. Warm Air Heating and Air Conditioning Systems	Natl. Fire Prot.
61. Environment Control: Air Conditioning and Refrigeration Theory and Application	Har-Row
62. Air Conditioning, Heating and Refrigeration Dictionary	Busn News

Electric Heating

Title	*Source
63. Heat Pumps and Electric Heating: Residential, Commercial, Industrial Year-Round Air Conditioning	Wiley
64. Electric Floor Warming with Notes on Ceiling Heating	Transatlantic
65. Basic Guide to Electric Heating	Busn News

Title	Source
66. How to Convert Your Present Heater to Low-Cost Electric	R Oman Pubns.

Environmental Engineering (Buildings)

Title	*Source
67. Building Mechanical Systems	Krieger
68. The Control of Indoor Climate	Pergamon
69. Environmental Planning	Technomic
70. Alternative Natural Engergy Sources	Van Nos Reinhold
71. How to Save Energy and Cut Costs in Existing Industrial and Commercial Buildings-an Energy Conservation Manual	Noyes
72. Concepts in Thermal Comfort	P-H
73. Thermal Comfort	McGraw
74. Architectural Interior Systems: Lighting, Air Conditioning, Acoustics	Van Nos Reinhold
74. Building Services and Equipment, Vol. 1	Longman
75. A New Language for Environmental Design	NYU Pr.
76. Responding to Social Change	DH&R
77. Encyclopedia of Energy-Efficient Building Design	Environ Design
78. Energy Conservation and Building Codes: The Legislative and Planning Processes	Environ Design
79. Building Technology: Mechanical and Electrical Systems	Wiley
80. Building for Energy Conservation	Pergamon
81. Embient Energy and Building Design	Longman
82. Design of Interior Circulation	Van Nos Reinhold
83. Energy Conservation Through Building Design	McGraw

Furnaces

	Title	Source
84.	Large Boiler Furnaces: Theory, Construction Control	Elsevier
85.	Marketing for Central Heating	Transatlantic
86.	Gasoline Blow Torches and Plumber's Furnaces	Natl Fire Prot.
87.	Furnace Operations	Gulf Pub .
88.	Convert Your Oil Furnace to Wood	FireBuilders

Heating

	Title	*Source
89.	Heating, Ventilating and Air Conditioning Estimating Manual	McGraw
90.	Complete Home Plumbing and Heating Handbook	Arco
91.	Environmental Factors in the Heating of Buildings	Halsted Pr.
92.	Small-Bore Heating and Hot Water Supply for Small Dwellings	Transatlantic
93.	Efficient Comfort Conditioning	Westview
94.	Central Heating	David & Charles
95.	Field Investigation of Underground Heat Distribution Systems	Natl Acad Sci.
96.	The Complete Solar House	Warner Bks.
97.	New Low Cost Sources of Energy for the Home	Garden Way Pub.
98.	Residential Fuel Policy and the Environment	Ballinger Pub.
99.	Microwave Heating	Avi.
100.	Home Guide to Plumbing, Heating, and Air Conditioning	Har-Row
101.	Fireplaces and Wood Stoves	Bobbs
102.	The Fixit Yourself Book of Plumbing and Heating	Petersen Pub.
103.	The Home Owner Handbook of Plumbing and Heating	Crown
104.	Trouble Shooters Bible for Refrigeration and Air-Conditioning	Wehman
105.	Heating and Cooling Load Calculations	Pergamon

Title	Source
106. Home Heating and Cooling	Reston
107. Concepts in Thermal Comfort	P-H
108. Handy Man's Plumbing and Heating Guide	Arco
109. Heating Handbook: A Manual of Standards, Codes and Methods	McGraw
110. Thermal Comfort	McGraw
111. Evaluation of Components for Underground Heat Distribution Systems	Natl Acad Sci.
112. Heating and Air Conditioning Ducts Encased in and Under Concrete Slabs-On-Ground	Natl Acad Sci.
113. Home Owner's Guide to Gas Heat	William-F
114. The Complete Book of Heating with Wood	Garden Way Pub.
115. Control Systems for Heating, Ventilating, and Air Conditioning	Van Nos Reinhold
116. How to Keep Your House Warm in Winter, Cool in Summer	Cornerstone
117. The Directory of Industrial Heating and Combustion Equipment: United States Manufacturers	Bermont Bks.
118. Environmental Engineering: Analysis and Practice	Har-Row
119. Keeping Warm	Music Sales
120. Process Heat Transfer	McGraw
121. Home Heating	McKay
122. Heating and Hot Water Services in Buildings	Pergamon
123. Warm Air Heating	Pergamon
124. Heating and Cooling Safety	Delmar
125. Comfort Heating	Reston
126. Air Conditioning and Heating Practice	HR&W
127. Home Heating	Lefax
128. Industrial Applications of Induction Heating	Pergamon

	Title	Source
129.	Heating, Ventilating, and Air Conditioning	Wiley
130.	Heating and Hot Water Services for Technicians	Butterworths
131.	Heating and Hot Water Services for Technicians	Transatlantic
132.	Heating and Ventilating for Craft Studies	Butterworths
133.	How to Design Heating-Cooling Comfort Systems	Busn News
134.	Estimator's Man-Hour Manual on Heating, Air Conditioning, Ventilating and Plumbing	Gulf Pub.
135.	Central Heating and Air Conditioning Repair Guide	Tab Bks.
136.	Energy Efficient Home: A Manual for Saving Fuel and Using Solar, Wood and Wind Power	NAL
137.	Automatic Heating	Natl Learning
138.	Senior Heating and Ventilating Engineer	Natl Learning
139.	Getting Started in Heating and Air Conditioning Service	Busn News
140.	How to Heat Your Home Without Going Broke: Build Yourself an Amazing Stainless Steel Wood Stove	JM Sadler
141.	Air Conditioning and Refrigeration	Wiley
142.	Heating with Wood	Har-Row
143.	Using SI Units (Standard International Metric) in Heating, Air Conditioning and Refrigeration	Busn News
144.	Home Heating and Fireplaces: A Do-It-Yourself Guide	Hutchinson
145.	Heating and Cooling	Time-Life
146.	Heating and Cooling (Home Repair and Improvement Ser.)	Silver
147.	Practical Drafting for the HVAC Trades	Sams
148.	Do-It-Yourselfer's Guide to Modern Energy-Efficient Heating and Cooling Systems	Tab Bks
149.	Urban Districk Heating Using Nuclear Heat	Unipub
150.	Wood Heat	Rodale Pr Inc.
151.	Warm Air Heating and Air Conditioning System	Natl Fire Prot.

Title	Source
152. Home Fires Burning: The History of Domestic Heating and Cooking	Routledge & Kegan
153. Air Conditioning, Heating, and Refrigeration Dictionary	Busn News

Heating-Tables, Calculations, etc.

Title	*Source
154. Estimating Heating and Ventilating	Transatlantic
155. Handbook of Heating, Ventilating and Air Conditioning	Transatlantic
156. Handbook of Air Conditioning, Heating, and Ventilating	Indus Pr.

Hot-Water Heating

Title	*Source
157. High-Temperature Water for Heating and Light Process Loads	Acad Sci.
158. Heating and Hot Water Services for Technicians	Butterworths

Heat Pumps

Title	*Source
159. Heat Pumps and Electric Heating Residential, Commercial, Industrial Year-Round Air Conditioning	Wiley
160. The Heat Pump: Commercial Forecasts	BCC

Oil Burners

Title	*Source
161. Oil Burner Installer	Arco
162. Domestic and Commercial Oil Burners	McGraw
163. Oil Burners	Audel
164. Installation of Oil Burning Equipment	Natl Fire Prot.
165. Installation and Servicing of Domestic Oil Burners	Arco
166. Prevention of Furnace Explosions in Fuel Oil-Fired Multiple Burner Boiler- Furnace	Natl Fire Prot.
167. Install Oil Burner Equipment	Natl Learning

Refrigeration and Refrigerating Machinery

Title	Source
168. Modern Refrigeration and Air Conditioning	Goodheart
169. Questions and Answers on Refrigeration	Hayden
170. Dictionary of Refrigeration and Air Conditioning	Intl Ideas
171. Doolin's Trouble Shooters Bible	Doolco Inc
172. Troubleshooters Bible	Wehman
173. Principles of Refrigeration	Wiley
174. Standard Refrigeration and Air Conditioning: Questions and Answers	McGraw
175. New Ways to Solve Your Refrigeration and Air Conditioning Problems	Busn News
176. Refrigeration, Air Conditioning and Cold Storage	Chilton
177. The Analysis of Engineering Cycles	Pergamon
178. Low Temperatures and Electric Power	Pergamon
179. Progress in Refrigeration Science and Technology	Pergamon
180. International Symposium on Cooling Systems. Proceedings	BHRA Fluid
181. Environmental Engineering: Analysis and Practice	Har-Row
182. Modern Refrigeration Practice	McGraw
183. Guide to Home Air Conditioners and Refrigeration Equipment	Hayden
184. Refrigeration and Air Conditioning	Reston
185. Electric Controls for Refrigeration and Air Conditioning	P-H
186. How to Repair Home and Auto Air Conditioners	Tab Bks.
187. Commercial and Industrial Refrigeration	McGraw
188. Principles of Refrigeration	Delmar
189. Refrigeration: Home and Commercial	Audel
190. Refrigeration	Tab Bks
191. Refrigeration: A Practical Manual for Apprentices	Intl Ideas

	Title	Source
192.	Refrigeration: A Practical Manual for Mechanics	Intl Ideas
193.	Air Conditioning and Refrigeration	Natl Learning
194.	Refrigerating Machine Mechanic	Natl Learning
195.	Refrigerating Machine Operator	Natl Learning
196.	How to Make It in the Service Business	Busn News
197.	Air Conditioning and Refrigeration	Wiley
198.	Refrigeration and Air Conditioning	McGraw
199.	Using SI Units (Standard International Metric) in Heating, Air Conditioning, and Refrigeration	Busn News
200.	Freezing Preservation of Foods, Vol.	Avi
201.	Principles of Refrigeration: Equipment for Freezing and Transporting Food, Vol. 1.	Avi
202.	Factors Affecting Quality in Frozen Foods, Vol. 2.	Avi
203.	Commercial Freezing Operations; Fresh Foods, Vol. 3.	Avi
204.	Freezing of Precooked and Prepared Foods, Vol. 4.	Avi.
205.	Handbook of Refrigerating Engineering	Avi
206.	Air Conditioning, Heating and Refrigeration Dictionary	Busn News

Sheet-Metal Work

	Title	*Source
207.	Sheet Metal Drafting	McGraw
208.	Sheet Metal Shop Drawing	Indus Pr.
209.	Fittings Used Today that Require Triangulation Including the Theory of Triangulation	Practical Pubns.
210.	Round Fittings Used Today Including Methods and Techniques of Fabricating Round Work	Practical Pubns.
211.	Today's Forty Most Frequently-Used Fittings	Practical Pubns.
212.	Sheet-Metal Pattern Drafting and Shop Problems	Bennett Co.
213.	Sheet Metal Drawing and Pattern Development	Soccer

Title	Source
214. Air Conditioning Sheet Metal Layout	Glencoe
215. Short-Cuts for Round Layouts	Glencoe
216. Triangulation Short-Cut Layouts	Glencoe
217. Sheet Metal Layout	McGraw
218. Sheet Metal Layout	McGraw
219. Ship and Aircraft Fairing and Development	Cornell Maritime
220. Sheet Metal Layout Simplified	HB Reid

Solar Heating

221. An Inexpensive Economical Solar Heating System for Homes	Solar Energy Info.
222. Solar Energy: Fundamentals in Building Design	McGraw
223. Sunspots	Zomeworks Corp.
224. Financing the Solar Home	Lexington Bks.
225. Solar Heating Design: By the F-Chart Method	Wiley
226. San Francisco Bay Area Solar Heating Guide and Directory: 1977 Edition	Solar Energy Info.
227. Build Your Own Solar Water Heater	Garden Way Pub.
228. Solar Homes and Sun Heating	Har-Row
229. How to Design and Build a Solar Swimming Pool Heater	Solar Energy Info.
230. It's in Your Power	Rawson Assocs.
231. Solcost: Design Method for Solar Heating and Cooling	Solar Energy Info.
232. Build-It Book of Solar Heating Projects	Tab Bks.
233. Homeowner's Guide to Solar Heating and Cooling	Tab Bks.
234. Solar Energy Heat Pump Systems for Heating and Cooling Buildings	Pa St U Pr.
235. Heat Transfer in Solar Energy Systems	ASME
236. The Solar Conspiracy	Morgan
237. Solar Heating and Cooling Systems: Engineering, Practical Design and Economics	McGraw

	Title	Source
238.	How to Build a Solar Heater	NAL
239.	How to Build a Solar Heater	Ritchie
240.	Solar Heating and Cooling: Recent Advances	Noyes
241.	The Solar House	Butterworths
242.	How to Heat Hot Water Without Going Broke: Build Yourself a Solar Heater in a One Year Payback	JM Sadler
243.	Solar Cooling and Heating: Architectural, Engineering and Legal Aspects, Proceedings	Hemisphere Pub.
244.	Solar Water Heating Reprint Series, 4 vols.	Solar Energy Info.
245.	Guide to Home Heating and Cooling with Solar Energy	Har-Row
246.	Solar Heating Your Home	Lane
247.	Solar Energy and Building	Halsted Pr.
248.	Designing and Building a Solar Home: Your Place in the Sun	Garden Way Pub.
249.	How to Buy Solar Heating Without Getting Burnt	Rodale Pr. Inc.
250.	Solar Heat for Less	Nautilus Bks.
251.	Natural Solar Architecture: A Passive Approach	Van Nos Reinhold
252.	Heating, Ventilating, and Air Conditioning Estimating Manual	McGraw
253.	Air Conditioning and Ventilating Systems	Natl Fire Prot.
254.	The Control of Noise in Ventilation Systems: A Designer's Guide	Halsted Pr.
255.	Estimating for Heating and Ventilating	Transatlantic
256.	Building Physics: Heat	Pergamon
257.	Blower and Exhaust Systems, Dust, Stock and Vapor Removal or Conveying	Natl Fire Prot.
258.	Heating, Ventilating, and Air Conditioning Library	Audel
259.	Airconditioning and Ventilation in Buildings	Pergamon
260.	Regulation of Ventilation and Gas Exchange	Acad Pr.

	Title	Source
261.	Uses and Abuses of Air: Showing Its Influence in Sustaining Life and Producing Disease	Arno
262.	Plant and Process Ventilation	Indus qr.
263.	Fire Ventilation Practices	Intl Fire Serv.
264.	Lectures on Ventilation Practices	Intl Fire Serv.
265.	Lectures on Ventilation	Am Life Foun.
266.	Handbook of Ventilation for Contaminant Control	Ann Arbor Sci.
267.	Heating, Ventilating, and Air Conditioning: Analysis and Design	Wiley
268.	Heating, Ventilation and Air Conditioning Plant: Planned Maintenance and Operation	Beekman Pubs.
269.	Heating and Ventilating for Craft Studies	Butterworths
270.	Estimator's Man-Hour Manual on Heating, Air Conditioning, Ventilating and Plumbing	Gulf Pub.
271.	Handbook of Heating, Ventilating and Air Conditioning	Transatlantic
272.	Foreman - Ventilation and Drainage	Natl Learning
273.	Senior Heating and Ventilating Engineer	Natl Learning
274.	Supervisor - Ventilation and Drainage	Natl Learning
275.	Ventilation and Drainage Maintainer	Natl Learning
276.	Handbook of Air Conditioning, Heating, and Ventilating	Indus Pr.
277.	Proceedings	Karger
278.	Practical Drafting for the HVAC Trades	Sams
279.	Ventilation and Drainage Maintainer: New York City Transit Authority	Arco

TRAINING AIDS*

Air Conditioning and Refrigeration Fundamentals - Theory

	Title	Source
1.	The ABC's of Central Air Conditioning	BDP
2.	Air and Refrigeration Cycles (R-3)	Westinghouse
3.	Air Conditioning Manual - Trane (750125)	Trane
4.	Basic Mechanical Refrigeration Cycle	BDP
5.	Basics of Room Air Conditioners (829721-22-23)	Whirlpool
6.	Basic Refrigeration (SVT-BRIA)	Westinghouse
7.	Building Pressure	McQuay
8.	Energy Management (A/SP-195)	McQuay
9.	Fundamentals of Refrigeration (AE-101)	Copeland
10.	Human Comfort (SVT-AT1)	Westinghouse
11.	Journey Through The Core (RAC-400)	Parker-Hannifin
12.	Physical Comfort-Rheem Mini Manual (NSAC 76)	Rheem
13.	Principles of Air Conditioning (R-1)	Westinghouse
14.	Reciprocating Refrigeration Manual (750126)	Trane
15.	Refrigeration and Air-Conditioning Principles and Products (R-2043)	Mueller
16.	Refrigeration Fundamentals (828983-84-85)	Whirlpool
17.	Refrigeration Fundamentals and Diagnosis (677147 to 677149)	Whirlpool
18.	Refrigeration System Components (AE-102)	Copeland
19.	Theory of Refrigeration	BDP

* The information in this section was extracted from the Bibliography of Training Aids, 5th Edition, 1979, ($5.00), available from the Air-Conditioning and Refrigeration Institute, 1815 N. Fort Myer Dr., Arlington, VA 22209. The Bibliography contains a description and the cost of the materials. All materials should be ordered directly from the source identified and not from ARI.

Air Conditioning and Refrigeration Fundamentals - Packets and Programmed Courses

	Title	Source
20.	Air Conditioning Clinic (750195)	Trane
21.	Air Conditioning Clinic Booklets (750209)	Trane
22.	Air Conditioning Clinic Filmstrips (750196)	Trane
23.	Air Conditioning Fundamentals - Part I Carrier Technical Development Program	Carrier
	Introduction	
	Psychrometrics	
	Load Estimating	
	Air Side	
	Principles of Mechanical Refrigeration	
24.	Educational Literature Packet	Sporlan
25.	Fundamentals of Refrigeration Carrier GTR Series	Carrier
	GTR- A Definitions	
	GTR-2A Refrigeration Cycle	
	GTR-3A Compressors	
	GTR-4A Condensers - Receivers	
	GTR-5A Evaporators	
	GTR-6A Metering Devices	
	GTR-7A Basic Cycle Controls	
	GTR-8A Refrigerant Characteristics	
	GTR-9A Refrigerant Oils	
	GTR-10A Accessories	
	GTR-11A Piping	
	GTR-12A Dehydration	
	GTR-13A Charging and Discharging Systems	
	GTR-14A Installation Procedures	

Air Conditioning and Refrigeration Fundamentals - Packets and Programmed Courses con't

Title	Source
25. Carrier GTR Series con't	
GTR-15A Multiple Systems	
GTR-16A Trouble Shooting	
26. Job Related Course in Heating and Air Conditioning	Lennox
Phase I - Job Related Training Manuals (Residential)	
Phase II - Job Related Training Manuals (Residential)	
Phase III - Job Related Training Manuals (Commercial)	

Air Conditioning and Refrigeration Trainers and Demonstrators

27. Cycle Trainer - Carrier	Carrier
28. Job Related Course Trainers and Demonstrators	Lennox
29. York Trainer - YT-74 Model (463-60342-000)	York Div. Borg-Warner

Air Conditioning and Refrigeration Troubleshooting - Testing - Installing - Servicing

30. Compression Ratio (77607)	Virginia Chemicals
31. Cooling Equipment, Rheem Mini Manual (NSAC 66)	Rheem
32. Evacuation (77-608)	Virginia Chemicals
33. Expansion Valve Plugging (77-606)	Virginia Chemicals
34. Fundamentals of Dehydrating a Refrigerant System (64-1R)	Robinair Mfg.
35. How to Determine Superheat (6144-1177)	Parker-Hannifin
36. How To Realize Maximum Service From Your Filters (AFS&S-4-103)	American Air Filter Co.
37. Installation and Service (AE-105)	Copeland
38. Installed Cost Savings	BDP
39. Motor Burn-Out Clean Up (77-601)	Virginia Chemicals

Air Conditioning and Refrigeration Troubleshooting - Testing - Installing - Servicing con't

	Title	Source
40.	Put 'Em In Right and Shootin' Service (RFT-210-121-3)	Sporlan
41.	Sealed System Repair (677153-677155)	Whirlpool
42.	Service Procedures for Electric Air Conditioning	BDP
43.	Shootin' Service (10-37)	Sporlan
44.	Single Phase Motors (SC-21-1000)	York Division Borg-Warner
45.	Start-Up Procedures for Commercial Rooftops	BDP
46.	Test Equipment, Selection, Care and Application (829965 - 829967)	Whirlpool
47.	Use of the Refrigerant Charging Cylinder (SVT-GS1)	Westinghouse
48.	Vacuum Equipment for Air Conditioning and Refrigeration Service	Robinair
49.	Water Chemical (104K)	Virginia Chem.

Air Conditioning and Refrigeration System Design, Application, Equipment Selection, Product Line Information

50.	Bottom Discharge Rooftop Systems for Modern Needs	BDP
51.	Cooling Systems (RCFG NS 1)	Rheem
52.	Commercial Products (RGPP NS 1)	Rheem
53.	Commercial Refrigeration	Tyler
54.	Heat Recovery Notes (DATAFILE NO. 105)	Standard
55.	Making a Survey (SVT-AT3A)	Westinghouse
56.	Manuals of Air Conditioning System Design	Carrier
	Part 1 - Load Estimating (510-304)	
	Part 2 - Air Distribution (510-308)	
	Part 3 - Piping Design (510-312)	
	Part 4 - Refrigerants, Brines, Oils (510-310)	

Air Conditioning and Refrigeration System Design, Application, Equipment Selection, Product Line Information con't

Title	Source
56. Carrier System Design Manuals con't	
Part 6 - Air-Handling Equipment (510-320)	
Part 7 - Refrigeration Equipment (510-324)	
Part 8 - Auxiliary Equipment (510-332)	
Part 9 - Systems and Applications (510-321)	
Part 10 - All-Air Systems (510-322)	
Part 11 - Air-Water Systems (510-327)	
Part 12 - Water and DX Systems (510-329)	
57. Oil Control System (OCB 78-1)	Henry Valve Co.
58. Preventive Maintenance (PM-4)	Henry Valve Co.
59. The Source	BDP
60. Specifying Replacement Air Filters (AFS&S-4-102	Am. Air Filter
61. System Design (AE-104)	Copeland
62. System Optimization (OP 1-55)	McQuay
63. Unitary vs. Central Systems (A/SP-185)	McQuay
64. Trane Educational Material Design, Application, Systems	Trane
Air Conditioning Systems Primer (AM-SYS-2 # 750142)	
VariTrane Rooftop Operation (AM-SYS-3 #750143)	
Rooftop/VAV Design Manual (AM-SYS-4 # 750144/750192)	
CenTraVac Operation and Maintenance (AM-FND-1 #750128/750176)	
Reciprocating Equipment Operation and Maintenance (AM-FND-2 # 750129/750177)	
Air Handling Operation and Maintenance (AM-FND-3 # 750130/750178)	
Absorption Operation and Maintenance (AM-FND-4 #750131/750179)	
Acoustics Seminar (AM-FND-5 # 750132/750171)	

Air Conditioning and Refrigeration System Design, Application, Equipment Selection, Product Line Information con't

Title	Source
Conserve Energy by Design (AM-FND-6 # 750133/750172)	
Vari-Trane Application Manual (AM-FND-7 # 750134/750173)	
Heat Recovery Seminar Manual (AM-FND-8 # 750135/750174)	
Introduction to Control (AM-CON 1 # 750147)	
Control of 4-Pipe Fan Coil System (AM-CON 3 # 750148/750181)	
Control of Recip. and Centrifugal System (AM-CON 4 # 750149/750182)	
Control of Absorption - Steam Drive Centrifugal (AM-CON 5 # 750150/750183)	
Control of Sprayed Coil Climate Changers (AM-CON 7 # 750152/750185)	
Control of Two CenTraVacs (AM-CON 8 # 750154/750187)	
Hot Gas Bypass Control (AM-CON 10 # 750155/750188)	
Coil Control (AM-CON 11 # 750156/750189)	
Control of Two Absorption Units (AM-CON 12 # 750157/750190)	
Control of VariTrane Rooftop Combination (AM-CON 13 # 750158)	

Air Conditioning and Refrigeration System Design, Application, Selection Packets and Programmed Courses

65. Air Conditioning System Design and Product Application-Part II, Carrier Technical Development Program — Carrier

    Cooling Load Estimate

    Cooling Coil Performance

    Room Air Distribution

    Air Duct Design

    Control Principles and Methods

    Reciprocating Refrigerant Equipment

Air Conditioning and Refrigeration System Design, Application, Equipment Selection, Product Line Information con't

	Title	Source
65.	Carrier Technical Development Program Part II con't	
	Heat Rejection Equipment	
	Centrifugal Refrigeration Equipment	
	Absorption Refrigeration Equipment	
	Large Package Equipment	
	Reciprocating Liquid Chilling Equipment	
	Water Piping Systems and Pumps	
	Refrigerant Piping Systems	
	Air Duct Design Using Carrier Duct Calculator	
	Heat Pumps in the Seventies (Economic Analysis)	
66.	Carrier Part III - Air Conditioning System Design Multiroom Structures	Carrier
67.	Carrier Part IV - Air Conditioning With Packaged Equipment	Carrier
68.	Rheem Mini Manual Set (NSAC 82)	Rheem
69.	Phase I(A) Application Course	Lennox

Air - Distribution - Ductwork - Properties - Psychrometrics

70.	Air Distribution Design	BDP
71.	Air Distribution Selection (SVT-AT8A)	Westinghouse
72.	Air Handling Operation and Maintenance (Manual-750130; Slides 750178)	Trane
73.	Air Properties and Measurement (GTA-3A)	Carrier
74.	Air Side (200SF7)	Carrier
75.	Duct Design (R-7)	Westinghouse
76.	Ductulator (750124)	Trane
77.	Duct Calculator Slide Rule (599-922)	Carrier

Air - Distribution - Ductwork - Properties - Psychrometrics con't

	Title	Source
78.	Fan Seminar	Trane
79.	Fundamentals of Psychrometrics (T200-20)	Carrier
80.	Psychrometric Charts - English units	Carrier
81.	Carrier Psychrometric Charts - SI units	Carrier
82.	Trane Psychrometric Charts	Trane
83.	The Physics of Air (2000-5-71-CPS)	Am. Air Filter
84.	Psychrometrics, Rheem Mini Manual (NSAC 73)	Rheem
85.	Residential Duct Design (Y70-3687)	York Division Borg-Warner
86.	Room Air Distribution (R-6)	Westinghouse
87.	Room Load and Air Requirements (SVT-AT6A)	Westinghouse
88.	Size-A-Duct Calculator (Y66-3073)	York Division Borg-Warner
89.	Sizing the Ductwork (SVT-AT9A)	Westinghouse
90.	Terminal Air Blender Application Manual (750137)	Trane
91.	Variable Air Volume Perimeter Systems (VAV Perimeter Systems PS 1-34)	McQuay
92.	Variable Air Volume Terminals (VVT (RT) 1-78)	McQuay

Compression Cycle Components - Compressors, Condensers, Evaporators, Pumps

93.	ABC's of Avoiding Burnout Callbacks	BDP
94.	Centrifugal Pump Selection and Application (TEH-375)	ITT,Bell & Gossett
95.	Coil Control (Manual 750156; Slides 750189)	Trane
96.	Be Compressor Wise (GTA-7)	Carrier
97.	Cause and Effect of CD Failures in a Heat Pump (SVT-CD2A)	Westinghouse
98.	CD Compressor Replacement in a Heat Pump (SVT-CD3A)	Westinghouse

Compression Cycle Components - Compressors, Condensers, Evaporators, Pumps - con't

	Title	Source
99.	Cleanout After Burnout (GTA-2)	Carrier
100.	Compressor Replacement - Rheem Mini Manual (NSAC 69)	Rheem
101.	General Catalogue	Standard
102.	Principles of Centrifugal Pump Construction and Maintenance (TEH-1166)	ITT, Bell, & Gossett
103.	Properly Lubricated Compressors Last Longer	Johnson
104.	Pump Data Book (TE-PD-162 Rev. 1)	ITT, Bell & Gossett
105.	Rangefinder	Standard
106.	Reciprocating Compressors Service Diagnosis (75091)	Trane
107.	Refrigeration Compressors (750282)	Trane
108.	Servicing Condensers (Datafile No. 101)	Standard
109.	Servicing the CD Compressor	BDP
110.	Datafile No. 103 - Sizing Condensers	Standard

Controls and Control Devices

	Title	Source
111.	Air Conditioning Control: Fundamentals (AV-12)	Honeywell
112.	Air Conditioning Control: Service (AV-11)	Honeywell
113.	Automatic Controls Principles (71-97512)	Honeywell
114.	Baso Gas Controls	Johnson
115.	Comfort is Standard Equipment in Today's Construction Industry	Johnson
116.	Commercial Air Conditioning Controls	Honeywell

Controls and Control Devices con't

	Title	Source
117.	Commercial Air Conditioning Controls - Basic Air Handling System (AV-14)	Honeywell
118.	Commercial Controls	Johnson
119.	Controls (Electric, Solid State, Pneumatic) (F-15894)	Barber-Colman
120.	Controllers: Thermostats, Warm Air, Hydronic	Honeywell
121.	Cooling Controls	Honeywell
122.	Electric Controls (F-15896)	Barber-Colman
123.	Electric Heat Controls	Honeywell
124.	Gas Heating Controls	Honeywell
125.	Gas Heating Control: Fundamentals (AV-16)	Honeywell
126.	Gas Heating Control: Service (AV-17)	Honeywell
127.	Y86 Gas Saver Retrofit Ignition Systems (AV-54)	Honeywell
128.	Direct Spark Ignition - Application and Operation (AV-42)	Honeywell
129.	Honeywell Direct Spark Ignition-Troubleshooting (AV-43)	Honeywell
130.	Honeywell W973 Single Zone Control System (AV-50)	Honeywell
131.	General Catalog (9000)	Ranco/Controls
132.	Introduction to Thermostats for Residential Heating and Cooling (Booklet - R3043; Test - R3044)	White-Rodgers
133.	Load Management Theory and Fundamentals (71-97432)	Honeywell
134.	Multiple Function Time Guard	Carrier
135.	Oil Heating Controls	Honeywell
136.	Oil Heating Control: Fundamentals (AV-18)	Honeywell
137.	Oil Heating Service: Service (AV-19)	Honeywell

Controls and Control Devices con't

Title	Source
138. Pneumatic Controls (F-15897)	Barber-Colman
139. Refrigerator Controls (R-31)	Whirlpool
140. Remote-Mounted Thermostats	Carrier
141. Service Handbook - Commercial Air Conditioning Controls	Honeywell
142. Service Handbook - Cooling Controls	Honeywell
143. Service Handbook Library (71-07546)	Honeywell
144. Service and Troubleshooting, S86 and Y86 Gas Saver Ignition Systems (AV-55)	Honeywell
145. Single Function Time Guard	Carrier
146. Solid State Control	Johnson
147. Temperature Responsive Power Elements (Bulletin 0030)	Ranco
148. Thermostats for Residential Heating and Cooling	White-Rodgers

Customer Relations and Sales

Title	Source
149. Customer Service Mini Manual (NSAC 70)	Rheem
150. Customer Relations #I (SVT-GS4)	Westinghouse
151. The Professional Approach (829179)	Whirlpool
152. Residential Air Conditioning Sales (Y70-3688)	York Division Borg-Warner
153. School of Commercial Knowledge	BDP

Electricity - Electrical Systems

154. Analyzing Control Circuits	Honeywell
155. Applied Electricity - Air Conditioning GTE Series	Carrier
GTE 1A Wiring Symbols	
GTE 2A The Wiring Diagram	

Title	Source
155. Carrier GTE Series con't	
GTE 3A Diagram Exercises	
GTE 4A Electric Meters	
GTE 5A Alternating Current	
GTE 6A Single Phase Motors	
GTE 7A Single Phase Motors	
GTE 8A Motor Protective Devices	
GTE 9A Troubleshooting	
156. Basic Electricity (AV-8)	Honeywell
157. Basic Electricity (SVT-EIA)	Westinghouse
158. Basic Electricity Manual (70-6714)	Honeywell
159. Basic Electricity Mini Manual (NSAC 64)	Rheem
160. Basic Electricity - Part I (S-2-1000)	York Division Borg-Warner
161. Basic Electricity - Part II (S-3-1000)	York Division Borg-Warner
162. Cooling (SVT-E3)	Westinghouse
163. Copeland Electrical Handbook (AE-6400)	Copeland Corp.
164. Electrical Controls Circuitry (SC 30-1000)	York Division Borg-Warner
165. Electrical Troubleshooting (SVT-E5)	Westinghouse
166. Electricity and How it Works	Carrier
167. Fundamentals of Residential Controls (71-97083)	Honeywell
168. Gas Furnace Electrical Circuit (SVT-E2)	Westinghouse
169. An Introduction to Basic Electricity (Booklet-R-2060; Test - R-2064)	White-Rodgers
170. An Introduction to Basic Solid State Theory (Booklet - R-2078; Test - R-2079)	White-Rodgers

Electricity - Electrical Systems con't

Title	Source
171. Introduction to Electronic Controls (SC 31)	York Division Borg-Warner
172. Solid State Controls (F-15895)	Barber-Colman
173. Solid State Motor Protection System	Carrier
174. The Source (Electricity Fundamentals) (603770)	Whirlpool
175. Spanish Language: Basic Electricity for Appliances (603146)	Whirlpool
176. Total Comfort Electrical Circuit (SVT-E4)	Westinghouse
177. Typical Wiring Diagrams, Mini Manual (NSAC 71)	Rheem

Electronic Air Cleaners - Filters

Title	Source
178. The Air Around Us (Bulletin 626)	Cambridge Filter
179. Beware the Wind	Electro-Air Div. Emerson
180. Electro-Air SST D Electronic Air Cleaner (SL-17A)	Electro-Air Emerson
181. Electronic Air Cleaner Fundamentals (AV-1)	Honeywell
182. Electronic Air Cleaner Operation and Installation (AV-2)	Honeywell
183. Full Line Residential Catalog	Electro-Air Div. Emerson
184. The "How To" of Filter Maintenance	Cambridge
185. How to Read Whirlpool Home Appliance Wiring Diagrams (G-11 829248)	Whirlpool
186. Paint Arrestor and Grease Filter Design Booklets	Research Products
187. Servicing Electronic Air Cleaners (AV-3)	Honeywell
188. Tech-Sheet Electronic Air Cleaner Installation and Service Tip Sheet	Electro-Air Div. Emerson

Guest Lecturers

Title	Source
189. Alco Control Division	Alco
190. Electronic Air Cleaners: Homeowners Solution to Air Pollution	Electro-Air Div Emerson
191. Leading Productive Meetings	BDP
192. Research Products Corporation	Research
193. Sporlan Valve Company	Sporlan

Heating and Heating Equipment

194. Basics of Heating with Electricity (750145; AM-HTG1)	Trane
195. Boilers for Steam and Hot Water (Manual 750146; Filmstrip 750169; Manual ED-BLR1)	Trane
196. Electric Duct Heater Manual	Electro-Air Div. Emerson
197. Electric Furnace, Mini Manual (NSAC 67)	Rheem
198. Gas Furnace, Mini Manual (NSAC 63)	Rheem
199. Heat Energy (R-2)	Westinghouse
200. Heating Fundamentals of Combustion (SC-26-1000)	York Div. Borg-Warner
201. Heating-Carrier General Training	Carrier

GTH-1 Gas Furnaces

GTH-2 Gas Controls

GTH-3 Properties of Gas and Gas Piping

GTH-4 Gas Combustion

GTH-5 Gas Burners

GTH-6 Gas Troubleshooting

GTH-7 Ventilation and Combustion

GTA-5 Oil Heat

GT-12 Oil Furnace Efficiency Checkout

Heating and Heating Equipment con't

	Title	Source
202.	Hydronic Heating Systems	BDP
203.	Heating: Types of Fuels (SC-27-1000)	York Div. Borg-Warner
204.	Hot Gas Bypass Control (Manual 750155; Slides 750188; Manual AM-CON10)	Trane
205.	Gas Furnace Installation (SVT-GH1)	Westinghouse
206.	Gas Furnace Operation (SVT-GH2)	Westinghouse
207.	Gas Furnace Servicing (SVT-GH3)	Westinghouse
208.	Gas Heat - Advanced General Training (GTA-6)	Carrier
209.	Oil Furnace, Mini Manual (NSAC 68)	Rheem
210.	Pocket Manual on Heating	Dunham-Bush, Inc.
211.	Gas Heating Service	BDP

Heat Pumps

212.	CEN TRA VAC Heat Pump Control (Manual 750154; Slides 750187)	Trane
213.	Guide for Residential Heat Pumps (GT14-01)	Carrier
214.	Heat Pumps - Advanced General Training (GTA-4A)	Carrier
215.	Heat Pump Controls (RPCA-NS2)	Rheem
216.	Heat Pump Dealer Certification Program	BDP
217.	Heat Pump Electrical Circuits (RPCA-NS3)	Rheem
218.	Heat Pump, Mini Manual (NSAC 72)	Rheem
219.	Heat Pump Product (RPCA-NS1)	Rheem
220.	Heat Pump Refrigerant Circuits (RPCA-NS4)	Rheem
221.	Installing the Packaged Heat Pump (SVT-HP7)	Westinghouse
222.	Installing the Split System Heat Pump (SVT-HP6)	Westinghouse
223.	Introduction to the Heat Pump (A-69879)	DuPont
224.	The Model "HP" Line HI/RE/LI Split System Heat Pumps (SVT-HP5)	Westinghouse

Heat Pumps con't

Title	Source
225. The Model HR Line of Packaged Heat Pumps (SVT-HP9)	Westinghouse
226. The Model HS Series Split System Heat Pump (SVT-HP8)	Westinghouse
227. Sales - HI/RE/LI Heat Pump (SLS-HP1)	Westinghouse

Humidity - Humidifiers

Title	Source
228. The Air We Live With (SFL99)	Skuttle Mfg.
229. The Aprilaire Humidifier Story	Research Products
230. Homeowner's Power Humidifier (756-125)	Skuttle Mfg.
231. Humidification Catalog	Skuttle Mfg.
232. The Non Humidified Man	Skuttle Mfg.
233. Skuttle Humidifiers	Skuttle Mfg.

Ice Makers and Machines

Title	Source
234. Cold Facts on Ice (AS-73)	Queen
235. Crystal Tips Ice Equipment Service Manual	McQuay
236. Servicing Whirlpool Commercial Ice Systems (P-37; 603187)	Whirlpool
237. Servicing Whirlpool Model 50 Ice Cuber (R38; 603188)	Whirlpool
238. Understanding Compact Automatic Ice Makers	Whirlpool

Load Calculations - Heat Gain/Loss

Title	Source
239. Calculations Forms (828634)	Whirlpool
240. Dial-A-Fix Card "Room Air Conditioner Load Calculation (821295)	Whirlpool
241. Heat Loss/Gain Slide Rule (SA-76-1)	Addison

357

Load Calculations - Heat Gain/Loss

	Title	Source
242.	Mobile Home Cooling Estimator (SA-75-69)	Addison
243.	Residential Cooling/Heating (SA-71-33 R1)	Addison
244.	Calculating the Load (SVT-AT5A)	Westinghouse
245.	CLAS/SELS - Computerized Local Analysis	BDP
246.	Comfort Control Proposal (SA-72-7)	Addison
247.	Commercial Cooling Worksheet (SA-71-34R1)	Addison
248.	Heat Flow Characteristics (SVT-AT2)	Westinghouse
249.	Factors of Heat Flow (R4)	Westinghouse
250.	Heat Gain/Loss Calculation	BDP
251.	Trane Heating and Cooling Load Estimate Sheets (750231)	Trnae
252.	Load Estimating (200FS4)	Carrier
253.	Load Factors	Rheem
254.	The Refrigeration Load (AE-103)	Copeland
255.	Refrigeration Load Estimating Manual (RLE-278)	Krack
256.	Refrigeration Load Requirement Manual	Russell
257.	Residential Load Estimating (Y70-3673)	York Div. Borg-Warner
258.	Load Factors, Mini Manual (NSAC 75)	Rheem
259.	Room Air Conditioner Load Calculation (821296)	Whirlpool
260.	Trane Summary Sheet - Building Data and Heat Gain (750232)	Trane
261.	Walk-In Cooler-Freezer Load Calculation and Equipment Selection Kit	McQuay

Refrigerants and Refrigerant Flow - Properties, Pressure Temperature, Oils and Lubrication

Title	Source
262. Oil Separators (OSB 78-1)	AC & R Com.
263. "Don't Lose Your Cool"	Virginia Chem.
264. Freon Refrigerant With Dytel Red Leak Detectant	DuPont
265. International Refrigerant Temperature-Pressure Tables	Alco
266. Oil Refrigerant Migration (GTA-1)	Carrier
267. Pressure-Temperature Charts	Virginia Chem.
268. Pressure-Temperature Conversion Pocket Card (1)	Sporlan
269. Pressure-Temperature Pocket Cards	Alco
270. Pressure-Temperature Wall Charts	Alco
271. Refrigerants - Charts and Tables	DuPont
272. Refrigerants - Technical Bulletins	DuPont
273. Refrigeration System Schematic (SP 500)	Henry Valve
274. The System and The Refrigerant (SVT-BR5)	Westinghouse
275. "Zephron" The Problem Solver Oil	DuPont
276. "Zephron" Synthetic Refrigeration Oil (RT-56)	DuPont

Refrigerants - Refrigerant Flow - Piping, Valves, Accessories

277. Acquiring the Skillfil Touch for Proper Superheat Adjustment (RAC-003)	Parker-Hannifin
278. Brazing - How and Why	Whirlpool
279. Brazing Tools and Test Equipment (667150-51-52)	Whirlpool
280. Quick Connect Couplings (SVT-GS2)	Westinghouse
281. Right the First Time	Gould
282. Imperial-Eastman Tubeworking Handbook	Gould
283. Clean-Up Dryer (RAC-200)	Parker-Hannifin
284. Ritchie Engineering Catalog (793)	Ritchie Engr.

Refrigerants - Refrigerant Flow - Piping, Valves, Accessories

	Title	Source
285.	How, What and Why of Solenoid Valves (13.00)	Alco
286.	Liquid Line Filter-Driers (14.00)	Alco
287.	Operating Principles and Application of the Thermostatic Expansion Valve (12.00)	Alco
288.	Piping Diagrams for Reciprocating Direct Expansion Systems (750138; AM-REF1)	Trane
289.	Product Wall Charts	Alco
290.	Product Wall Charts	Sporlan
291.	QL Connections for Split Systems (RAC-001)	Parker-Hannifin
292.	Refrigerant Flow Controls (11.01)	Alco
293.	Refrigeration System Piping (75283)	Trane
294.	Safety Relief Devices (20-SRD-3)	Henry Valve
295.	Solenoid Service Hints (13.01.10)	Alco
296.	System Sanitation	Virginia Chem.
297.	The TEV Story... Theory of Operation (RFT-210-121-1)	Sporlan
298.	Thermo Expansion Valve Service Hints (12.01.11)	Alco
299.	Thermostatic Expansion Valves: Theory of Operation-Application-Selection (10-56)	Sporlan
300.	Thermostatic Expansion Valves: Installation-Field Service-Assembly (10-11)	Sporlan
301.	Vilter Refrigeration Piping Data Manual for NH3, R-12, R-22, R502 (790)	Vilter Mfg.
302.	Wide Range Thermostatic Expansion Valve (RAC-300)	Parker-Hannifin

Solar

	Title	Source
303.	Solar Application Course - Phase 1 (SA)	Lennox
304.	Solar Energy Systems	BDP
305.	Solar Heating Basics (GT 18-01, #020422; GT 18-02; #020423)	Carrier

Solar con't

Title	Source
306. Suncell Air-To-Air Solar Heating System	Research Products
307. Lennox Industries Course Trainer and Demonstrators	Lennox

Transport Refrigeration

Title	Source
308. Service Training Materials for Transport Refrigeration Mechanics	Thermo King
309. Refrigeration System - Manuals	
310. Refrigeration System - Schematics and Information Sheets	
311. Refrigeration System - Posters	
312. Electrical System - Manuals	
313. Electrical System - Individual Circuit Series	
314. Engine - Engine Manuals	
315. Unit Operation/Service Material - Diesel Powered Units	
316. Unit Operation/Service Material - Gasoline/LPG Units	

Miscellaneous

317. Acoustics Seminar (Manual 750132; Slides 750171)	Trane
318. Incinerator Application Manual (750141)	Trane
319. Technical Trade Talks	Tyler

Industry Trade Associations - Educational and Training Programs

Other Educational Materials Available from the Heating, Air Conditioning, and Refrigeration Industry

Many industry trade associations include training and provide educational material among their services. Seminars, workshops, short courses, night school and correspondence courses are offered. For additional details, each organization should be contacted directly.

ACCA (Air Conditioning Contractors of America)
Formerly NESCA
1228 17th St., N. W.
Washington, DC 20036

National Solar Heating and Cooling Information Center
P.O. Box 1607
Rockville, MD 20850

HRAI (Heating, Refrigerating, and Air Conditioning Institute of Canada)
5468 Dundas Street, West, Suite 226
Islington, Ontario M9B 6E3

NHAW (Northamerican Heating and Air Conditioning Wholesalers Association)
1661 West Henderson Road
Columbus, Ohio 43220

RETA (Refrigerating Engineers and Technicians Association)
435 North Michigan Avenue
Chicago, Illinois 60611

SMACNA (Sheet Metal and Air Conditioning Contractors' National Association, Inc)
8224 Old Courthouse Road, Tysons Corners
Vienna, Virginia 22180

Source

Addison Products Company
P.O. Box 100
Addison, MI 49220

Air-Conditioning and Refrigeration Institute (ARI)
1815 N. Fort Myer Drive
Arlington, VA 22209

Air Conditioning Contractors of America (ACCA-formerly NESCA)
1228 17th Street, N. W.
Washington, DC 20036

Alco Controls Division
Emerson Electric Company
Sales Dept., Box 12700
St. Louis, MO 63141

American Air Filter Company, Inc.
Advertising Department
215 Central Avenue
Louisville, KY 40277

Barber-Colman Company
Dept. 2347
1300 Rock Street
Rockford, IL 61101

Contributing Member-Companies and Associations con't

BDP Company
Division of Carrier Corporation
Training and Dealer Development
7310 West Morris Street
Indianapolis, IN 46231

Cambridge Filter Corporation
P.O. Box 4906
Syracuse, NY 13221

Carrier Air Conditioning
Carrier Parkway
P.O. Box 4808
Syracuse, NY 13221

Copeland Corporation
Sidney, OH 45365

Dunham-Bush, Inc.
Advertising Department
30 Holmes Road
Newington, CT 06111

duPont Company
"Freon" Products Division
Buidling N-9400
Wilmington, DE 19898

Electro-Air Division
Emerson Electric Co.
N. Industrial Park Road
Harrison, AR 72601

Gould Inc.
Valve & Fitting Division
7500 Croname Road
Chicago, IL 60648

Henry Valve Company
(AC&R Components, Inc.)
3215 North Avenue
Melrose Park, IL 60160

Honeywell Inc.
Training Administrator MN12-B126
Honeywell Plaza
Minneapolis, MN 55408

ITT Bell & Gossett
(Fluid Handling Division)
8200 N. Austin Avenue
Morton Grove, IL 60053

Johnson Controls, Inc.
Control Products Division
2221 Canden Court
Oak Brook, IL 60521

Krack Corporation
401 S. Rohlwing Road
Addisonn, IL 60101

Lennox Industries Inc.
Lennox Educational Products
P.O. Box 400450
Dallas, TX 75240

McQuay Group
Advertising Department
P.O. Box 1551
Minneapolis, MN 55440

Mueller Brass Co.
Advertising Department
1925 Lapeer Avenue
Port Huron, MI 48060

National Solar Heating and Cooling Information Center
P.O. Box 1607
Rockville, MD 20850

Northamerican Heating and Air Conditioning Wholesalers Association (NHAW)
1661 W. Henderson Road
Columbus, OH 43220

Parker-Hannifin Corporation
15 Depew Avenue
Lyons, NY 14489
Attn: Wm. T. Gorman

Queen Products Division
Adversiting Department
505 Front Street
Albert Lea, MN 56007

Ranco/Controls Division
601 West Fifth Avenue
Columbus, OH 43201

Refrigerating Engineers and Technicians Association (RETA)
435 North Michigan Avenue
Chicago, IL 60011

Contributing Member-Companies and Associations con't

Research Products Corporation
Attn: Michael H. Giese
Advertising Dept.
P.O. Box 1467
Madison, WI 53701

Rheem Air Conditioning Division
Training Department
5600 Old Greenwood Raod
Ft. Smith, AR 72901

Robinair Manufacturing Corporation
Robinair Way
Montpelier, OH 43543

Ritchie Engineering Co., Inc.
999 East 79th Street
Minneapolis, MN 55420

Russell Coil Company
221 South Berry Street
Brea, CA 92621

Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
8224 Old Courthouse Rd.
Tysons Corner
Vienna, VA 22180

Skuttle Manufacturing Company
Route 1
Marietta, OH 45750

Sporlan Valve Company
7525 Sussex Avenue
St. Louis, MO 63143

Standard Refrigeration Company
2050 N. Ruby Street
Melrose Park, IL 60160

Thermo King Corporation
314 West 90th Street
Minneapolis, MN 55420

Trane Company
Educational Division
3600 Pammel Creek Raod
La Crosse, WI 54601

Tyler Refrigeration Corporation
c/o Dean Ware, Service Manager
1329 Lake Street
Niles, MI 49120

Vilter Manufacturing Corporation
Marketing Services Dept.
2217 South First Street
Milwaukee, WI 53207

Virginia Chemicals, Inc.
Marketing Department
4100 Platinum Way
Dallas, TX 75237

Westing Electric Corporation
Heating and Cooling Business Unit
Training Administrator
875 Greentree Road
Building 7, 6th Floor
Pittsburgh, PA 15220

Whirlpool Corporation
Publications Dept.
La Porte, IN 46350

White-Rodgers Training Division
9797 Reavis Road
St. Louis, MO 63123

York Division
Borg-Warner Corporation
Publications Warehouse
P.O. Box 1592
York, PA 17405

AIR CONDITIONING, HEATING, AND REFRIGERATION

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AIR CONDITIONING, HEATING, AND REFRIGERATION

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Air Conditioning, Heating, and Refrig.

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East Carteret High
Carteret County

Climate Control

Jerry Porter
Wilkes Co. Vocational Ctr.
Wilkes County

Stephen R. Pinkerton
Stanley Co. Vocational Ctr.
Stanley County

Ben Albright
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Jackson Refrigeration Serv.
Walkup Avenue
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Steele Electric Co.
Mechanical Div.
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600 East Trade Street
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Piedmont Natural Gas
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Lutz-Yelton Heating and Air Conditioning
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Keith Long
Long's Heating and Air Conditioning
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Cherryville, NC 28021

Johnny Condrey
Condrey Metal Shop Inc.
Hwy 180 South
Shelby, NC 28150

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Sears Roebuck and Company
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Major Appliance & Furniture Co.
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Jacksonville, NC 28540

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Jacksonville Heating Contractors
Marine Blvd.
Jacksonville, NC 28540

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Neuse Service Center
Havelock, NC 28532

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c/o Maola Co.
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Craven Community College con't

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New Bern, NC 28560

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Havelock, NC 28532

Mr. Harry C. Bennett
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Mr. William Rowe
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W. R. (Dick) Robey, Instructor

Mason-Blankenship
Plumb-Mecks, Inc.
509 E. Russell Street
High Point, NC 27260

M. J. Zett
Zett Air Conditioning & Heating Co.
2009 N. Main Street
High Point, NC 27260

Mr. Richard Lacy
Central Trane Air Conditioning Co.
1800 Fairfax Rd.
Greensboro, NC

Mr. G. F. Koonts
Koonts Refrigeration Service, Inc.
14 Talbert Blvd.
Lexington, NC 27292

Mr. Tom Austin
Austin Refrigeration Co.
W. Ennis Street
Salisbury, NC

Forsyth Technical Institute
Lester Jones, Instructor
Industrial Maintenance

Forsyth Technical Institute con't

R. J. Reynolds Tobacco Co.
401 N. Main Street
ATTN: Elmer Colins, Air Conditioning
ATTN: Bob Holder, Electric Controls Dept.

Jos Schlitz Brewing Co.
Schlitz Avenue
ATTN: Mr. Wooten

Hanes Corporation
2000 W. First Street
ATTN: Steve Beauchamp
Stratford Road Plant

Archer Aluminum
Div. of Reynolds Industries
401 N. Main Street
ATTN: Bobby Hoover

Duke Power Company
1405 S. Broad Street
ATTN: Raymond Warden

Commercial and Industrial Air Cond.

Air Conditioning Corporation
347 Witt Street
ATTN: Paul Paschal

Sam W. Turner
Wall-Turner
587 S. Stratford Road
ATTN: Sam Turner

M & W Contractors
Clemmons, NC
ATTN: James Minor

Reedy's Air Cond. & Htg. Co., Inc.
626 Brookstown Avenue
ATTN: Manager

Piedmont Sheet Metal Co., Inc.
801 N. Broad Street
ATTN: Manager

Bowman Gray School of Medicine
300 S. Hawthorn Road
Winston-Salem, NC, 27103
ATTN: George P. Jones, Chief Engineer

Forsyth Technical Institute con't

N. C. Baptist Hospital, Inc.
S. Hawthorne Road
ATTN: Wayne Reed

Domestic and Commercial Refrigeration

Sears
Hanes Mall
ATTN: Ray Manhan

Salem Refrigeration
1650 Hutton Street
ATTN: Jim Vernon

L. J. McGee Refrigeration Co.
4804 Walkertown Road
ATTN: L. J. McGee

Advanced Appliance Service, Inc.
3919 Renolda Road
ATTN: Manager

Forsyth Appliance Service Inc.
11 Brookstown Avenue
ATTN: Felix Long

Locke Refirgeration
1024 Crestwood Drive
ATTN: Mr. Locke

P & J Appliance Service
Route #4, Hickory Treet Road
ATTN: Mr. Swain

NOTE: All of addresses would be Winston-Salem, NC

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Harold McNeely

APFCO Heating and Air Conditioning
P.O. Box 2319
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Roland Black Heating and Cooling
415-A Bessemer City Road
Gastonia, NC 28052

Bryant Electric Repair Co.
P.O. Box 1658
Gastonia, NC 28052

H. F. Thornburg
Carlton Yarn Mills
East Main Street
Cherryville, NC 28021

City Heating Co.
108 W. Mountain Street
Kings Mountain, NC 28086

Crawford Heating and Cooling
Route 1, Box 608
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Criswell Refrigeration Service
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Bessemer City, NC 28016

David Dilling
Dilling Heating Company
410 York Road
Kings Mountain, NC 28086

East Gastonia Appliance Service
1308 Jenkins Road
Gastonia, NC 28052

Allen Refrigeration Service
204 N. Washington Street
Shelby, NC 28150

David W. Butler
Butler Refrigeration Co.
310 N. Piedmont Avenue
Kings Mountain, NC 28086

Chiller Service Inc.
P.O. Box 8163
Charlotte, NC 28208

Gaston College con't

Bob Stuckey
Climate Conditioning
2923 Griffith Street
Charlotte, NC 28208

Elmore Service Co.
524 Bowview
Lincolnton, NC 28092

Gaston Co. School Food Service
225 Reid Street
Lowell, NC 28098
ATTN: Robert Caldwell

Walter Gettis Refrigeration
Route 1
Lawndale, NC 28090

Harris Teeter Super Market
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Charlotte, N C 28208

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J. N. Long, Jr.
Jim Long Inc.
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Melton Heating and Air Conditioning
312 Lineburger Street
Shelby, NC 28150

Pepsi Cola Bottling Co.
1462 W. Airline
Gastonia, NC 28052

Pharr Yarns Inc.
McAdenville, NC 28101
ATTN: Tony Cornelius

Pittsburg Plate Glass Co.
Fibre Glass Div.
Route 4
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R & W Sheet Metal
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Raymond Service, Inc.
3629 I-85 South
Charlotte, NC 28208

Charles Ruff, Inc.
1103 Marietta Street
Gastonia, NC 28052

Danny E. Turner
Turner Refrigeration & Appliance
341 Ridge Drive
Mt. Holly, NC 28120

York Division of Borg-Warnor
645 Pressley Road
Charlotte, NC 28210

Scotts Appliance Service
901 Mauney Road
Stanley, NC 28164

Guilford Technical Institute
J. Orville Garrett

Dick and Kirkman, Inc.
1119 Gercade Street
Greensboro, NC
Joe Kirkman, Jr.

Edward and Mills, Inc.
107 South Walnut Circle
Greensboro, NC
Bill Mills

Central Trane Air Conditioning
1800 Fairfax Road
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Dick Lacey

Loman Garrett Supply Co.
509 South Edgeworth St.
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Phillip Garrett

Guilford Technical Institute con't

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McBane Brown Oil Co., Inc.
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Joe H.McBane

Johnston Technical Institute
Ormond Carolan

Mr. Fred Toole
Electritemp Services, Inc.
Route 4
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Mr. Ralph Davis
Climatrol
811 North Smithfield
Smithfield, NC 27577

Mr. E. C. Holloway
Holloway Air Conditioning & Heating
Four Oaks, NC 27524

Mr. James Jones
Jones Electric Service
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Mr. G. Carlton Pernell
Pernell Inc.
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Smithfield, NC 27577

Wake Technical Institute
Milton Dixon

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Refrigeration and Air Conditioning Maint.
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Garner, NC

Mr. Ed Cole
Stahl Cole Corporation
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Arnie Pulliam, Instructor

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D & W Heating & AC Co.
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Clyde Williams
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Durham, NC 27701

Huffman Metal Works
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P.O. Box 1864
Hickory, NC 28601

Flynt, Heating and Air Conditioning
2225 W. Lee Street
Greensboro, NC

NC Heating and Air Conditioning
Contractors Association con't

Anchor Supply Co., Inc.
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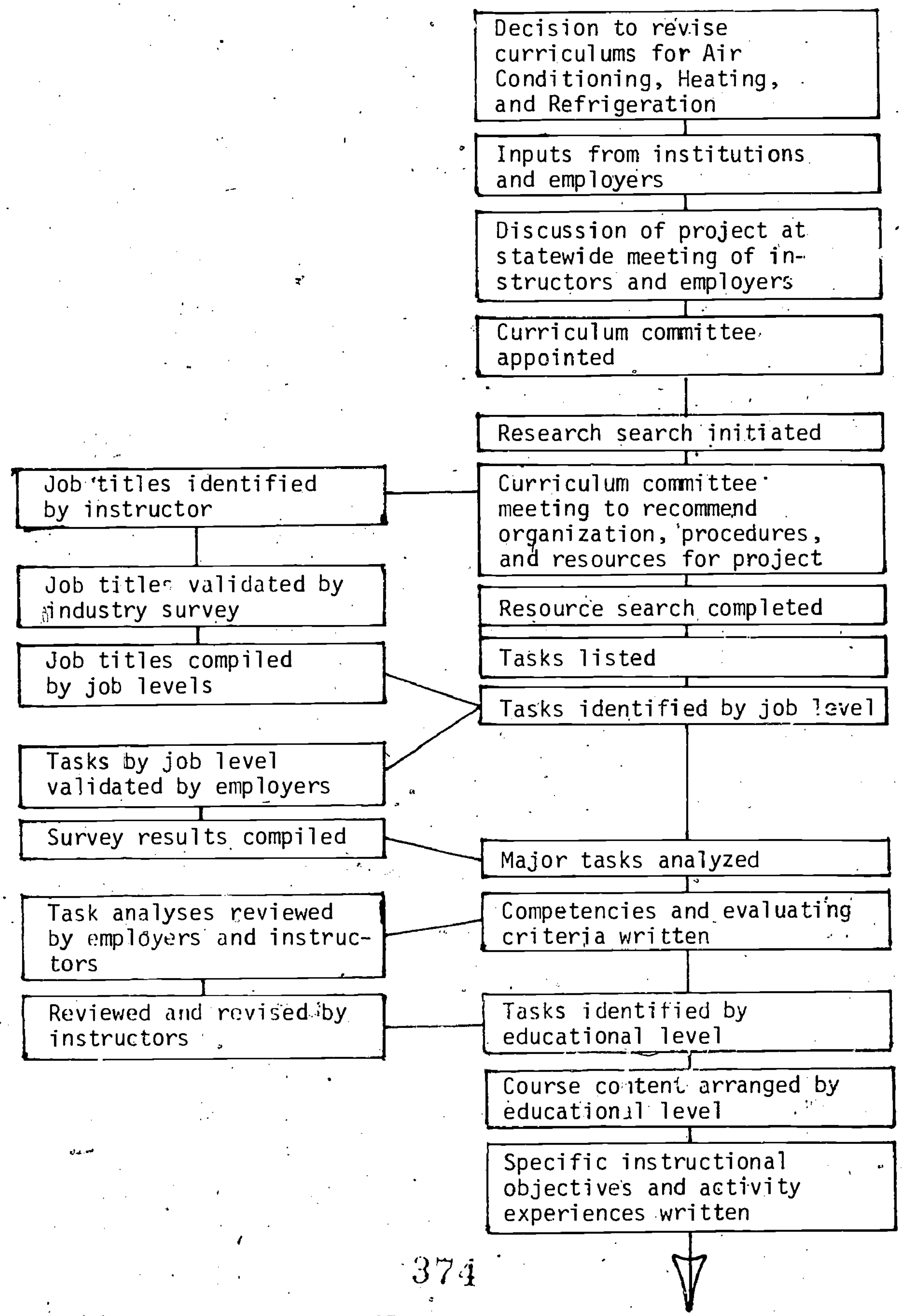
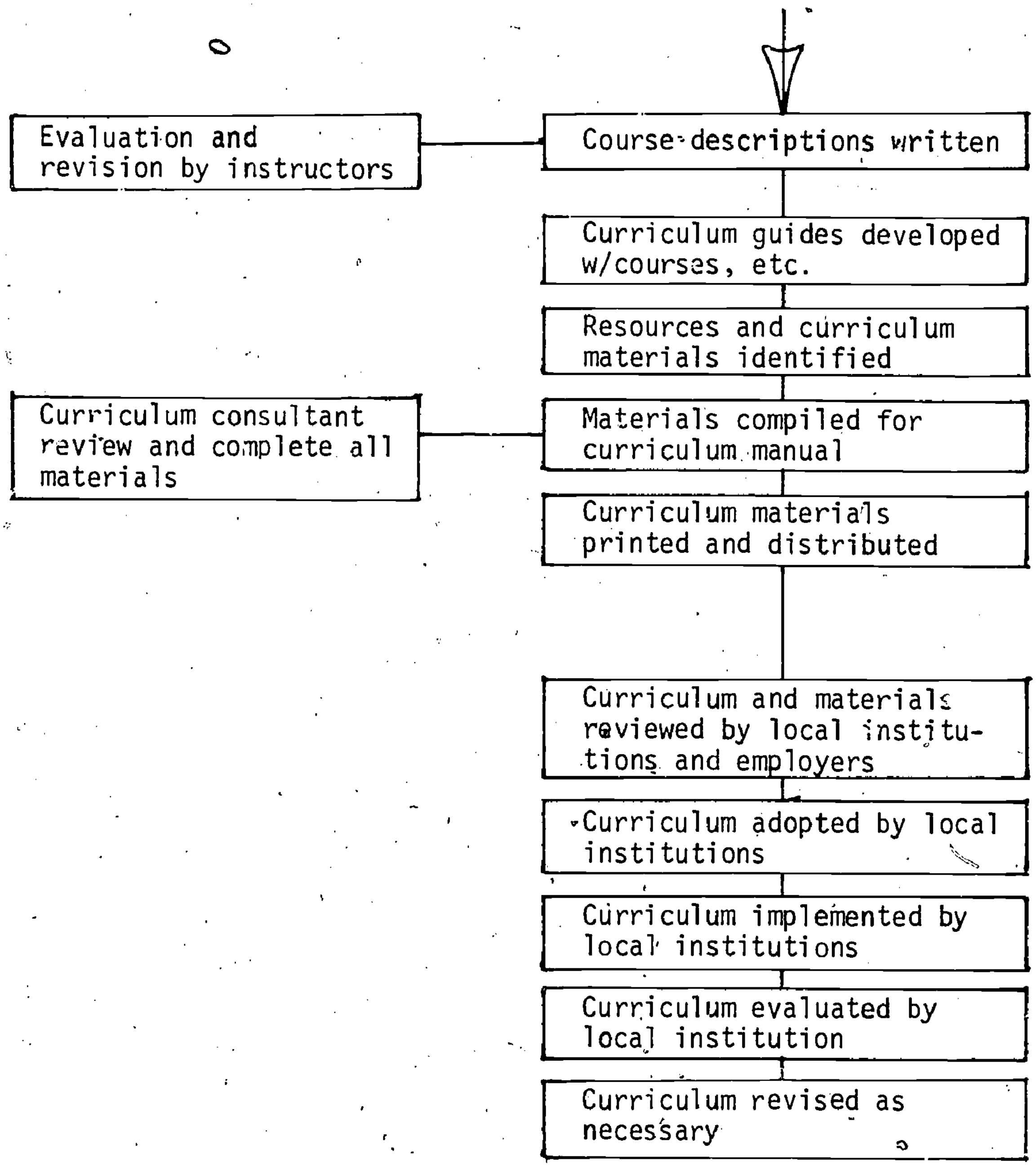
ATTN: Larry D.Cline

APPENDIX D

ACTIVITY NETWORK
AIR CONDITIONING, HEATING, AND REFRIGERATION
CURRICULUM



374


Evaluation and revision by instructors
Course descriptions written
Curriculum guides developed w/courses, etc.
Resources and curriculum materials identified
Curriculum consultant review and complete all materials
Materials compiled for curriculum manual
Curriculum materials printed and distributed
Curriculum and materials reviewed by local institutions and employers
Curriculum adopted by local institutions
Curriculum implemented by local institutions
Curriculum evaluated by local institution
Curriculum revised as necessary

DEFINITION OF TERMS

For the purpose of clarifying the meanings of specific terms in this project the following words are defined:

Attitude - mental position, a feeling or an emotion toward a face or state; a predisposition to act in a certain way; a state of readiness that influences a person to act in a given manner.

Competency - sufficient judgment, skill and knowledge to perform a particular task.

Competency-Based Education - the educational process that specifies learning goals in measurable terms and requires that the learner achieve observable behavioral changes in knowledge, skill and/or attitude to demonstrate competency before proceeding to more complex goals.

Competency-Based Instruction - the sequencing and modularization of curriculum into small, manageable units of instruction. The key concept is that the instruction is based on specific competencies validated by industry.

Curriculum - a course or group of courses organized in a logical sequence to meet occupational educational goals.

Curriculum Advisory Committee - a group of local representatives including employees, employers, secondary and post-secondary educators who counsel and advise the institutions regarding the improvement of occupational programs, in an effort to more adequately meet the needs of the community.

Educators - refers to individuals employed in educational institutions and in local, state or federal agencies, both secondary and post-secondary.

Job Analysis - a detailed listing of tasks currently being performed by workers in a clearly defined, specific job.

Knowledge - the recall of specifics and universals, the recall of methods and processes and the recall of a pattern.

Learning Experience - an activity planned by educational institutions whereby the student can practice behavior implied by the objectives.

Occupational Survey - a procedure using mail questionnaires and/or personal interviews to gain knowledge of a community and its educational interests or occupational needs to assist in planning.

Skill - the ability to use one's knowledge effectively and readily in execution or performance--dexterity or coordination in the execution of learned physical or mental tasks.

Syllabus - a course guide which includes overall and specific educational objectives; an arrangement of subject matter; learning experiences to give direction in meeting the stated objectives; and suggested texts and references.

An illustration of evaluation techniques may be included.

Task - a logically related set of actions required for the completion of a job objective; also a task may be a complete job element.

Task Analysis - a study to determine the steps a worker must know and the key points of knowledge to know in order to perform a given task.

Technical Programs - course of study consisting of occupational-oriented courses and general education courses that lead to the awarding of an Associate in Applied Science Degree and prepare students for jobs in semi- or para-professional fields.

Understanding - the power to make experience intelligible by applying concepts and theories; the comprehension of ideas and the ability to use abstractions in particular and concrete situations.

Vocational Programs - systematic groups of courses or sequences of subjects designed to train students for skilled or semiskilled employment opportunities.

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JOB TITLES AND DESCRIPTIONS*

INSTALLER HELPER

INSTALLER HELPER

The installer helper assists the installer by performing a variety of duties, such as transporting and uncrating equipment, identifying parts and materials, reading orders and parts lists, following instructions, observing safe working practices, installing equipment, keeping the workspace clean and orderly and performing other routine duties.

AIR-CONDITIONING INSTALLER-SERVICER HELPER, WINDOW UNIT

Assists the AIR-CONDITIONING INSTALLER-SERVICER, WINDOW UNIT in repairing, servicing, or installing window-mounted air-conditioning units, performing any combination of following duties: Carries unit from delivery vehicle to worksite. Assembles window-support brackets, using handtools. Cuts opening through wall for insertion of unit, using hammer and chisel. Applies caulking compound to excess space between air conditioner and wall opening. Performs other duties as described under HELPER.

FURNACE-INSTALLER-AND-REPAIRER HELPER; HOT AIR FURNACE REPAIRER HELPER

Assists FURNACE-INSTALLER-AND-REPAIRER, HOT AIR in installing and repairing hot-air furnaces: Carries tools and components, such as furnace, casing, duct sections, and materials to work area. Cleans fire pots, smoke, and hot-air ducts (FURNACE CLEANER). Holds furnace parts in place for assembling. Loosens or tightens nuts, screws, and bolts in assembling or dismantling furnace, using handtools. Performs other tasks as described under HELPER.

OIL-BURNER-SERVICER-AND-INSTALLER HELPER

Assists OIL-BURNER-SERVICER-AND-INSTALLER in installing and servicing automatic oil burners in homes and commercial establishments: Carries tools and equipment, such as burners, pipes, pipefittings, handtools, portable power tools, plaster, and insulating materials from truck to worksite. Loosens bolts and screws of ashpit and grate bars. Lifts disassembled parts from work area. Hands tools and parts to worker drilling holes in walls, installing oil storage tanks, pipes, and insulating materials. Loosens bolts of oil burners, using wrenches, and removes and cleans oil strainer and sediment bowl with rag. Performs other duties as described under HELPER.

HELPER

A worker who assists another worker, usually of a higher level of competence or expertness, by performing a variety of duties, such as furnishing another worker with materials, tools, and supplies; cleaning work area, machines, and equipment; feeding or offbearing machines; holding materials or tools; and performing other routine duties. A HELPER may learn a trade but does so without an agreement with employer that such is the purpose of their relationship. Consequently, the title HELPER is sometimes used as synonym for APPRENTICE, a practice that is incorrect technically. A worker whose

* From the Dictionary of Occupational Titles, 4th ed., US Dept. of Labor, Employment and Training Administration, 1977.

duties are limited or restricted to one type of activity, such as moving materials from one department to another, feeding machines, removing products from conveyors or machines, or cleaning machines or work areas is not technically a HELPER and is classified according to duties performed as MATERIAL HANDLER; MACHINE CLEANER; CLEANER, INDUSTRIAL. A worker who performs a variety of duties to assist another worker is a HELPER technically and is classified according to worker assisted as BRICKLAYER HELPER (const.); DRY-CLEANER HELPER (clean, dye, and press).

INSTALLER

INSTALLER

The installer installs heating and cooling equipment, air handlers, filters, humidifiers, dehumidifiers, and ductwork and refrigeration units in private residences and small business establishments, as dictated by individual employer needs. The installer connects necessary drains, piping, wiring, and fixtures to complete the job; directs helper to prepare system for installation; and works with all materials and tools of the trade. The installer may start unit, adjust controls and listen for indications of malfunction.

REFRIGERATOR TESTER

Inspects and tests refrigeration units to evaluate functional operation of system, using knowledge of refrigeration systems and operating specifications: Connects unit to electrical outlet and starts compressor. Observes units to detect malfunction and insure that cooling is taking place. Tests compressors on nonfunctioning units for specified wattage, using watt-meter. Times operating cycle of unit, using watch and replaces relay switches, or orders compressor replacement to regulate length of operating cycle. Feels lines and other components at various points in system to determine if unit is functioning. Examines coolant lines for damage and accumulations of frost indicating constriction or obstruction in lines. Records and attaches inspection tag to malfunctioning units, indicating type and location of defects. May attach gauges to verify conformance of unit to temperature, pressure, B.T.U., and other operational specifications. May work in controlled temperature room.

FURNACE INSTALLER

Installs and regulates gas-burner units in building-heating furnaces to convert furnaces from wood, coal, or oil to gas: Directs helper to prepare furnace for installation of gas burner unit. Lays brick foundation (BRICKLAYER (const.)) in furnace ashpit and positions heating unit on foundation. Draws sketch of pipes and fittings required to connect gas burner to gas supply. Measures, cuts, threads, bends, and installs pipe between burner and gas supply with assistance of helper, using pipefitters' tools. Installs thermostat in heated area and makes wiring connections between building terminal box, switchbox, burner motor, and thermostat (ELECTRICIAN (any ind.)). Ignites gas burner and adjusts gas-flow and air-supply control valves until observation of gas flame indicates correct combustion.

REFRIGERATION UNIT REPAIRER

Replaces defective components and reassembles refrigeration units to work orders and blueprint specifications: Studies rejection slips from inspection department or customer's letters and observes functioning of components, such as controls, fan, condenser, evaporator, or compressor to determine need for repair or replacement. Drains oil and pumps gas from unit. Loosens bolts, and melts soldered or brazed seams, to dismantle unit, using handtools and torch. Removes and replaces defective components. Brazes or solders parts to repair defective joints and leaks. Reassembles unit, using measuring instruments, handtools, soldering iron, and hand torch. Routes defective components to salvage department. May adjust unit controls. Records cause of malfunction, repairs, and replacements made.

AIR-CONDITIONING INSTALLER, DOMESTIC; AIR-CONDITIONING-WINDOW-BOX INSTALLER

Installs window- or central-air-conditioning units in private residences and small business establishments: Inspects existing wiring, fuses, or circuit-breaker panels on customer's premises to insure adequate power supply for operating air conditioner. Measures window, transom, or other existing openings for air-conditioning unit, using measuring tape or rule, or cuts opening through wall, using mallet and cold-chisel. Assembles and positions support brackets in place, using screws, clamps, or other braces and handtools and power tools. Fills space between window support and edge of opening with caulking compound and filler board. Places air conditioner on support frame and secures unit in position, leveling unit with screws, clips, and bolts. Starts unit, adjusts controls and listens for excessive noise or sounds indicating malfunction. May give instructions to customer regarding operation and care of unit. May change filters, lubricate machine, replace fan motor or fan belt, and make minor adjustments. May specialize in installation of central units and be designated CENTRAL-AIR-CONDITIONING INSTALLER.

MECHANIC HELPER

MECHANIC HELPER

The mechanic helper assists the mechanic in installing, repairing and servicing residential and commercial environmental-control systems such as heating and cooling equipment, air handlers, filters, humidifiers, dehumidifiers, ductwork and refrigeration units. The helper installs tanks, piping, smoke pipe and ducts. The helper also reads thermometers and gauges, charges refrigerant system, lubricates parts, uses handtools, installs filters, assembles components, sets equipment, and performs other routine duties under the direction of the mechanic.

ENVIRONMENTAL-CONTROL-SYSTEM INSTALLER-SERVICER HELPER; HEATING-AND-AIR-CONDITIONING-MECHANIC HELPER

Assists workers engaged in installing, repairing, and servicing industrial, commercial, and residential environmental-control systems performing any combination of following duties: Cuts, punches, flanges, shears, and solders sheet metal ducts and parts, using handtools and portable power tools. Cuts threads and packs pipes. Cements insulation in place over finished piping or tubing. Passes electrical wire through conduit, splices wire connections, and tapes wire. Assembles sheet metal components of prefabricated furnaces, using handtools. Replaces exhausted or defective containers of refrigerant with new refrigerant. Lubricates fans, motors, and control units. Installs air and water filters in completed assembly. Performs other duties as described under HELPER. May be designated according to type of equipment serviced as AIR-CONDITIONING-MECHANIC-HELPER, INDUSTRIAL.

REFRIGERATION-MECHANIC HELPER

Assists REFRIGERATION MECHANIC in installing, maintaining, and repairing industrial and commercial refrigerating systems: Transports tools, materials, components, and refuse to and from work area. Lifts or holds parts while REFRIGERATION MECHANIC fits, alines, and fastens them into position. Bolts or unbolts parts, using handtools. May cut and thread pipe to specified length, using pipe cutter, stock, and die. May insulate cabinets and systems. Performs other duties as described under HELPER.

AIR-CONDITIONING INSTALLER-SERVICER, WINDOW UNIT

Installs, services, and repairs air-conditioning units, ranging from 1/2 to 2 tons capacity, in private residences and small business establishments: Examines unit visually for defective parts, or listens to machine in operation, utilizing knowledge of mechanical, electrical, and refrigeration theory, to determine cause of malfunction. Dismantles whole or part of machine, as indicated by type of malfunction, and repairs or replaces such parts as switches, relays, fan motors, thermostats, and other components, using handtools and power tools. Replaces filters, lubricates unit, and adjusts controls. Reassembles machine, making necessary adjustments to insure efficient operation. May estimate cost of repairs or adjustments. May remove machines from customer's premises for major repairs or overhaul in shop, or for return to manufacturer for extensive repairs. May repair sealed refrigeration units of machines.

OIL-BURNER-SERVICER-AND-INSTALLER

Installs and services automatic oil burners in furnaces in homes and commercial establishments, using handtools and pipe-threading tools: Assembles and positions oil-storage tank between furnace and wall of building. Drills holes in wall and affixes oil inlet and outlet pipes from storage tank through holes to outside of building. Removes ashpit and grate bars from furnace and installs burner in opening. Seals space around burner with plaster. Connects pipe and storage tank and burner to convey oil. Installs thermostatic control and damper in chimney. Observes color and height of flame and volume of smoke emitted to determine causes of faulty operation. Examines flue draft, using draftstat, and changes balance weight to adjust damper. May install and service automatic coal stokers.

AIR-CONDITIONING-MECHANIC APPRENTICE; REFRIGERATION-MECHANIC APPRENTICE

Performs duties as described under APPRENTICE. Frequently specializes, after completing apprenticeship program, in such areas as refrigeration (REFRIGERATION MECHANIC; air-conditioning (ENVIRONMENTAL-CONTROL-SYSTEM INSTALLER-SERVICER); PIPE FITTER (ship and boat bldg. and repair); gasline fitting (PIPE); or gas, oil, hot water, and steam heating systems (OIL-BURNER-SERVICER-AND-INSTALLER); GAS-APPLIANCE SERVICER.

APPRENTICE

A worker who learns, according to written or oral contractual agreement, a recognized skilled craft or trade requiring one or more years of on-the-job training through job experience supplemented by related instruction, prior to being considered a qualified skilled worker. High school or vocational school education is often a prerequisite for entry into an apprenticeship program. Provisions of apprenticeship agreement regularly include length of apprenticeship; a progressive scale of wages; work processes to be taught; and amount of instruction in subjects related to the craft or trade, such as characteristics of materials used, physics, mathematics, estimating, and blueprint reading. Apprenticeability of a particular craft or trade is best evidenced by its acceptability for registration as a trade by a State apprenticeship agency or the Federal Bureau of Apprenticeship and Training. Generally, where employees are represented by a union, apprenticeship programs come under the guidance of joint apprenticeship committees composed of representatives of the employers or the employer association and representatives of the employees. These committees may determine need for apprentices in a locality and establish minimum apprenticeship standards of education, experience, and training. In instances where committees do not exist, apprenticeship agreement is made between apprentice and employer, or an employer group. The title, APPRENTICE, is often loosely used as a synonym for beginner, HELPER, or TRAINEE. This practice is technically incorrect and leads to confusion in determining what is meant. Typical classifications for apprentices are BLACKSMITH APPRENTICE (forging); MACHINIST APPRENTICE (mach. shop); and PLUMBER APPRENTICE (const.).

MECHANIC

MECHANIC

The mechanic installs, services, and repairs environmental-control systems in residences and commercial establishments using heating, cooling, and refrigeration theory and skills; follows blueprints or engineering specifications; reads gauges and instruments; adjusts mechanisms; dismantles malfunctioning components; tests components; replaces defective parts; and operates system to observe performance. The mechanic fabricates and installs ductwork, joins tubing or pipes to units, installs relief valves, connects electrical components to control panels, completes and checks out system installation, and starts up system to insure proper operation. The mechanic also directs the helper in installing, servicing and repairing systems.

ENVIRONMENTAL-CONTROL-SYSTEM INSTALLER-SERVICER; AIR-CONDITIONING-MECHANIC; HEATING-AND-AIR-CONDITIONING MECHANIC; HEATING MECHANIC

Installs, services, and repairs environmental-control systems in residences, department stores, office buildings, and commercial establishments, utilizing knowledge of refrigeration theory, pipefitting, and structural layout: Mounts compressor and condenser units on platform or floor, using handtools, following blueprints or engineering specifications. Fabricates, assembles, and installs ductwork and chassis parts, using portable metalworking tools and welding equipment (DUCT INSTALLER (const; mfd. bldgs.)). Installs evaporator unit in chassis or in air-duct system, using handtools. Cuts and bends tubing to correct length and shape, using cutting and bending equipment and tools. Cuts and threads pipe, using machine-threading or hand-threading equipment. Joins tubing or pipes to various refrigerating units by means of sleeves, couplings, or unions, and solders joints, using torch, forming complete circuit for refrigerant (PIPE FITTER (const.)). Installs expansion and discharge valves in circuit. Connects motors, compressors, temperature controls, humidity controls, and circulating-ventilation fans to control panels and connects control panels to power source (ELECTRICIAN). Installs air and water filters in completed installation. Injects small amount of refrigerant into compressor to test systems, and adds freon gas to build up prescribed operating pressure. Observes pressure and vacuum gauges and adjusts controls to insure proper operation. Tests joints and connections for gas leaks, using gauges or soap-and-water solution. Wraps pipes in insulation batting and secures them in place with cement or wire bands. Replaces defective breaker controls, thermostats, switches, fuses, and electrical wiring to repair installed units, using electrician's handtools and test equipment. May install, repair, and service air conditioners, ranging from fifteen to twenty tons cooling capacity, in warehouses and small factory buildings and be designated AIR-CONDITIONING MECHANIC, INDUSTRIAL.

REFRIGERATION MECHANIC

Installs and repairs industrial and commercial refrigerating systems according to blueprints and engineering specifications, using knowledge of refrigeration, structural layout, and function and design of components: Layout reference points for installation of structural and functional components, using measuring instruments, such as tape, transit, plumb bob, levels, and square. Drills holes and installs mounting brackets and hangers into floor and walls of building. Lifts and alines components into position, using hoist or block and tackle. Screws, bolts, rivets, welds, and brazes parts to assemble structural and functional components, such as motors, controls, switches, gauges, wiring harnesses, valves, pumps, compressors, condensors, cores, and pipes. Cuts, threads, and connects pipe to functional components and water or power system of premises (PIPE FITTER (const.)). Pumps specified gas or fluid into system. Starts system, observes operation, reads gauges and instruments, and adjusts mechanisms, such as valves, controls, and pumps to control level of fluid, pressure, and temperature in system. Dismantles malfunctioning systems and tests components, using electrical, mechanical, and pneumatic testing equipment. Replaces or adjusts defective or worn parts to repair systems. May insulate shells and cabinets of systems. May install wiring to connect components to electric power source. May specialize in installing systems and be designated REFRIGERATION-SYSTEM INSTALLER.

SHEET-METAL WORKER;
SHEET-METAL MECHANIC

Fabricates, assembles, installs, and repairs sheet metal products and equipment, such as control boxes, drainpipes, ventilators, and furnace casings, according to job order or blueprints: Selects gauges and type of sheet metal according to product being fabricated and knowledge of metal. Locates and marks dimension and reference lines on metal sheet (SHEET-METAL LAY-OUT WORKER). Sets up and operates fabricating machines, such as shears, brakes, bending rolls, and punch and drill presses to cut, bend, and straighten sheet metal. Shapes metal over anvils, blocks, or forms, using hammer. Sets up and operates soldering and welding equipment to join together sheet metal parts. Smooths seams, joints, or burred surfaces, using files and portable grinder or buffer. Installs assemblies in plant or worksite according to blueprint specifications, using handtools and portable power tools. Inspects assemblies and installation for conformance with specifications using measuring instruments, such as calipers, scales, and micrometer. May be designated according to type of metal used as COPPERSMITH; TINSMITH; or according to type of activity as FABRICATOR, SPECIAL ITEMS; MODEL MAKER, SHEET METAL; PRODUCT-DEVELOPMENT WORKER; ROOFER, METAL (const.); SHEET-METAL INSTALLER; SHEET-METAL WORKER; MAINTENANCE; SHOP MECHANIC.

DUCT MAKER

Cuts and shapes fiberglass sheet to form heating and air conditioning ducts, using handtools: Places sheet on worktable for cutting. Measures and marks sheet according to specifications, using tape measure and marker. Cuts wedge shaped grooves according to marking to facilitate folding, using straightedge and knife. Folds sheet to form rectangular duct and fastens open edge of duct, using pneumatic stapler. Cuts aluminum tape according to length of duct and tapes edge of duct to make air tight seal. Writes model number on completed sections of duct with felt pen. Moves ducts to designated storage area.

ADVANCED LEVEL JOBS

AIR-CONDITIONING-UNIT TESTER

Tests efficiency of heating and air-conditioning equipment under simulated operating conditions: Connects heating and air-conditioning equipment to facilities, such as heating units, waterlines, and spray devices to set up controlled temperature and moisture conditions. Constructs cardboard air ducts and other accessories for use in testing equipment. Couples gauges and instruments to system and starts equipment. Observes and records readings of instruments, such as thermometers, psychrometers, thermocouples, air flowmeters, voltmeters, ammeters, and pressure and draft gauges. Informs supervisor of unusual noise and instrument readings during operation of equipment. May plot instrument reading data.

ELECTRICAL-APPLIANCE SERVICER;
APPLIANCE-SERVICE REPRESENTATIVE

Installs, services, and repairs stoves, refrigerators, dishwashing machines, and other electrical household or commercial appliances, using handtools, test equipment, and following wiring diagrams and manufacturer's specifications: Connects appliance to power source and test meters, such as wattmeter, ammeter, or voltmeter. Observes readings on meters and graphic recorders. Examines appliance during operating cycle to detect excess vibration, overheating, fluid leaks, and loose parts. Disassembles appliance and examines mechanical and electrical parts. Traces electrical circuits, following diagram, and locates shorts and grounds, using ohmmeter. Calibrates timers, thermostats, and adjusts contact points. Cleans and washes parts, using wire brush, buffer, and solvent, to remove carbon, grease, and dust. Replaces worn or defective parts, such as switches, pumps, bearings, transmissions, belts, gears, blowers, and defective wiring. Repairs and adjusts appliance motors. Reassembles appliance, adjusts pulleys, and lubricates moving parts, using handtools and lubricating equipment. May be known according to appliance repaired as CLOTHES-DRIER REPAIRER; COFFEE-MAKER SERVICER; DISHWASHING-MACHINE REPAIRER; ELECTRIC-RANGE SERVICER; ELECTRIC-REFRIGERATOR SERVICER; WASHING-MACHINE SERVICER.

ESTIMATOR;
COST ESTIMATOR; PRODUCTION ESTIMATOR

Prepares cost estimates for manufacturing of products, construction projects, or services requested to aid management in bidding on or determining price of product or service: Compiles list of type of materials, tool or fixture, or equipment requirements, utilizing knowledge of products to be manufactured, services to be performed, or type of structure to be built, using blueprints and specifications. Itemizes tools, fixtures, or equipment to be manufactured by company or purchased from outside sources. Computes cost estimates for materials, purchased equipment, subcontracted work, production activities and requirements, and labor. May conduct special studies to develop and establish standard hour and related cost data or effect cost reductions. May consult with personnel of other departments relating to cost problems. May specialize according to particular service performed, type of product produced, or phase of work in which involved, as tool and fixture costs, production costs, construction costs, or material costs.

AIR CONDITIONING TECHNICIAN; HEATING TECHNICIAN;
REFRIGERATING TECHNICIAN;
HEAT-TRANSFER TECHNICIAN

Plans requirements for fabricating, installing, testing, and servicing climate control and heat transfer assemblies and systems to assist engineering personnel, utilizing knowledge of heat transfer technology and engineering methods: Calculates required capacities for equipment units of proposed system to obtain specified performance and submits data to engineering personnel for approval. Studies supplier catalogs and technical data to recommend equipment unit selections for system. Prepares unit design layouts and detail drawings for fabricating parts and assembling system. Estimates cost factors, such as labor and material for purchased and fabricated parts, and costs for assembling, testing, and installing in customer's premises. Fabricates non-standard parts for system, using metalworking machinery and assembles system, using handtools and power tools. Installs test fixtures, apparatus, and controls and conducts operational tests under specified conditions. Analyzes test data and prepares report for evaluation by engineering personnel. Installs system in customer premises and tests operational performance for compliance with contract specifications and applicable codes. Diagnoses special service problems of systems under service contract and writes instructions for service or repair personnel.

SALESPERSON

Sells merchandise to individuals in store or showroom, utilizing knowledge of products sold: Greets customers on sales floor and ascertains make, type, and quality of merchandise desired. Displays merchandise, suggests selections that meet customer's needs, and emphasizes selling points of article, such as quality and utility. Prepares sales slip or sales contract. Receives payment or obtains credit authorization. Places new merchandise on display. May wrap merchandise for customer. May take inventory of stock. May requisition merchandise from stockroom. May visit customer's home by appointment to sell merchandise on shop-at-home basis. Classifications are made according to products sold as SALESPERSON, HEATING SYSTEMS.

DRAFTER, HEATING AND VENTILATING

Performs duties of DRAFTER, but specializes in drawing plans for installation of heating, air-conditioning, and ventilating equipment. May calculate heat loss and heat gain for buildings for use in determining equipment specifications, using slide rule and following standardized procedures. May specialize in drawing plans for installation of refrigeration equipment as DRAFTER, REFRIGERATION.

DRAFTER

Prepares clear, complete, and accurate working plans and detail drawings from rough or detailed sketches or notes for engineering or manufacturing purposes, according to specified dimensions: Makes final sketch of proposed drawings, checking dimension of parts, materials to be used, relation of one part to another, and relation of various parts to whole structure or project. Makes any adjustments or changes necessary or desired. Inks in lines and letters on pencil drawings as required. Exercises manual skill in manipulation of triangle, T-square, and other drafting tools. Draws charts for representation of statistical data. Draws finished designs from sketches. Utilizes knowledge of various machines, engineering practices, mathematics, building materials, and other physical sciences to complete drawings. Classifications are made according to type of drafting as DRAFTER, ARCHITECTURAL (profess. & kin.); DRAFTER, ELECTRICAL (prof. & kin.).

SUPERVISOR- boss; chief; head; leader; manager; overlooker; overseer; principal; section chief; section leader

Supervises and coordinates activities of workers engaged in one or more occupations: Studies production schedules and estimates worker-hour requirements for completion of job assignment. Interprets company policies to workers and enforces safety regulations. Interprets specifications, blueprints, and job orders to workers, and assigns duties. Establishes or adjusts work procedures to meet production schedules, using knowledge of capacities of machines and equipment. Recommends measures to improve production methods, equipment performance, and quality of product, and suggests changes in working conditions and use of equipment to increase efficiency of shop, department, or work crew. Analyzes and resolves work problems, or assists workers in solving work problems. Initiates or suggests plans to motivate workers to achieve work goals. Recommends or initiates personnel actions, such as promotions, transfers, discharges, and disciplinary measures. May train new workers. Maintains time and production records. May estimate, requisition, and inspect materials. May confer with other SUPERVISORS to coordinate activities of individual departments. May confer with workers' representatives to resolve grievances. May set up machines and equipment. When supervising workers engaged chiefly in one occupation or craft, is required to be adept in the activities of the workers supervised. When supervising workers engaged in several occupations, is required to possess general knowledge of activities involved. Classifications are made according to process involved, craft of workers supervised, product manufactured, or according to industry in which work occurs. Classifications are made according to workers supervised.

SALES ENGINEER; MARKETING ENGINEER

Sells chemical, mechanical, electro-mechanical, electrical, electronic equipment and supplies or services requiring knowledge of engineering and cost effectiveness: Calls on management representatives such as engineers, architects, or other professional and technical personnel at commercial, industrial, and other establishments in attempt to convince prospective client of desirability and practicability of products or services offered. Reviews blueprints, plans, and other customer documents to develop and prepare cost estimates or projected increases in production from client's use of proposed equipment or services. Draws up or proposes changes in equipment, processes, or use of materials or services which would result in cost reduction or improvement in operations. Provides technical services to clients relating to use, operation, and maintenance of equipment. May draw up sales or service contract for products or services. May provide technical training to employees of client. Usually specializes in sale of one or more closely related group of products or types of services, such as electrical or electronic equipment or systems, industrial machinery, processing equipment or systems, air conditioning and refrigeration equipment, electric power equipment, or chemical goods.

TECHNICIAN; TECHNICAL AIDE; ENGINEERING AIDE; TECHNICAL ASSISTANT

A term applied to a worker who works in direct support of ENGINEERS (profess. & kin.) or SCIENTISTS (profess. & kin.), utilizing theoretical knowledge of fundamental scientific, engineering, mathematical, or draft design principles. Solves practical problems encountered in fields of specialization, such as those concerned with development of electrical and electronic circuits, and establishment of testing methods for electrical, electronic, electromechanical, and hydromechanical devices and mechanisms; application of engineering principles in solving design, development, and modification problems of parts or assemblies for products or systems; and application of natural and physical science principles to basic or applied research problems in fields, such as metallurgy, chemistry, and physics. Classifications are made according to specialization as ELECTRONICS TECHNICIAN (profess. & kin.); MATHEMATICAL TECHNICIAN (profess. & kin.).

CONTRACTOR

Contracts to perform specified construction work in accordance with architect's plans, blueprints, codes, and other specifications: Estimates costs of materials, labor, and use of equipment required to fulfill provisions of contract and prepares bids. Confers with clients to negotiate terms of contract. Subcontracts specialized craft work, such as electrical, structural steel, concrete, and plumbing. Purchases material for construction. Supervises workers directly or through subordinate supervisors. May be designated according to specialty license or scope of principal activities as CONTRACTOR, GENERAL ENGINEERING (const.); CONTRACTOR, GENERAL BUILDING (const.).

MECHANICAL-ENGINEERING TECHNICIAN; ENGINEERING TECHNICIAN; LABORATORY-DEVELOPMENT TECHNICIAN; MECHANICAL TECHNICIAN

Develops and tests machinery and equipment, applying knowledge of mechanical engineering technology, under direction of engineering and scientific staff: Reviews project instructions and blueprints to ascertain specifications, procedures, objectives, test equipment, nature of mechanical problem, and possible solutions, such as part redesign, substitution of material or parts, or rearrangement of parts or subassemblies. Drafts detail drawing or sketch for drafting room completion or as request parts fabrication by machine sheet metal or wood shops. Designs, fabricates, and assembles new or modified mechanical components or assemblies for products, such as industrial equipment and machinery, power equipment, servosystems, machine tools, and measuring instruments. Sets up and conducts tests of complete units and components under operational conditions to investigate design proposals for improving equipment performance or other factors, or to obtain data for development, standardization, and quality control. Analyzes indicated and calculated test results in relation to design or rated specifications and test objectives, and modifies or adjusts equipment to meet specifications. Records test procedures and results, numerical and graphical data, and recommendations for changes in product or test method.

SALES REPRESENTATIVE; SALES AGENT; SALES ASSOCIATE

Sells products to business and industrial establishments or individual for manufacturer or distributor at sales office, store, showroom, or customer's place of business, utilizing knowledge of product sold: Compiles lists of prospective customers for use as sales leads, based on information from newspapers, business directories and other sources. Travels throughout assigned territory to call on regular and prospective customers to solicit orders or talks with customers on sales floor or by phone. Displays or demonstrates product, using samples or catalog, and emphasizes salable features. Quotes prices and credit terms and prepares sales contracts for orders obtained. Estimates date of delivery to customer, based on knowledge of own firm's production and delivery schedules. Prepares reports of business transactions and keeps expense accounts. Classifications are made according to products sold as SALES REPRESENTATIVE, INDUSTRIAL MACHINERY (whole tr.).

MAINTENANCE MECHANIC; MACHINE REPAIRER; MECHANICAL ADJUSTER

Repairs and maintains, in accordance with diagrams, sketches, operation manuals, and manufacturer's specifications, machinery and mechanical equipment such as engines, motors, pneumatic tools conveyor systems, and production machines and equipment, using handtools, power tools, and precision-measuring and testing instruments: Observes mechanical devices in operation and listens to their sounds to locate causes of trouble. Dismantles devices to gain access to and remove defective parts, using hoists, cranes, handtools, and power tools. Examines form and texture of parts to detect imperfections. Inspects used parts to determine changes in dimensional requirements, using rules, calipers, micrometers, and other measuring instruments. Adjusts functional parts of devices and control instruments, using handtools, levels, plumb bobs, and straightedges. Repairs or replaces defective parts, using handtools and power tools. Installs special functional and structural parts in devices, using handtools. Starts devices to test their performance. Lubricates and cleans parts. May set up and operate lathe, drill press, grinder, and other metalworking tools to make and repair parts. May initiate purchase order for parts and machines. May repair electrical equipment. May be designated according to machine repaired, as CARTON-FORMING-MACHINE ADJUSTER; MACHINE ADJUSTER (tobacco); MAINTENANCE MECHANIC; RECORD PROCESSING EQUIPMENT (phonograph).

APPENDIX G
CAREER OPPORTUNITY SURVEY
AND RESPONSE

DEPARTMENT OF
COMMUNITY COLLEGES
NORTH CAROLINA STATE BOARD OF EDUCATION
RALEIGH 27611

July 14, 1977

MEMO TO: Selected Employers of Air Conditioning, Heating and Refrigeration Personnel

FROM: Frank A. Gourley, Jr., Assistant Director
Engineering Technology

SUBJECT: Career Opportunity Survey

The Program Development Division, Department of Community Colleges, is conducting a project to determine the competencies required by employers in order for their employees to be successful on the job. This project is designed to: (1) develop a validated list of tasks performed by employees in a given job; (2) develop from the tasks, competencies which are required to perform successfully in the job; (3) develop curriculum guidelines; and (4) develop and/or revise curriculum materials based on the guidelines to assist educational personnel in providing quality occupational education programs. You, as a member of the employment field, can provide essential information for the development of competency-based programs.

You have been selected to assist in determining employment opportunities in air conditioning, heating, and refrigeration. The enclosed form identifies careers open to individuals in this field. These opportunities may or may not exist. Please add titles of other jobs you feel exist for persons interested in this field. Your response to the survey will contribute to the identification of jobs that do exist.

After you have completed the survey, please return it in the stamped, self-addressed envelope by August 1, 1977. Your responses will be compiled with other responses. No individual responses will be identified.

Your participation in this project by the completion of this survey is greatly appreciated.

FAG/bc

CC:

Career Opportunity Survey

The following employment opportunities have been identified as being possible careers open to individuals in air conditioning, heating, and refrigeration. These opportunities may or may not exist.

Please indicate your opinion as to whether these employment opportunities do exist by checking (✓) the yes or no block next to the career identified. Please add additional opprotunites that were omitted from the careers listed.

Career Opportunity	Yes	No	Comments
Mechanics Helper	24	5	
Mechanic	27	2	
Service Technician Helper	21	8	
Service Technician	27	2	
Air Conditioning Serviceman	28	2	
Oil Heat Serviceman	27	3	
Gas Heat Serviceman	[illegible]	3	
Heat Pump Serviceman	23	3	
Refrigeration Serviceman	25	2	
Heating and Air Conditioning Installer	32	1	
Heating, Air Conditioning & Refrigeration Service Mechanic	33	1	
Commercial Refrigeration Contractor	16	6	
Commercial Refrigeration Mechanic	23	3	
Refrigeration Mechanic	23	3	
Self Employed Air Conditioning and Refrigeration Apprentice	8	18	
Self Employed Air Conditioning and Refrigeration Mechanic	15	10	
Maintenance Mechanic (Industrial)	26	3	
Installation Mechanic (domestic and small commercial)	22	6	
Installation Mechanic Apprentice	23	4	
Sheet Metal Mechanic	32	1	

Career Opportunity	Yes	No	Comments
Dispatcher	15	7	
Controller	16	7	
Salesman	26	1	
Estimator	23	3	
Oil Burner Mechanic	21	8	
Oil Burner Installer	18	9	
Maintenance Manager	19	7	
Plant Engineer	20	5	
Boiler & Refrigeration Maintenance Man	19	5	
Controls Serviceman	26	3	
Building Engineer	21	4	
Dealer/Contractor	18	4	
Instrumentation Technician	15	6	
Controls Technician	17	7	
Auto Air Conditioning Specialist	23	6	
Maintenance Foreman	20	6	
Operating Engineer	16	7	
Service Engineer	18	6	
Shop Technician	19	7	
Stationary Engineer	11	9	
Environmental Systems Engineer	21	4	
Troubleshooter	18	6	
Journeyman	17	6	
Apprentice	18	7	
Hydronics Design Technician	17	5	
Transport Refrigeration Technician	15	5	
Maintenance Man	17	4	
Insurance Adjuster	12	9	
Inspector	14	8	
Electric Motor Repairman	20	7	
Compressor Rebuilder	16	10	

Other	Yes	No	Comments
Retrofit Contractor			
Retrofit Mechanic			
Retrofit Journeyman			
Design Engineer			
Heating Equipment Specialist			
Load Calculations Specialist			
Mechanical Draftsman			
Hydronics Installer			
System Designer			

SUMMARY OF RESPONSES:

122 questionnaires mailed, 42 replies

Size of HVAC Staff: [8]* 1-5 [16] 6-25 [15] 26or more [3] N/A
Number of Employees

Type HVAC with which involved

[31] Heating [31] Air Conditioning [17] Refrigeration

[28] Domestic [19] Industrial [1] Transport

[29] Commercial

* Summary of survey responses.

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APPENDIX H

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS:

RESPONSE FROM INDUSTRY

The attached Air Conditioning, Heating, and Refrigeration Task List identifies those tasks that employers feel are required for each of the jobs listed. The job categories used in the survey were determined by a group of instructors and employers from an earlier survey to determine job needs. The job levels identified are representative of the jobs available to persons with varying degrees of skills.

The survey was sent to one-hundred and thirty employers requesting a response. Thirty-one employers responded to the survey. Determination of the tasks required for each job was made on the basis of a percent response. If greater than five of the thirty-one responses added a task to a job, it was included as required task to be taught in preparing a person for that job. If greater than five of the thirty-one responses removed a task from a job, it was removed.

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer		
1.00 I. Heating							
1.10 A. Oil							
1.11. Install storage tank above or below ground	X	X					
1.12. Run oil line with filter and valves	X	X					
1.13. Run vent and fill lines	X	X					
1.14. Select equipment to be installed					X		
1.15. Install equipment	X	X					
1.16. Connect to prefabricated or job erected flue	X	X					
1.17. Service equipment			X	X			
1.20 B. Gas							
1.21. Install piping for gas line	X	X					
1.22. Select equipment					X		
1.23. Install equipment	X	X					
1.24. Connect to prefabricated or job erected vents and flues	X	X					
1.25. Service equipment			X	X			
1.30 C. ELECTRIC							
1.31. Size conductors					X		
1.32. Run conduit from disconnect to equipment				X			
1.33. Select equipment					X		
1.34. Install equipment	X	X					
1.35. Service equipment selected and installed			X	X			
1.40 D. Heat Loss Calculations							
1.41. Calculate air heating heat loss and heat gain					X		
1.42. Calculate hydronic heat loss					X		

X Tasks requir by job level as validated survey of em ployers

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AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL		Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
.00	I. Heating					
1.50	E. Combustion					
	1.51. Match proper oil/gas and heating equipment...........				X	X
	1.52. Select heating medium..............................				X	X
	1.53. Select heating equipment...........................					X
	1.54. Select and evaluate draft and combustion equipment....			X	X	
	1.55. Determine combustion air requirements................		X	X	X	
	1.56. Determine combustion by-products.....................		X	X	X	
	1.57. Choose burner shape and nozzle to match heat exchanger		X	X	X	
	1.58. Obtain peak operating efficiency using test instruments..			X	X	
.00	II. Air Conditioning and Heat Pumps					
2.10	A. Mechanical Diagnosis and Servicing					
	2.11. Locate job site......................................			X	X	
	2.12. Locate system trouble..............................			X	X	
	2.13. Correct problem........................			X	X	
2.20	B. Electrical Diagnosis and Servicing					
	2.21. Locate and repair or replace defective components in low voltage control circuits........................			X	X	
	2.22. Locate and replace components in line voltage circuits			X	X	
2.30	C. Hand Tools					
	2.31. Use basic hand tools................................	X	X	X	X	
	2.32. Use specialized tools...............................	X	X	X	X	
2.40	D. Electrical Instruments					
	2.41. Use electrical instruments to determine voltage, current, and resistance			X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
2.42 Use electrical instruments to determine power........			X	X	
2.50 E. System Cleanup after Burnout					
2.51. Disconnect a tube and flush..........................			X	X	
2.52. Tear down TEV and flush..............................			X	X	
2.53. Pump cleaner through condenser.......................			X	X	
2.54. Pump cleaner through evaporator......................					
2.55. Clean all refrigerant piping.........................			X	X	
2.56. Replace compressor and put system into operation.....			X	X	
2.60 F. Heat Pumps					
2.61. Install outdoor unit on concrete pad with consideration given for snow and ice accumulation............	X	X	X	X	
2.62. Install indoor unit with proper sound baffling........		X	X	X	
2.63. Install supplemental heat section in indoor unit.....		X	X	X	
2.64. Install indoor thermostat.............................	X	X	X	X	
2.65. Install outdoor thermostat (if used).................	X	X	X	X	
2.66. Install all low voltage wiring from schematic wiring diagram....................................		X	X	X	
2.67. Install refrigeration lines..........................	X	X	X	X	
2.68. Use pressure-temperature methods to check out reversing valve..		X	X	X	
2.69. Use steel tool to check magnetism of reversing valve solenoid..	X	X	X	X	
2.610. Check defrost timer clock for operation..............	X	X	X	X	
2.611. Check defrost control sensing bulb for good contact with outdoor coil.................................	X	X	X	X	
2.612. Test check valves with magnet (unit off).............		X	X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
2.613. Test for temperature difference across check valve (unit on)		X	X	X	
2.614. Check refrigerant pressures		X	X	X	
2.615. Check electric resistance elements for proper operation		X	X	X	
2.616. Test complete system for refrigerant leaks	X	X	X	X	
00 III. Refrigeration					
3.10 A. Tools and Materials					
3.11. Use hand tools (flaring, swaging, bending)	X	X	X	X	
3.12. Work with materials (tubing, refrigerants)	X	X	X	X	
3.13. Use test instruments (gauges, thermometers)		X	X	X	
3.20 B. Mechanical Compression Systems					
3.21. Recognize cycle components		X	X	X	
3.22. Connect cycle components to form a complete cycle		X	X	X	
3.23. Operate a cycle using a capillary tube, an AEV, a TEV.		X	X	X	
3.24. Record pressures and temperatures	X	X			
3.25. Observe cycle component behavior		X	X	X	
3.26. Leak test a system using three methods of detection		X	X	X	
3.27. Evacuate a system using a vacuum pump		X			
3.28. Charge a system		X	X	X	
3.30 C. Motors and Controls					
3.31. Recognize various types of motors		X	X	X	
3.32. Install and wire (connect) an electric motor (use unit diagram)		X	X	X	
3.33. Wire in different types of starting relays (use diagram)		X	X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
3.34. Install a thermostat	X	X	X	X	
3.35. Have a knowledge of various defrost systems		X	X	X	
3.36. Connect a defrost system		X	X	X	
3.37. Install an ice maker		X	X	X	
3.40 D. Refrigerated Cabinets					
3.41. Recognize key features of different styles and models		X	X	X	
3.42. Check and service a cabinet		X	X	X	
3.50 E. Repair of Cabinets and Mechanisms - Mechanical					
3.51. Replace a compressor			X	X	
3.52. Repair a condenser			X	X	
3.53. Repair leaking evaporator			X	X	
3.54. Replace a defrost heater			X	X	
3.55. Replace a defrost timer		X	X	X	
3.56. Repair a system leak and recharge			X	X	
3.57. Repair a restricted capillary tube			X	X	
3.58. Diagnose a system that has an inefficient compressor			X	X	
3.60 F. Troubleshoot and Repair Cabinets and Mechanisms - Electrical					
3.61. Check and replace a defective start relay			X	X	
3.62. Check and replace a defective hermetic compressor			X	X	
3.63. Check and replace defective run and start capacitors			X	X	
3.64. Check and repair a defective ice maker				X	
3.65. Check and replace a hermetic compressor after a burn-out				X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL

Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
. Refrigeration					
3.70 G. Commercial Refrigeration Systems					
3.71. Diagram an electrical wiring system from the disconnect switch			X	X	X
3.72. Select wire size for each circuit			X	X	X
3.73. Locate motor control and electrical troubles			X	X	
3.74. Read trouble analysis charts			X	X	
3.75. Recognize and correct compressor troubles, low charge, overcharge, high heat, and high head pressure		X	X	X	
3.76. Know purpose and application of multiple evaporator systems			X	X	
3.77. Select major components and arrangements of multiple evaporator systems			X	X	X
3.78. Install and adjust evaporator pressure regulator, EPR valves and refrigerant controls			X	X	
3.79. Select and know when to use internal equalizer, external equalizer, and pressure limiter thermostatic expansion valves			X	X	
3.710. Install and adjust head pressure controls if condensors are exposed to outdoor weather temperature			X	X	
3.711. Know types and purpose of heat exchangers			X	X	
3.712. Know where and when heat exchangers should and should not be installed		X	X	X	
3.713. Know advantages of accumulators and where to install		X	X	X	
3.714. Know type and purpose of oil separators, their location, and installation requirements		X	X	X	
3.715. Determine the correct storage life, temperature, and humidity of various commodities			X	X	X
3.716. Know reason for evacuating a refrigeration system		X	X	X	

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS

BY JOB LEVEL

Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
3.717. Know evacuating procedures		X	X	X	
3.718. Know charging procedures and determine correct charge.		X	X	X	
3.719. Charge a comfort cooling unit		X	X	X	
3.80 H. Refrigeration Servicing					
3.81. Adhere to safety rules pertaining to handling of refrigerants and electrical circuits	X	X	X	X	
3.82. Read and follow piping blueprints and electrical schematics	X	X	X	X	
3.83. Be able to service or suitably replace electrical and mechanical refrigeration components			X	X	
3.84. Locate malfunctioning components in a refrigeration system			X	X	
3.85. Organize a systematic method of repair of the malfunctioning component			X	X	
3.86. Install refrigeration systems	X	X	X	X	
00 IV. Air Distribution					
4.10 A. Air Handler					
4.11. Set air handler		X			
4.12. Level air handler	X	X	X	X	
4.13. Tighten screws and bolts	X	X	X	X	
4.14. Install air filters	X	X	X	X	
4.15. Install and align drive system		X	X	X	
4.16. Wire motor		X	X	X	
4.17. Start and check rotation and RPM		X	X	X	
4.18. Check amperage and voltage		X	X	X	
4.19. Install condensate drain piping		X	X	X	
4.110. Check for proper drainage	X	X	X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL

		Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
4.20	B. Duct System					
	4.21. Properly design duct system				X	
	4.22. Install duct system from working drawings	X	X			
	4.23. Check all hangers, joints, and dampers		X	X	X	
	4.24. Insulate duct system	X	X			
	4.25. Cut openings for ducts, diffusers, and grills	X	X			
	4.26. Install diffusers and grills	X	X			
	4.27. Balance system for proper quantity and direction of air flow		X	X	X	X
	4.28. Adjust mechanical and electric controls				X	X
	4.29. Apply good safety rules	X	X	X	X	X
4.30	C. Exhaust and Make-up Air System					
	4.31. Cut proper openings	X	X			
	4.32. Set fan and/or louvers	X	X			
	4.33. Check and adjust air quantities		X	X	X	
00	V. Air Treatment					
5.10	A. Checking Condition of Air					
	5.11. Use psychrometer			X	X	X
	5.12. Use psychrometric charts and tables			X	X	X
	5.13. Check volume of air (to determine make-up)			X	X	X
	5.14. Determine enthalpy				X	X
5.20	B. Humidification					
	5.21. Install humidifier	X	X	X	X	
	5.22. Service humidifier				X	
	5.23. Size and select humidifier				X	X

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL

	Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
5.30	C. Dehumidifying Air					
	5.31. Install dehumidifier	X	X		X	
	5.32. Service dehumidifier				X	
	5.33. Size and select dehumidifier					X
5.40	C. Cleaning Air					
	5.41. Install and service filters	X	X	X	X	
	5.42. Install or service electrostatic filters		X	X	X	
	5.43. Install and service electronic air cleaners			X	X	
	5.44. Install viscous filters			X	X	
0 VI.	Controls					
6.10	A. Wiring Diagrams					
	6.11. Recognize and use the symbols of a control diagram		X	X	X	X
	6.12. Compose a schematic diagram of control systems			X	X	X
	6.13. Compare mechanical control elements		X	X	X	X
	6.14. Illustrate the differences between mechanical, electrical, electronic, and pneumatic controls			X	X	X
	6.15. Use schematic diagrams in the process of diagnosing control problems in equipment			X	X	
6.20	B. Test Equipment					
	6.21. Use test equipment for checking controls			X	X	X
	6.22. Diagnose problems in control circuits			X	X	
	6.23. Test and replace oil burner controls			X	X	
	6.24. Test and replace gas burner controls			X	X	
	6.25. Test and replace electric heat controls and elements			X	X	
	6.26. Diagnose zone control systems			X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
6.30 C. Components					
6.31. Recognize the different types of relays and their applications			X	X	
6.32. Identify the types of unit-heater control systems, unit-ventilator control methods, outdoor thermostat controls				X	
6.33. Install and calibrate a thermostat			X	X	
6.34. Determine component coordination and operational sequence			X	X	
6.35. Install electric pneumatic controls for domestic and commercial heating and cooling		X	X	X	
6.36. Identify the types of controls and their function in domestic and commercial refrigeration			X	X	
6.40 D. Refrigerant Controls					
6.41. Replace and repair refrigerant controls for refrigeration and air conditioning			X	X	
6.42. Use solenoid valves, modulating controls, and three-way valves to control the distribution of refrigerant.			X	X	
6.50 E. Wiring and Controls					
6.51. Determine ampere draw and install proper relay to control fractional horsepower motors			X	X	
6.52. Determine ampere draw and install proper contactor for larger horsepower motors			X	X	
6.53. Install electric solenoid valve for pump down control on commercial refrigeration system			X	X	
6.54. Wire electric solenoid from wiring schematic		X	X	X	
6.55. Install motor overload on domestic freezer or refrigerator	X	X	X		
6.56. Wire internal motor overload on air conditioner			X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY JOB LEVEL

Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
6.57. Wire external motor overload on air conditioner.......			X	X	
6.58. Mount bi-metallic thermostat in proper location for air conditioner..........		X	X	X	
6.59. Wire bi-metallic thermostat into control system using wiring schematic..........		X	X		
6.510. Install temperature type thermostat on domestic refrigerator or freezer..........			X	X	
6.511. Install pressure type thermostat on commercial refrigeration system..........		X	X	X	
6.512. Wire high-low pressure switch on commercial refrigeration system from wiring schematic..........		X	X	X	
OOVII. Duct Fabrication and Installation					
7.10 A. Fabrication					
7.11. Interpret ductwork on plans and working drawings....		X		X	X
7.12. Use fabricating tools and machinery	X	X			
7.13. Lay out and make square and round fittings..........		X			
7.14. Insulate ducts - interior and exterior..........	X	X			
7.20 B. Installation					
7.21. Hang ducts..........	X	X			
7.22. Use devices for fastening and joining ducts..........	X	X			
7.23. Seal and insulate joints and seams..........	X	X			
7.24. Install duct accessories, grills, registers, dampers, boots, and take offs..........	X	X			
7.25. Apply duct insulation..........	X	X	X		
OOVIII. Costing and Estimating					

8 A. Cost Factors

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY JOB LEVEL

	Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
	8.11. Interpret construction prints for all types of construction for cost estimating purposes		X			X
	8.12. Calculate time and labor costs				X	X
	8.13. Calculate overhead				X	X
	8.14. Calculate travel time and lodging				X	X
	8.15. Calculate profit required				X	X
.20	B. Procurement					
	8.21. Know where to procure materials		X	X	X	X
	8.22. Determine lead time for materials				X	X
.30	C. Pricing Factors					
	8.31. Know advertising procedure for bids					X
	8.32. Calculate contract price of turnkey job					X
	8.33. Procure and contract with subcontractors					X
	8.34. Procure cost of permits					X
.40	D. Specification Factors					
	8.41. Must understand codes for pricing purposes					X
	8.42. Determine costs of bid bonds and performance bond					X
IX.	Energy Conservation					
.10	A. Mechanical Systems					
	9.11. Use applicable equipment to maintain peak operating efficiency				X	
	9.12. Clean air cooled condenser			X	X	
	9.13. Clean water cooled condenser			X	X	
	9.14. Treat circulating water			X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL

Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
9.15. Clean furnace heat exchangers			X	X	
9.16. Lubricate moving parts where required			X	X	
9.17. Inspect and replace belts			X	X	
9.18. Clean boilers			X	X	
9.19. Clean and replace air/fuel filters			X	X	
9.110. Clean and replace fuel jets			X	X	
9.111. Evaluate source of air supply for heating system			X	X	
9.112. Charge air conditioning systems			X	X	
9.113. Evaluation system for retrofit					X
9.114. Determine feasibility of adding heat recovery system				X	X
9.115. Locate equipment for maximum energy efficiency				X	X
9.116. Adjust primary air to obtain proper CO_2 and flue gas temperature		X		X	
9.117. Adjust blower for proper cfm		X		X	
B. Electrical Systems					
9.21. Clean controls			X		
9.22. Install thermostats and timers	X	X	X		
9.23. Explain energy efficiency ratios			X	X	
9.24. Compute power used by a system			X	X	
9.25. Measure power used by a system			X	X	
9.26. Advise owner of benefits of additional controls			X	X	
C. Records					
9.31. Maintain system performance records		X	X		
9.32. Maintain system maintenance records		X	X		
9.33. Record system variables for evaluating energy utilization			X	X	
9.34. Analyze charts to determine system efficiencies			X	X	

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer		
D. Public Relations							
9.41. Explain energy conservation features of systems to customers		X		X	X		
9.42. Inform owner of saving method				X	X		
9.43. Discuss features of alternative energy systems				X	X		
E. Insulation Materials							
9.51. Evaluate existing insulation				X	X		
9.52. Determine additional requirements to meet energy efficiency standards				X	X		
9.53. Determine building orientation, shading, landscaping for new construction					X		
9.54. Evaluate new insulation type and installation procedures					X		
F. Oil Burner - Efficiencies							
9.61. Determine the heat content of each type of oil			X	X	X		
9.62. Evaluate the advantages and disadvantages of the oil by the grade of oil				X	X		
9.63. Determine the components needed to handle a certain grade of oil				X	X		
9.64. Identify the type of burner being used and those things required to burn the oil completely			X	X	X		
9.65. Determine the advantage of each type of burner				X	X		
9.66. Determine the size nozzle to use and how much fuel can be burned in the combustion chamber				X	X		
9.67. Determine the amount of air required to burn the oil			X	X	X		
9.68. Determine the proper ventilation for the furnace or boiler room				X	X		

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL

	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer	
9.69. Know the chemicals needed for complete combustion and why excess air is required..........................				X	X	
9.610. Know the by-products of combustion and how to use instruments to measure the CO_2 level..................			X	X		
9.611. Determine from the shape of the combustion chamber the angle of the nozzle needed..........................			X	X		
9.612. Place the burner in proper location in the combustion chamber..			X	X		
9.613. Adjust the burner oil pressure and adjust the air supply so that the proper CO_2 can be reached...........				X		
9.614. Use the smoke spot tester to determine if any sooting is taking place..			X	X		
9.615. Determine if the blast tube and turbulator are properly set...			X	X		
9.616. Measure combustion draft and make changes necessary for proper draft..			X	X		
.70 G. Gas Burner - Efficiencies						
9.71. Calculate heat load..			X	X		
9.72. Size chimney for draft and combustion..........................				X	X	
9.73. Install gas burner according to code..........................		X	X			
9.74. Size fuel piping to match pressure and BTU....................		X	X	X		
9.75. Install electrical wiring and controls for maximum conservation..		X	X			
9.76. Troubleshoot and service gas burners to optimize performance...			X	X		
0 X. Design						
.10 A. Hydronic Distribution Systems						
.11. Design four different types of hydronic systems......			X	X	X	

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer	
10.12. Estimate water temperature requirements for a given application					X	
10.13. Select all equipment and components for a given application					X	
10.14. Choose the correct size chiller and/or boiler					X	
10.15. Estimate hot water requirements for domestic or potable purposes					X	
10.16. Select the type of domestic or potable water heating system best suited for a particular application					X	
10.17. Estimate pipe sizes for entire system					X	
10.18. Select proper pipe insulation					X	
10.19. Design a cooling tower installation					X	
10.110. Select pump capacity and types					X	
10.111. Estimate all pipe sizes, including valves and accessories					X	
10.112. Evaluate all work done against industry standards and various codes				X	X	
10.20 B. Hydronic Systems Balance						
10.21. Measure water temperatures in various sections of systems			X	X	X	
10.22. Measure water flow in specified sections of systems			X	X	X	
10.23. Use a wide variety of instruments in testing, adjusting, and balancing a properly designed and installed system				X	X	
10.24. Compare several designs and applications					X	
10.25. Choose the best design for a specific system					X	
10.26. Evaluate effect on operation and efficiency of a specific system, with possible revision to maximize efficiency				X	X	

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer		
10.27. Measure water temperature at various terminal units to determine BTU output..........			X	X	X		
10.28. Construct a system curve based on water flow..........					X		
10.29. Use pump curves to estimate flow rate and head.......				X	X		
10.210. Evaluate overall efficiency of a system under test, both before and after test and balance has been performed to assure optimum performance..............				X	X		
10.30 C. Gas Piping							
10.31. Demonstrate a knowledge and understanding of the American Gas Association (A.G.A.). Recommended procedures for gas piping and appliance installation and the N. C. State Building Code, Volume III, Chapter XIV, Section 1400-1415..........................				X	X		
10.32. Select the proper size gas piping for any specified application..				X	X		
10.33. Correctly estimate the size, type and quantity of fittings required..................................				X	X		
10.34. Select the correct vent material and size for any given application..................................				X	X		
10.35. Estimate the correct amount of combustion and ventilation air for any given application................			X	X	X		
10.36. Evaluate a given system and specify the net clearances required by code..................................		X	X	X	X		
10.40 D. Transport Refrigeration							
10.41. Choose the best type system for a specified application..					X		
10.42. Compare various methods of air distribution used in transport refrigeration..............................					X		

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer	
10.43. Select all special equipment and controls required to meet the needs of various types of transport refrigeration					X	
10.44. Accurately estimate or calculate the load requirements of a specified transport refrigeration application					X	
10.45. Select the correct size system for the application specified					X	
10.46. Analyze and solve theoretical and practical design problems in existing and proposed systems					X	
10.50 E. Commercial Refrigeration Systems						
10.51. Calculate the refrigeration load requirements for commercial refrigeration applications				X	X	
10.52. Choose the proper condensing unit					X	
10.53. Select the correct evaporator coil assembly					X	
10.54. Select the proper operating and safety controls for a given application					X	
10.55. Inspect, test and analyze existing systems				X	X	
10.56. Estimate the materials required to construct a given walk-in cooler					X	
10.57. Measure the internal volume of a given unit and estimate the actual storage capacity of various products				X	X	
10.58. Design a proper refrigerant piping system			X		X	
10.59. Diagram the piping system illustrating all components thereof				X	X	
10.510. Estimate the average compressor running time for any given commercial refrigeration application				X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer	
10.60 F. Industrial Refrigeration Systems						
10.61. Estimate the cooling load requirements for industrial refrigeration applications...........................					X	
10.62. Differentiate between various types of refrigeration equipment and systems................................					X	
10.63. Demonstrate a working knowledge of the fundamentals of industrial refrigeration theory and application...			X	X	X	
10.64. Analyze the pressure-temperature relationship........			X	X	X	
10.65. Compare and select the best refrigerant for specified applications..				X	X	
10.66. Compare theoretical and actual capacities............				X	X	
10.67. Design a refrigerant piping system for a specified application...				X	X	
10.68. Select all system components, including all operating and safety controls..................................					X	
10.69. Evaluate the function of condensing systems, heat rejection systems, and the components thereof.........					X	
10.610 Plan the duties of a plant operating engineer........					X	
10.70 G. Residential Air Conditioning Systems						
10.71. Calculate the heating and cooling needs of a residence..				X	X	
10.72. Select the proper equipment to meet the estimated needs..					X	
10.73. Choose operating and safety controls.................					X	
10.74. Prepare data for load calculations to be made by computer..					X	
10.75. Calculate the humidity requirements for a residence..					X	
10.76. Select humidifier and controls.......................					X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
10.77. Analyze existing systems for alterations to conserve energy..				X	X
0.80 H. Residential Air Distribution					
10.81. Demonstrate an understanding of air movement in a distribution system................................				X	X
10.82. Measure and calculate air volume.....................				X	X
10.83. Measure and calculate air velocities................				X	X
10.84. Estimate blower capacity and air quantities required.				X	X
10.85. Estimate and measure friction loss..................				X	X
10.86. Correctly size and lay out an air distribution system					X
10.87. Balance an existing residence system................				X	X
10.88. Appraise a residential air distribution system and distinguish between good and bad systems............				X	X
10.89. Make recommendations as may be indicated for improving an unsatisfactory residential air distribution system..				X	X
0.90 I. Commercial Air Conditioning Systems					
10.91. Calculate the heating and/or cooling requirements of a commercial type structure........................					X
10.92. Select the correct size and type of heating and/or cooling equipment to meet these requirements.........					X
10.93. Interpret a psychrometric chart to measure the state of mixture of two (or more) air streams.............				X	X
10.94. Use various engineering data in the form of charts, tables and graphs to evaluate specific heat, humidification and dehumidification.......................				X	X
10.95. Calculate humidity requirements and select humidifier with control system for type of heating system employed..					X

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL

Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer	
10.96. Evaluate a commercial air conditioning system for maximum energy utilization and conservation..........					X	
10.97. Determine air flow requirements....................				X	X	
10.100 J. Commercial Air Distribution Systems						
10.101. Accurately calculate air flow requirements...........				X	X	
10.102. Demonstrate knowledge and understanding of air and its behavior in a commercial air distribution system.					X	
10.103. Design a simple constant velocity system............					X	
10.104. Design a simple velocity reduction system...........					X	
10.105. Design a simple equal friction system..............					X	
10.106. Design a simple static regain system...............					X	
10.107. Compare the four systems and evaluate each..........					X	
10.108. Select the best system for a specific application....					X	
10.109. Calculate individual room air volume requirements....					X	
10.1010. Select proper diffusers, registers and grills........					X	
10.1011. Design a complex equal friction system.............					X	
10.1012. Calculate air requirements for each outlet..........					X	
10.1013. Calculate air volume and velocity in each section of duct..					X	
10.1014. Calculate friction loss for each component and all ductwork....................................					X	
10.1015. Determine blower capacity requirements..............					X	
10.1016. Use instruments in testing, adjusting and balancing various air distribution systems for commercial use..				X	X	
10.1017. Evaluate air motion within a conditioned commercial area using modern instrumentation..................				X	X	
10.1018. Make recommendations as may be indicated for improving a unsatisfactory commercial air distribution system..				X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY JOB LEVEL

	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer	
10.110 K. Electric Heat Systems						
10.111. Calculate the heat loss in wattage on a room basis for a structure					X	
10.112. Select the most appropriate type of system of a particular application					X	
10.113. Choose the correct operating and safety controls for the system selected					X	
10.114. Design and lay out the complete system					X	
10.115. Demonstrate the ability to inspect and test systems and components for safe and proper operation				X	X	
10.116. Correct problems with electric heat system, its design or any component thereof				X	X	
10.117. Compare and evaluate various systems				X	X	
10.118. Estimate approximate annual operating cost					X	
10.119. Measure efficiency of any electric heat system				X	X	
10.1110. Make recommendations as may be indicated for greater energy conservation and/or comfort				X	X	
10.120 L. Solar Heating and Cooling Systems						
10.121. Demonstrate an understanding of terminology associated with solar energy					X	
10.122. Determine promising applications of solar energy					X	
10.123. Evaluate the economics and performance of solar systems					X	
10.124. Estimate average energy availability at the earth's surface					X	
10.125. Differentiate between climatic constants in different areas					X	
10.126. Select collectors					X	
10.127. Select storage medium					X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer		
10.128. Determine collector orientation......................							
10.129. Compare concentration systems......................					X		
10.1210. Evaluate solar water heating......................					X		
10.1211. Compare solar air conditioning and dehumidification systems......................					X		
10.1212. Assess types of solar power generation......................					X		
10.1213. Perform F-chart analysis......................							
10.1214. Solve design problems in existing and proposed solar heating/cooling systems......................					X		
0.130 M. Automotive Air Conditioning							
10.131. Install gauge manifold......................				X			
10.132. Interpret pressure readings......................				X			
10.133. Determine correct refrigerant level......................				X			
10.134. Identify component failure......................				X			
10.135. Use sling psychrometer to obtain wet bulb temperature......................				X			
10.136. Know oil type and amount required for system lubrication......................				X			
10.137. Know how to replace components, evacuate, and recharge systems......................				X			
10.138. Use electrical schematics......................				X			
10.139. Check fuses......................				X			
10.1310. Check for open circuits......................				X			
10.1311. Check for grounding (shorts)......................				X			
10.1312. Demonstrate air by-pass and diversion from outside vents to bi-level, defrost, heating, and cooling....				X			
10.1313. Perform miscellaneous service, i.e., drains, belts, vibration, drives, bolts and nuts, and cleaning process......................				X			

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY JOB LEVEL

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer		
1.00 XI. Drafting and Blueprint Reading							
11.10 A. Planning							
11.11. Organize activities for efficiency					X		
11.12. Outline data for use					X		
11.20 B. Sketching							
11.21. Sketch objects		X		X	X		
11.22. Sketch working drawings		X		X	X		
11.30 C. Technical Drawing							
11.31. Use drafting equipment					X		
11.32. Draw objects so as to describe their shape through orthographic, pictorial, sectional, and/or auxilary view techniques					X		
11.33. Use scales to describe the size of an object					X		
11.34. Do lettering and dimensioning					X		
11.40 D. Blueprint Reading							
11.41. Visualize shapes of objects		X		X	X		
11.42. Determine dimensions		X		X	X		
11.43. Interpret specifications		X		X	X		
11.44. Know meanings of lines and symbols	X	X	X	X	X		
11.50 E. Graphics							
11.51. Prepare charts and graphs					X		
11.52. Develop diagrams				X	X		
11.53. Develop maps, pictures, and/or drawings					X		

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
12.00 XII. Mathematics					
12.10.A. General Math					
12.11. Perform basic operations		X	X	X	X
12.12. Perform operations involving fractions, decimals, and percentages		X	X	X	X
12.20 B. Measurement					
12.21. Use English system	X	X	X	X	X
12.22. Use Metric system	X	X	X	X	X
12.30 C. Algebra					
12.31. Perform basic operations			X	X	X
12.32. Perform advanced operations					X
12.40 D. Geometry					
12.41. Use plain and solid figures			X	X	X
12.42. Determine area and volume			X	X	X
12.50 E. Trigonometry					
12.51. Peform basic operations				X	X
12.52. Perform advanced operations					X
13.00 XIII. Safety and First Aid					
13.10 A. Safety					
13.11. Use safety equipment	X	X	X	X	X
13.12. Know and abide by safety rules and regulations	X	X	X	X	X
13.13. Locate and switch off the master power switch	X	X	X	X	X

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer	
13.14. Perform safe evacuation from shop	X	X	X	X	X	
13.15. Protect equipment and personnel from unsafe conditions		X	X	X	X	
13.20 B. First Aid						
13.21. Perform simple first aid procedures	X	X	X	X	X	
13.22. Know location of first aid kit	X	X	X	X	X	
14.00 XIV. Welding						
14.10 A. Oxyacetelyne						
14.11. Perform soldering operations		X	X	X		
14.12. Perform brazing operations		X	X	X		
14.13. Perform welding operations		X	X	X		
14.14. Perform cutting operations		X	X	X		
14.20 B. Arc						
14.21. Set up equipment		X				
14.22. Select electrode			X	X		
14.23. Perform welding operation			X	X		
15.00 XV. Science						
15.10 A. Units and Measurements						
15.11. Identify units of length, weight and volume	X	X	X	X	X	
15.12. Estimate the length and weight of objects in metric units	X	X	X	X	X	
15.13. Convert from inches to mm or cm and from lb. to kg	X	X	X	X	X	
15.14. Convert from in^3 to cm^3	X	X	X	X	X	
15.15. Perform measurements using British or metric machinist rules	X	X	X	X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL

Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer		
15.16. Perform measurements using British or metric micrometer calipers	X	X	X	X	X		
15.17. Perform measurements using British or metric venier calipers	X	X	X	X	X		
15.18. Use the correct number of significant figures							
15.19. Estimate error in measurements and calculations							
15.20 B. Properties of Materials							
15.21. Use tables of density, specific gravity, and specific heat			X	X	X		
15.22. Read gauges and meters			X	X	X		
15.23. Make measurements to determine density or specific gravity			X	X	X		
15.24. Measurements to determine tensile strength					X		
15.25. Apply terms relating to properties of materials					X		
15.26. Calculate density, specific gravity, and specific heat					X		
15.27. Calculate temperature, volume, and pressure changes in a gas			X	X	X		
15.28. Relate densities to buoyancy and flotation					X		
15.29. Follow directions, both oral and written, from lab experiences	X	X	X	X	X		
15.210. Graph and interpret graphs			X	X	X		
15.30 C. Mechanics							
15.31. Measure the power output of a rotating shaft			X	X	X		
15.32. Determine the efficiency of a machine			X	X	X		
15.33. Determine the energy required to do a given job				X	X		
15.34. Calculate velocity, distance or time				X	X		

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
15.35. Calculate acceleration, change in velocity or time..				X	X
15.36. Identify all forces acting on a body................				X	X
15.37. Determine force required to start or stop a body....				X	X
15.38. Identify causes of inefficiency in a machine........			X	X	X
15.40 D. Heat					
15.41. Select correct thermometric device..................			X	X	X
15.42. Use a thermometeric device to determine temperature.			X	X	X
15.43. Calibrate thermometer...............................			X	X	X
15.44. Calculate linear expansion and apply to job at hand.			X	X	X
15.45. Calculate volume expansion of materials and apply to job at hand......................................				X	X
15.46. Calculate or estimate heat absorbed and given up due to a temperature change..............................				X	X
15.47. Calculate or estimate heat produced in a mechanical operation..				X	X
15.50 E. Light and Sound					
15.51. Determine the efficiency of a light fixture.........					X
15.52. Lay out a simple lighting system....................					X
15.53. Predict the results of additive color mixing........					X
15.54. Predict the results of subtractive color mixing......					X
15.55. Determine the reverberation time of a room..........					X
15.56. Analyze the performance of a loud speaker...........					X
15.57. Measure and evaluate noise level....................			X	X	
15.58. Calculate BTU gain or loss from a structure.........			X	X	X
15.60 F. Electricity and Magnetism					
15.61. Install meters and take readings....................			X	X	X

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY JOB LEVEL

Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
15.62. Set up simple circuits			X	X	X
15.63. Test with an ohmeter			X	X	X
15.64. Convert joules to foot-pounds				X	X
15.65. Convert joules to calories				X	X
15.66. Convert watts to horsepower			X	X	X
15.67. Determine cost of electrical energy used				X	X
15.68. Replace blown fuses		X	X	X	X
15.69. Determine wire size		X	X	X	X
15.610. Use an electromagnet				X	X
15.611. Use an induction coil			X	X	X
15.612. Charge a lead storage battery			X	X	X
15.613. Use a transformer				X	X
15.614. Build an induction heater (furnace)				X	
15.615. Rectify alternating current				X	X
15.616. Use a capacitor to produce phase shift			X	X	X
15.617. Use a variable resistor to control current			X	X	X
15.618. Use an oscilloscope				X	
15.619. Determine charge of lead battery with a hydrometer	X	X	X	X	X
15.620. Use Ohm's law to find resistance			X	X	X
15.621. Use a relay			X	X	X
15.622. Use generator			X	X	X
15.623. Use an electric motor				X	X
15.624. Build a copper-wire cell				X	X
15.625. Ground an electrical device		X	X	X	X
15.626. Determine the impedance of a coil			X	X	X
15.627. Show lines of force of a magnet			X	X	X
15.628. Determine compound resistances			X	X	X
15.629. Determine how voltages combine		X	X	X	X
15.630. Determine how currents combine		X	X	X	X
15.631. Determine that like charges repel, etc		X	X	X	X

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer		
15.632. Determine the power used by a lamp, etc.		X	X	X	X		
15.633. Find the resistivity of a metal		X	X	X	X		
15.634. Determine the electrical equivalent of heat		X	X	X	X		
15.635. Find the horsepower of a motor		X	X	X	X		
15.636. Use the laws of transformers		X	X	X	X		
15.637. Explain the operation of a voltmeter or ammeter				X	X		
15.638. Find the field lines around a current-carrying wire		X	X	X	X		
15.639. Use the National Electric Code Handbook		X	X	X	X		
15.70 G. Auxillary							
15.71. Plot a graph			X	X	X		
15.72. Read a graph		X	X	X	X		
15.73. Read diagrams and charts (pie charts and histograms, for example)	X	X	X	X	X		
15.74. Perform the four basic arithmetic functions	X	X	X	X	X		
15.75. Extract a square root				X	X		
15.76. Add inverses			X	X	X		
16.00 XVI Communications							
16.10 A. Reading							
16.11. Read manuals, workbooks, work orders and memos	X	X	X	X	X		
16.12. Read books in the field	X	X	X	X	X		
16.13. Read the bulletin board and company publications	X	X	X	X	X		
16.14. Look up words in the dictionary	X	X	X	X	X		
16.15. Read articles in trade journals	X	X	X	X	X		
16.16. Read and interpret written instructions	X	X	X	X	X		
16.20 B. Writing							
16.21 Write reports, work orders, memos and instructions		X		X	X		

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY JOB LEVEL

	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
16.22. Make written application for employment - include resume	X	X	X	X	X
16.23. Fill out a job application form	X	X	X	X	X
16.24. Write a business letter				X	X
16.25. Spell major terms related to job		X		X	X
16.26. Write legibly	X	X	X	X	X
16.27. Complete requisitions and purchase orders		X		X	X
16.28. Make out a bill for goods sold		X		X	X
16.30 C. Talking					
16.31. Give oral directions		X		X	X
16.32. Speak to a small group		X		X	X
16.33. Solve problems by asking questions	X	X	X	X	X
16.34. Make suggestions to superiors - constructively	X	X	X	X	X
16.35. Talk on the telephone in a job setting		X		X	X
16.36. Participate in discussions	X	X	X	X	X
16.37. Report orally on work		X	X	X	X
16.38. Show conversational courtesy to others	X	X	X	X	X
16.40 D. Listening					
16.41. Listen for correct meaning	X	X	X	X	X
16.42. Listen for information and directions	X	X	X	X	X
16.43. Listen to understand a person	X	X	X	X	X
16.44. Listen to share feelings	X	X	X	X	X
16.50 E. Visual Interpretation					
16.51. Be aware of surroundings	X	X	X	X	X
16.52. Recognize problems and dangers	X	X	X	X	X
16.53. Interpret signs, symbols, posters, and other visuals	X	X	X	X	X
16.54. Interpret freehand sketches and diagrams	X	X	X	X	X

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY JOB LEVEL

Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
17.00 XVII Professional Practice					
17.10 A. Business Management					
17.11. Maintain good relations with other employees	X	X	X	X	X
17.12. Keep records of customers on file			X	X	
17.13. Maintain good public relations	X	X	X	X	X
17.14. Compute overhead cost of each job				X	X
17.15. Know local, state, and federal regulations pertaining to equipment to be used				X	X
17.20 B. Ethics					
17.21. Respect competitors in same field				X	X
17.22. Feel obligation to public to do a good job	X	X	X	X	X
17.23. Have obligation to employee to give fair treatment				X	X
17.24. Knows the value of work competently done	X	X	X	X	X
17.25. Respects laws, rules, and regulations which must be observed	X	X	X	X	X
17.30 C. Standards					
17.31. Keep up-to-date records of changes				X	X
17.32. Keep in touch with manufacturer's recommendations				X	X
17.33. Know laws pertaining to equipment				X	X
17.34. Keep informed	X	X	X	X	X
17.35. Does those "plus" jobs	X	X	X	X	X
17.40 D. Marketing					
17.41. Aware of total cost of equipment				X	X
17.42. Know overhead cost to deliver and/or install material				X	X
17.43. Maintain list of available supplies to choose from				X	X
17.44. Aware of alternate systems to be used				X	X

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY JOB LEVEL

	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
17.45. Can explain health benefits related to installation of job				X	X
17.46. Analyzes what could be done to decrease cost of installation and operation without sacrificing quality				X	X
17.47. Can compute first cost of job relative to operational cost				X	X
18.00 XVIII Cultural Attributes					
18.10 A. Values					
18.11. Interested in being informed	X	X	X	X	X
18.12. Interested in becoming a better employee	X	X	X	X	X
18.13. Interested in concerns of employer	X	X	X	X	X
18.14. Careful in use of salary	X	X	X	X	X
18.15. Committed to personal and professional goals	X	X	X	X	X
18.16. Concerned for standard of living	X	X	X	X	X
18.17. Has desire to learn	X	X	X	X	X
18.20 B. Attitudes					
18.21. Has desire to please	X	X	X	X	X
18.22. Understands others' problems	X	X	X	X	X
18.23. Is willing to work hard to improve	X	X	X	X	X
18.24. Wants to fit into scheme of things	X	X	X	X	X
18.30 C. Philosophy					
18.31. Interested in all persons benefiting from improved working conditions by performing quality work efficiently	X	X	X	X	X
18.32. Consistent attitude toward all phases of work and private life	X	X	X	X	X

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY JOB LEVEL

Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
18.33. Has a definite purpose for working................	X	X	X	X	X
18.40 D. Humanistic and Social Skills					
18.41. Is dependable..................................	X	X	X	X	X
18.42. Understands all people........................				X	X
18.43. Has aggressiveness to get the job done..............	X	X	X	X	X
18.44. Is thorough in work habits........................	X	X	X	X	X
18.45. Is thoughtful of others' problems..................	X	X	X	X	X
9.00 XIX Interpersonal-Interacting Skills					
19.10 A. Leadership					
19.11. Is able to coordinate different phases of jobs.......				X	X
19.12. Is able to take as well as give clear, concise instructions in a business-like manner................		X	X	X	X
19.13. Completes job in a professional manner so company is complimented..................................	X	X	X	X	X
19.14. Motivates co-workers and helpers to accomplish objectives in least amount of time with quality retained..................................		X	X	X	X
19.15. Insures company equipment and supplies are not misused..................................	X	X	X	X	X
19.20 B. Teamsmanship					
19.21. Works well with other employees..................	X	X	X	X	X
19.22. Respects views and opinions of others...............	X	X	X	X	X
19.23. Does not openly discriminate......................	X	X	X	X	X
19.24. Is concerned with total company objectives...........	X	X	X	X	X
19.30 C. Personnel Management					
19.31. Understands and appreciates need for rules and regulations that are a function of good management practices.	X	X	X	X	X

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY JOB LEVEL

	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
19.32. Understands and follows chain of command..........	X	X	X	X	X
19.33. Decides who is to be assigned to job and how to best effect completion..................................		X	X	X	
19.40 D. Group Interaction					
19.41. Enjoys participation in group activities............	X	X	X	X	X
19.42. Has something to contribute to group...............	X	X	X	X	X
19.43. Understands that the good of the group should come first..	X	X	X	X	X
19.44. Aware of responsibilities of relating to individuals who are not as involved as they might be............	X	X	X	X	X
19.50 E. Salesmanship					
19.51. Understands and has knowledge of product and services to be sold..				X	X
19.52. Attentive to customer's "signals", moods, etc., and analyzing these, adjusts sales pitch to benefit sale.				X	X
19.53. Attempts to get best reasonable price for company....				X	X
19.54. Understands and appreciates fact that the better financial condition company is in, the better one's position..				X	X
20.00 XX Information Retrieval					
20.10 A. Recall					
20.11. The recall of basic ideas by memory games, word/object associations, and other techniques...........	X	X	X	X	X
20.12. Takes notes to help recall technical facts..........	X	X	X	X	X
20.13. Keeps log books for all jobs or installations that are not of the ordinary design......................		X		X	X

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY JOB LEVEL

Task	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer
20.20 B. Data Collecting					
20.21. Reads technical manuals and trade journals, then files according to predetermined system............			X	X	X
20.22. Keeps personal technical library.................				X	X
20.23. Collects manufacturers' releases and files in library.				X	X
20.24. Requests engineering data from related manufacturers' files for future use.............................				X	X
20.25. Removes installer's information sheets from new equipment and files under area and customer.........		X		X	X
20.30 C. Self Instruction					
20.31. Obtains subscriptions to trade journals............				X	X
20.32. Collects and files trade releases for new products for study and evaluation............................				X	X
20.33. Attends service schools sponsored by both industry and educational institutions..........................		X	X	X	X
20.34. Checks "junk mail" sent by manufacturing companies for new or improved products or designs or performance changes......................................			X	X	X
21.00 XXI Personal Skills and Traits					
21.10 A. Reliability					
21.11. Arrives on time................................	X	X	X	X	X
21.12. Keeps promises.................................	X	X	X	X	X
21.13. Follows orders intelligently..................	X	X	X	X	X
21.20 B. Thoroughness					
21.21. Willing to finish the job.....................	X	X	X	X	X
21.22. Listens carefully for complete instructions.........	X	X	X	X	X
21.23. Uses best information and tools available for job....	X	X	X	X	X

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS

BY JOB LEVEL

	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer	
21.30 C. Neatness						
21.31. Always cleans up after job is done	X	X	X	X	X	
21.32. Keeps tools in proper shape	X	X	X	X	X	
21.33. Dresses appropriately for the job	X	X	X	X	X	
21.34. Keeps hair well groomed and uniform clean	X	X	X	X	X	
21.40 D. Efficiency						
21.41. Looks for ways to save time and labor	X	X	X	X	X	
21.42. Completes tasks in appropriate period of time	X	X	X	X	X	
21.43. Looks for ways to save materials, use less expensive materials and not waste materials	X	X	X	X	X	
21.44. Looks for ways to decrease non-productive work	X	X	X	X	X	
21.50 E. Integrity						
21.51. Can be trusted at all times	X	X	X	X	X	
21.52. Provides accurate information about the job	X	X	X	X	X	
21.60 F. Honesty						
21.61. Can handle money safely	X	X	X	X	X	
21.62. Is careful and honest with time allotted	X	X	X	X	X	
21.70 G. Receptivity						
21.71. Accepts authority easily	X	X	X	X	X	
21.72. Accepts job assignments willingly	X	X	X	X	X	
21.73. Understands reason for job	X	X	X	X	X	
21.74. Takes time to get proper instructions and asks when there is doubt	X	X	X	X	X	

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY JOB LEVEL

	Installer's Helper	Installer	Service Technician's Apprentice	Service Technician	Designer	
21.80 H. Sensitivity						
21.81. Has a feel for human relations	X	X	X	X	X	
21.82. Responds to other's feelings constructively	X	X	X	X	X	
21.83. Explains that overall needs must be met despite some difference of opinion	X	X	X	X	X	
21.90 I. Practicability						
21.91. Has ability to keep proper perspective of job relations	X	X	X	X	X	
21.92. Uses good judgement in work decisions	X	X	X	X	X	
21.100 J. Friendliness						
21.101. Willing to accept other's viewpoints	X	X	X	X	X	
21.102. Meets new people easily	X	X	X	X	X	
21.103. Helps new personnel become productive	X	X	X	X	X	
21.110 K. Altruism						
21.111. Can place oneself in another's shoes	X	X	X	X	X	
21.112. Interested in employer, employee, and customer's concerns	X	X	X	X	X	

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TASKS BY JOB LEVEL

Tasks Required Of The Installer's Helper

Task Code	
1.11	Install storage tank above or below ground
1.12	Run oil line with filter and valves
1.13	Run vent and fill lines
1.15	Install oil heating equipment
1.16	Connect oil furnace to prefabricated or job erected flue
1.21	Install piping for gas line
1.23	Install gas heating equipment
1.24	Connect gas furnace to prefabricated or job erected vents and flues
1.34	Install electric heating equipment
2.31	Use basic hand tools
2.32	Use specialized tools
2.61	Install outdoor unit on concrete pad with consideration given for snow and ice accumulation
2.64	Install indoor thermostat for heat pump
2.65	Install outdoor thermostat (if used)
2.67	Install refrigeration lines
2.69	Use ammeter to check magnetism of reversing valve solenoid
2.610	Check defrost timer clock for operation
2.611	Check defrost control sensing bulb for good contact with outdoor coil
2.616	Test complete system for refrigerant leaks
3.11	Use hand tools (flaring, swaging, bending)
3.12	Work with materials (tubing, refrigerants)
3.24	Record pressures and temperatures in refrigeration system
3.34	Install a thermostat for refrigeration system
3.81	Adhere to safety rules pertaining to handling of refrigerants and electrical circuits
3.82	Read and follow piping blueprints and electrical schematics
3.86	Install refrigeration systems
4.12	Level air handler
4.13	Tighten screws and bolts on air handler
4.14	Install air filters
4.110	Check for proper drainage of air handler unit
4.111	Install vibration eliminators
4.22	Install duct system from working drawings
4.24	Insulate duct system
4.25	Cut openings for ducts, diffusers, and grills
4.26	Install diffusers and grills
4.29	Apply good safety rules
4.31	Cut proper openings for exhaust and make-up air systems
4.32	Set fan and/or louvers
5.21	Install humidifier
5.31	Install dehumidifier
5.41	Install and service filters
6.55	Install motor overload on domestic freezer or refrigerator
7.12	Use duct fabricating tools and machinery
7.14	Insulate ducts - interior and exterior

7.21 Hang ducts
7.22 Use devices for fastening and joining ducts
7.23 Seal and insulate joints and seams
7.24 Install duct accessories, grills, registers, dampers, boots, and takeoffs
7.25 Apply duct insulation
11.44 Know meaning of lines and symbols on blueprints
12.21 Use English system of measurement
12.22 Use metric system of measurement
13.11 Use safety equipment
13.12 Know and abide by safety rules and regulations
13.13 Locate and switch off the master power switch
13.14 Perform safe evacuation from shop
13.21 Perform simple first aid procedures
13.22 Know location of first aid kit
15.11 Identify units of length, weight and volume
15.12 Estimate the length and weight of objects in metric units
15.13 Convert from inches to mm or cm and from lb. to kg.
15.14 Convert from in^3 to cm^3
15.15 Perform measurements using British or metric machinist rules
15.16 Perform measurements using British or metric micrometer calipers
15.17 Perform measurements using British or metric venier calipers
15.29 Follow directions, both oral and written, from lab experiences
15.619 Determine charge of lead battery with a hydrometer
15.73 Read diagrams and charts (pie charts and histograms, for example)
15.74 Perform the four basic arithmetic functions
16.11 Read manuals, workbooks, work orders and memos
16.12 Read books in the field
16.13 Read the bulletin board and company publications
16.14 Look up words in the dictionary
16.15 Read articles in trade journals
16.16 Read and interpret written instructions
16.22 Make written application for employment-include resume'
16.23 Fill out a job application form
16.26 Write legibly
16.33 Solve problems by asking questions
16.34 Make suggestions to superiors - constructively
16.36 Participate in discussions
16.38 Show conversational courtesy to others
16.41 Listen for correct meaning
16.42 Listen for information and directions
16.43 Listen to understand a person
16.44 Listen to share feelings
16.51 Be aware of surroundings
16.52 Recognize problems and dangers
16.53 Interpret signs, symbols, posters, and other visuals
16.54 Interpret freehand sketches and diagrams
17.11 Maintain good relations with other employees
17.13 Maintain good public relations
17.22 Feel obligation to public to do a good job
17.24 Know the value of work competently done
17.25 Respect laws, rules, and regulations which must be observed
17.34 Keep informed
17.35 Do those "plus" jobs

18.11 Interested in being informed
18.12 Interested in becoming a better employee
18.13 Interested in concerns of employer
18.14 Careful in use of salary
18.15 Committed to personal and professional goals
18.16 Concerned for standard of living
18.17 Have desire to learn
18.21 Have desire to please
18.22 Understand others' problems
18.23 Be willing to work hard to improve
18.24 Want to fit into scheme of things
18.31 Interested in all persons benefitting from improved working conditions by performing quality work efficiently
18.32 Consistent attitude toward all phases of work and private life
18.33 Have a definite purpose for working
18.41 Be dependable
18.43 Have aggressiveness to get the job done
18.44 Be thorough in work habits
18.45 Be thoughtful of others' problems.
19.13 Complete job in a professional manner so company is complimented
19.15 Insure company equipment and supplies are not misused
19.21 Work well with other employees
19.22 Respect views and opinions of others
19.23 Will not discriminate
19.24 Be concerned with total company objectives
19.31 Understand and appreciate need for rules and regulations that are a function of good management practices
19.32 Understand and follows chain of command
19.41 Enjoy participation in group activities
19.42 Have something to contribute to group
19.43 Understand that the good of the group should come first
19.44 Be aware of responsibilities of relating to individuals who are not as involved as they might be
20.11 Recall basic ideas by memory games, word/object associations, and other techniques
20.12 Take notes to help recall technical facts
21.11 Arrive on time
21.12 Keep promises
21.13 Follow orders intelligently
21.21 Be willing to finish the job
21.22 Listen carefully for complete instructions
21.23 Use best information and tools available for job
21.31 Always clean up after job is done
21.32 Keep tools in proper shape
21.33 Dress appropriately for the job
21.34 Keep hair well groomed and uniform clean
21.41 Look for ways to save time and labor
21.42 Complete tasks in appropriate period of time
21.43 Look for ways to save materials, use less expensive materials and not waste materials
21.44 Look for ways to decrease non-productive work
21.51 Be trusted at all times
21.52 Provide accurate information about the job
21.61 Handle money safely
21.62 Be careful and honest with time allotted

21.71 Accept authority easily
21.72 Accept job assignments willingly
21.73 Understand reason for job
21.74 Take time to get proper instructions and asks when there is doubt
21.81 Have a feel for human relations
21.82 Respond to other's feelings constructively
21.83 Explain that overall needs must be met despite some difference of opinion
21.91 Have ability to keep proper perspective of job relations
21.92 Use good judgement in work decisions
21.101 Be willing to accept other's viewpoints
21.102 Meet new people easily
21.103 Help new personnel become productive
21.111 Place oneself in another's shoes
21.112 Interested in employer, employee, and customer's concerns

TASKS BY JOB LEVEL

Tasks Required of the Installer

(In Addition To Tasks Required Of Helper)

Task Code	
1.55	Determine combustion air requirements
1.56	Determine combustion by-products
1.57	Choose burner shape and nozzle to match heat exchanger
2.62	Install indoor heat pump unit with proper sound baffling
2.63	Install supplemental heat section in indoor heat pump unit
2.66	Install all low voltage wiring from schematic wiring diagram
2.68	Use pressure-temperature methods to check out reversing valve
2.612	Test check valves with magnet (unit off)
2.613	Test for temperature difference across check valve (unit on)
2.614	Check refrigerant pressures
2.615	Check electric resistance elements for proper operation
3.13	Use test instruments (gauges, thermometers)
3.21	Recognize refrigeration cycle components
3.22	Connect cycle components to form a complete cycle
3.23	Operate a cycle using a capillary tube, an AEV, a TEV
3.25	Observe cycle component behavior
3.26	Leak test a system using three methods of detection
3.27	Evacuate a system using a vacuum pump
3.28	Charge a system
3.31	Recognize various types of motors
3.32	Install and wire (connect) an electric motor (use unit diagram)
3.33	Wire in different types of starting relays (use diagram)
3.35	Have a knowledge of various defrost systems
3.36	Connect a defrost system
3.37	Install an ice maker
3.41	Recognize key features of refrigerated cabinets
3.42	Check and service a cabinet
3.55	Replace a defrost timer
3.75	Recognize and correct compressor troubles, low charge, overcharge, high heat, and high head pressure
3.712	Know where and when heat exchangers should and should not be installed
3.713	Know advantages of accumulators and where to install
3.714	Know type and purpose of oil separators, their location, and installation requirements
3.716	Know reason for evacuating a refrigeration system
3.717	Know evacuating procedures
3.718	Know charging procedures and determine correct charge
3.719	Charge a comfort cooling unit
4.11	Set air handler
4.15	Install and align drive system for air handler
4.16	Wire motor
4.17	Start and check rotation and RPM
4.18	Check amperage and voltage
4.19	Install condensate drain piping
4.23	Check all hangers, joints, and dampers

4.27 Balance system for proper quantity and direction of air flow
4.33 Check and adjust air quantitites
5.42 Install or service electrostatic filters
6.11 Recognize and use the symbols of a control diagram
6.13 Compare mechanical control elements
6.35 Install electric pneumatic controls for domestic and commercial heating and cooling
6.54 Wire electric solenoid from wiring schematic
6.58 Mount bi-metallic thermostat in proper location for air conditioner
6.59 Wire bi-metallic thermostat into control system using wiring schematic
6.511 Install pressure type thermostat on commercial refrigeration system
6.512 Wire high-low pressure switch on commercial refrigeration system from wiring schematic
7.11 Interpret ductwork on plans and working drawings
7.13 Lay out and make square and round fittings
8.11 Interpret construction prints for all types of construction for cost estimating purposes
8.21 Know where to procure materials
9.22 Install thermostats and timers for energy conservation on existing systems
9.41 Explain energy conservation features of systems to customers
9.73 Install gas burner according to code
9.74 Size fuel piping to match pressure and BTU
9.75 Install electrical wiring and controls for maximum conservation
10.36 Evaluate a given system and specify the net clearances required by code
11.21 Sketch objects
11.22 Sketch working drawings
11.41 Visualize shapes of objects
11.42 Determine dimensions
11.43 Interpret specifications
12.11 Perform basic math operations
12.12 Perform operations involving fractions, decimals, and percentages
13.15 Protect equipment and personnel from unsafe conditions
14.11 Perform soldering operations
14.12 Perform brazing operations
14.13 Perform welding operations
14.14 Perform cutting operations
14.21 Set up arc welding equipment
15.68 Replace blown fuses
15.69 Determine wire size
15.625 Ground an electrical device
15.629 Determine how voltages combine
15.630 Determine how currents combine
15.631 Determine that like charges repel, etc.
15.632 Determine the power used by a lamp, etc.
15.633 Find the resistivity of a metal
15.634 Determine the electrical equivalent of heat
15.635 Find the horsepower of a motor
15.636 Use the laws of transformers
15.637 Explain the operation of a voltmeter or ammeter
15.638 Find the field lines around a current-carrying wire
15.639 Use the National Electric Code Handbook
15.72 Read a graph

16.21	Write reports, work orders, memos and instructions
16.25	Spell major terms related to job
16.27	Complete requisitions and purchase orders
16.28	Make out a bill for goods sold
16.31	Give oral directions
16.32	Speak to a small group
16.35	Talk on the telephone in a job setting
16.37	Report orally on work
16.55	Interpret graphs and maps
19.12	Take as well as give clear, concise instructions in a business-like manner
19.14	Motivate co-workers and helpers to accomplish objectives in least amount of time with quality retained
19.33	Decide who is to be assigned to job and how to best effect completion
20.13	Keep log books for all jobs or installations that are not of the ordinary design
20.25	Remove installer's information sheets from new equipment and files under area and customer
20.33	Attend service schools sponsored by both industry and educational institutions

TASKS BY JOB LEVEL

Tasks Required Of The Mechanic Helper

(In Addition To Tasks Required Of The Installer)

Task Code	
1.17	Service oil heating equipment
1.25	Service gas heating equipment
1.35	Service electric heat equipment selected and installed
1.54	Select and evaluate draft and combustion equipment
1.58	Obtain peak operating efficiency using test instruments
2.11	Locate job site
2.12	Locate system trouble
2.13	Correct problem
2.21	Locate and repair or replace defective components in low voltage control circuits
2.22	Locate and replace components in line voltage circuits
2.41	Use electrical instruments to determine voltage, current, and resistance
2.42	Use electrical instruments to determine power
2.51	Disconnect a refrigerant tube and flush
2.52	Tear down TEV and flush
5.53	Pump cleaner through condenser
2.55	Clean all refrigerant piping
2.56	Replace compressor and put system into operation
3.51	Replace a compressor
3.52	Repair a condenser
3.53	Repair leaking evaporator
3.54	Replace a defrost heater
3.56	Repair a system leak and recharge
3.57	Repair a restricted capillary tube
3.58	Diagnose a system that has an inefficient compressor
3.61	Check and replace a defective start relay
3.62	Check and replace a defective hermetic compressor
3.63	Check and replace defective run and start capacitors
3.71	Diagram an electrical wiring system from the disconnect switch
3.72	Select wire size for each circuit
3.73	Locate motor control and electrical troubles
3.74	Read trouble analysis charts
3.76	Know purpose and application of multiple evaporator systems
3.77	Select major components and arrangements of multiple evaporator systems
3.78	Install and adjust evaporator pressure regulator, EPR valves and refrigerant controls

3.79 Select and know when to use internal equalizer, external equalizer, and pressure limiter thermostatic expansion valves
3.710 Install and adjust head pressure controls if condensors are exposed to outdoor weather temperature
3.711 Know types and purpose of heat exchangers
3.715 Determine the correct storage life, temperature, and humidity of various commodities
3.83 Be able to service or suitably replace electrical and mechanical refrigeration components
3.84 Locate malfunctioning components in a refrigeration system
3.85 Organize a systematic method of repair of the malfunctioning component
5.11 Use psychrometer
5.12 Use psychrometric charts and tables
5.13 Check volume of air (to determine make-up)
5.43 Install and service electronic air cleaners
5.44 Install vicous filters
6.12 Compose a schematic diagram of control systems
6.14 Illustrate the differences between mechanical, electrical, electronic, and pneumatic controls
6.15 Use schematic diagrams in the process of diagnosing control problems in equipment
6.21 Use test equipment for checking controls
6.22 Diagnose problems in control circuits
6.23 Test and replace oil burner controls
6.24 Test and replace gas burner controls
6.25 Test and replace electric heat controls and elements
6.26 Diagnose zone control systems
6.31 Recognize the different types of relays and their applications
6.33 Install and calibrate thermostat
6.34 Determine component coordination and operation sequence
6.36 Identify the types of controls and their function in domestic and commercial refrigeration
6.41 Replace and repair refrigerant controls for refrigeration and air conditioning
6.42 Use solenoid valves, modulating controls, and three-way valves to control the distribution of refrigerant
6.51 Determine ampere draw and install proper relay to control fractional horsepower motors
6.52 Determine ampere draw and install proper contactor for larger horsepower motors
6.53 Install electric solenoid valve for pump down control on commercial refrigeration system
6.56 Wire internal motor overload on air conditioner
6.57 Wire external motor overload on air conditioner
6.510 Install temperature type thermostat on domestic refrigerator or freezer
9.12 Clean air cooled condenser
9.13 Clean water cooled condenser
9.14 Treat circulating water
9.15 Clean furnace heat exchangers
9.16 Lubricate moving parts where required 443
9.17 Inspect and replace belts
9.18 Clean boilers
9.19 Clean and replace air/fuel filters

9.110 Clean and replace fuel jets
9.111 Evaluate source of air supply for heating system
9.112 Charge air conditioning systems
9.116 Adjust primary air to obtain proper CO_2 and flue gas temperature
9.117 Adjust blower for proper cfm
9.31 Maintain system performance records
9.32 Maintain system maintenance records
9.61 Determine the heat content of each type of oil
9.64 Identify the type of burner being used and those things required to burn the oil completely
9.67 Determine the amount of air required to burn the oil
9.610 Know the by-products of combustion and how to use instruments to measure the CO_2 level
9.611 Determine from the shape of the combustion chamber the angel of the nozzle needed.
9.612 Place the burner in proper location in the combustion chamber
9.614 Use the smoke spot tester to determine if any sooting is taking place
9.615 Determine if the blast tube and turbulator are properly set
9.616 Measure combustion draft and make changes necessary for proper draft
9.71 Calculate heat load
9.76 Troubleshoot and service gas burners to optimize performance
10.11 Design four different types of hydronic systems
10.21 Measure water temperatures in various sections of systems
10.22 Measure water flow in specified sections of systems
10.27 Measure water temperature at various terminal units to determine BTU output
10.35 Estimate the correct amount of combustion and ventilation air for any given application
10.58 Design a proper refrigerant piping system
10.63 Demonstrate a working knowledge in the fundamentals of industrial refrigeration theory and application
10.64 Analyze the pressure-temperature relationship
12.31 Perform basic algebraic operations
12.41 Use plain and solid geometric figures
12.42 Determine area and volume
14.22 Select electrode for arc welding
14.23 Perform arc welding operation
15.21 Use tables of density, specific gravity, and specific heat
15.22 Read gauges and meters
15.23 Make measurements to determine density or specific gravity
15.27 Calculate temperature, volume, and pressure changes in a gas
15.210 Graph and interpret graphs
15.31 Measure the power output of a rotating shaft
15.32 Determine the efficiency of a machine
15.33 Determine the energy required to do a given job
15.34 Calculate velocity, distance or time
15.38 Identify causes of inefficiency in a machine
15.41 Select correct thermometric device
15.42 Use a thermometric device to determine temperature
15.43 Calibrate thermometer
15.44 Calculate linear expansion and apply to job at hand
15.57 Measure and evaluate noise level
15.58 Calculate BTU gain or loss from a structure
15.61 Install meters and take readings

15.62 Set up simple circuits
15.63 Test with an ohmeter
15.66 Convert watts to horsepower
15.611 Use an induction coil
15.612 Charge a lead storage battery
15.616 Use a capacitor to produce phase shift
15.617 Use a variable resistor to control current
15.620 Use Ohm's law to find resistance
15.621 Use a relay
15.622 Use generator
15.626 Determine the impedance of a coil
15.627 Show lines of force of a magnet
15.628 Determine compound resistances
15.71 Plot a graph
15.76 Add inverses
17.12 Keep records of customers on file
20.21 Read technical manuals and trade journals, then files according to predetermined system
20.34 Check "junk mail" sent by manufacturing companies for new or improved products or designs or performance changes

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TASKS BY JOB LEVEL

Tasks Required Of The Mechanic

(In Addition To Tasks Required Of The Mechanic Helper)

Task Code	
1.32	Run conduit from disconnect to electric heating equipment
1.51	Match proper oil/gas nozzle to heating equipment
1.52	Select heating medium
3.64	Check and repair a defective ice maker
3.65	Check and replace a hermetic compressor after a burnout
4.21	Properly design duct system
4.28	Adjust mechanical and electric controls
5.14	Determine enthalpy
5.23	Size and select humidifier
6.32	Identify the types of unit-heater control systems, unit-ventilator control methods, outdoor thermostat controls
9.11	Use applicable equipment to maintain peak operating efficiency
9.114	Determine feasibility of adding heat recovery system
9.115	Locate equipment for maximum energy efficiency
9.21	Clean controls
9.23	Explain energy efficiency ratios
9.24	Compute power used by a system
9.25	Measure power used by a system
9.26	Advise owner of benefits of additional controls
9.33	Record system variables for evaluating energy utilization
9.34	Analyze charts to determine system efficiencies
9.42	Inform owner of saving method
9.43	Discuss features of alternative energy systems
9.51	Evaluate existing insulation
9.52	Determine additional requirements to meet energy efficiency standards
9.62	Evaluate the advantages and disadvantages of the oil by the grade of oil
9.63	Determine the components needed to handle a certain grade of oil
9.65	Determine the advantage of each type of burner
9.66	Determine the size nozzle to use and how much fuel can be burned in the combustion chamber
9.68	Determine the proper ventilation for the furnace or boiler room
9.69	Know the chemicals needed for complete combustion and why excess air is required
9.613	Adjust the burner oil pressure and adjust the air supply so that the proper CO_2 can be reached
9.72	Size chimney for draft and combustion
10.112	Evaluate all work done against industry standards and various codes
10.23	Use a wide variety of instruments in testing, adjusting, and balancing a properly designed and installed system
10.26	Evaluate effect on operation and efficiency of a specific system, with possible revision to maximize efficiency
10.29	Use pump curves to estimate flow rate and head
10.210	Evaluate overall efficiency of a system under test, both before and after test and balance has been performed to assure optimum performance

10.31 Demonstrate a knowledge and understanding of the American Gas Association (A.G.A.). Recommended procedures for gas piping and appliance installation and the N.C. State Building Code, Volume III, Chapter XIV, Section 1400-1415
10.32 Select the proper size gas piping for any specified application
10.33 Correctly estimate the size, type and quantity of fittings required
10.34 Select the correct vent material and size for any given application
10.51 Calculate the refrigeration load requirements for commercial refrigeration applications
10.55 Inspect, test, and analyze existing systems
10.57 Measure the internal volume of a given unit and estimate the actual storage capacity of various products
10.59 Diagram the piping system illustrating all components thereof
10.510 Estimate the average compressor running time for any given commercial refrigeration application
10.65 Compare and select the best refrigerant for specified applications
10.66 Compare theoretical and actual capacities
10.67 Design a refrigerant piping system for a specified application
10.71 Calculate the heating and cooling needs of a residence
10.77 Analyze existing systems for alterations to conserve energy
10.81 Demonstrate an understanding of air movement in a distribution system
10.82 Measure and calculate air volume
10.83 Measure and calculate air velocities
10.84 Estimate blower capacity and air quantities required
10.85 Estimate and measure friction loss
10.87 Balance an existing residence system
10.88 Appraise a residential air distribution system and distinguish between good and bad systems
10.89 Make recommendations as may be indicated for improving an unsatisfactory residential air distribution system
10.93 Interpret a psychrometric chart to measure the state of mixture of two (or more) air streams
10.94 Use various engineering data in the form of charts, tables and graphs to evaluate specific heat, humidification and dehumidification
10.97 Determine air flow requirements
10.101 Accurately calculate air flow requirements
10.1016 Use instruments in testing, adjusting, and balancing various air distribution systems for commercial use
10.1017 Evaluate air motion within a conditioned commercial area using modern instrumentation
10.1018 Make recommendations as may be indicated for improving a unsatisfactory commercial air distribution system
10.115 Demonstrate the ability to inspect and test systems and components for safe and proper operation
10.116 Correct problems with electric heat system, its design or any component thereof
10.117 Compare and evaluate various electric heat systems
10.119 Measure efficiency of any electric heat system
10.1110 Make recommendations as may be indicated for greater energy conservation and/or comfort
10.131 Install gauge manifold on automotive air conditioning system (optional)
10.132 Interpret pressure readings on auto air conditioning system (optional)
10.133 Determine correct refrigerant level on auto air conditioning system (optional)

10.134 Identify component failure on automotive air conditioning system (opt.)
10.135 Use sling psychrometer to obtain wet bulb temperature " " "
10.136 Know oil type and amount required for system lubrication " "
10.137 Know how to replace components, evacuate, and recharge systems " "
10.138 Use electrical schematics "
10.139 Check fuses "
10.1310 Check for open circuits "
10.1311 Check for grounding (shorts) "
10.1312 Demonstrate air by-pass and diversion from outside vents to bi-level, defrost, heating, and cooling "
10.1313 Perform miscellaneous service, i.e., drains, belts, vibration, drives, bolts and nuts, and cleaning process "
11.52 Develop diagrams of air conditioning, heating and refrigeration systems
12.51 Perform basic trigonometric operations
15.35 Calculate acceleration, change in velocity or time
15.36 Identify all forces acting on a body
15.37 Determine force required to start or stop a body
15.45 Calculate volume expansion of materials and apply to job at hand
15.46 Calculate or estimate heat absorbed and given up due to a temperature change
15.47 Calculate or estimate heat produced in a mechanical operation
15.64 Convert joules to foot-pounds
15.65 Convert joules to calories
15.67 Determine cost of electrical energy used
15.610 Use an electromagnet
15.613 Use a transformer
15.614 Build an induction heater (furnace)
15.615 Rectify alternating current
15.618 Use an oscilloscope
15.623 Use an electric motor
15.624 Build a copper-wire cell
15.75 Extract a square root
16.24 Write a business letter
17.14 Can compute overhead cost of each job
17.15 Know local, state, and federal regulations pertaining to equipment to be used
17.21 Respect competitors in same field
17.23 Ha obligation to employee to give fair treatment
17.31 Keep up-to-date records of changes
17.32 Keep in touch with manufacturer's recommendations
17.33 Know laws pertaining to equipment
17.41 Aware of total cost of equipment
17.42 Know overhead cost to deliver and /or install material
17.43 Maintain list of available supplies to choose from
17.44 Aware of alternate systems to be used
17.45 Can explain health benefits related to installation of job
17.46 Analyze what could be done to decrease cost of installation and operation without sacrificing quality
17.47 Can compute first cost of job relative to operational cost
18.42 Understand all people
19.11 Is able to coordinate different phases of jobs
19.51 Understand have knowledge of product and services to be sold
19.52 Attentive to customer's "signals", moods, etc., and analyzing these, adjusts sales pitch to benefit sale

19.53 Attempt to get best reasonable price for company
19.54 Understand and appreciates fact that the better financial condition company is in, the better one's position
20.22 Keep personal technical library
20.23 Collect manufacturers releases and file in library
20.24 Request engineering data from related manufacturers files for future use
20.31 Obtain subscriptions to trade journals
20.32 Collect and files trade releases for new products for study and evaluation

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TASKS BY JOB LEVEL

Tasks Required Of The Design Technician

Task Code	
1.14	Select oil heating equipment to be installed
1.22	Select gas heating equipment
1.31	Size conductors for electric heat
1.33	Select equipment for electric heat
1.41	Calculate air heating heat loss
1.42	Calculate air heat gain
1.53	Select heating equipment to maximize energy conservation
5.33	Size and select dehumidifier
8.31	Know advertising procedure for bids
8.32	Calculate contract price of turn key job
8.33	Procure and contract with sub contractors
8.34	Procure cost of permits
8.41	Must understand codes for pricing purposes
8.42	Determine costs of bid bonds and performance bond
9.113	Evaluat system for retrofit
9.53	Determine building orientation, shading, landscaping for new construction
9.54	Evaluate new insulation type and installation procedures
10.12	Estimate water temperature requirements for a given application
10.13	Select all equipment and components for a given application
10.14	Choose the correct size chiller and/or boiler
10.15	Estimate hot water requirements for domestic or potable purposes
10.16	Select the type of domestic or potable water heating system best suited for a particular application
10.17	Estimate pipe sizes for entire system
10.18	Select proper pipe insulation
10.19	Design a cooling tower installation
10.110	Select pump capacity and types
10.111	Estimate all pipe sizes, including valves and accessories
10.28	Construct a system curve based on water flow
10.41	Choose the best type system for a specified transport application (opt.)
10.42	Compare various methods of air distribution used in transport refrigeration (opt.)
10.43	Select all special equipment and controls required to meet the needs of various types of transport refrigeration (opt.)
10.44	Accurately estimate or calculate the load requirements of a specified transport refrigeration application (opt.)
10.45	Select the correct size system for the application specified (opt.)
10.46	Analyze and solve theoretical and practical design problems in existing and proposed systems (opt.)
10.52	Choose the proper condensing unit for a commercial refrigeration system
10.53	Select the correct evaporator coil assembly
10.54	Select the proper operating and safety controls for a given application
10.56	Estimate the materials required to construct a given walk-in cooler
10.61	Estimate the cooling load requirements for industrial refrigeration applications (opt.)
10.62	Differentiate between various types of refrigeration equipment and systems (opt.)

10.68 Select all system components, including all operating and safety controls
10.69 Evaluate the function of condensing systems, heat rejection systems, and the components thereof
10.610 Plan the duties of a plant operating engineer
10.72 Select the proper equipment to meet the estimated cooling needs of residence
10.73 Choose operating and safety controlsfor residential air conditioning system
10.74 Prepare data for load calculations
10.75 Calculate the humidity requirements for a residence
10.76 Select humidifier and controls
10.86 Correctly size and lay out an air distribution system
10.91 Calculate the heating and/or cooling requirements of a commercial type structure
10.92 Select the correct size and type of heating and/or cooling equipment to meet these requirements
10.95 Calculate humidity requirements and select humidifier with control system for type of heating system employed
10.96 Evaluate a commercial air conditioning system for maximum energy untilization and conservation
10.102 Demonstrate knowledge and understanding of air and its behavior in a commercial air distribution system
10.103 Design a simple constant velocity system
10.104 Design a simple velocity reduction system
10.105 Design a simple equal friction system
10.106 Design a simple static regain system
10.107 Compare the four systems and evaluate each
10.108 Select the best system for a specific application
10.109 Calculate individual room air volume requirements
10.1010 Select proper diffusers, registers and grills
10.1011 Design a complex equal friction system
10.1012 Calculate air requirements for each outlet
10.1013 Calculate air volume and velocity in each section of duct
10.1014 Calculate friction loss for each component and all duct work
10.1015 Determine blower capacity requirements
10.111 Calculate the heat loss in wattage on a room basis for a structure
10.112 Select the most appropriate type of system of a particular application
10.113 Choose the correct operating and safety controls for the system selected
10.114 Design and lay-out the complete system
10.118 Estimate approximate annual operating cost
10.121 Demonstrate an understanding of terminology associated with solar energy
10.122 Determine promising applications of solar energy
10.123 Evaluate the economics and performance of solar systems
10.124 Estimate average energy availability at the earth's surface
10.125 Differentiate between climatic constants in different areas
10.126 Select collectors
10.127 Select storage medium
10.129 Compare concentration systems
10.1210 Evaluate solar water heating
10.1211 Compare solar air conditioning and dehumidification systems
10.1212 Assess types of solar power generation
10.1214 Solve design problems in existing and proposed solar heating/cooling systems
11.11 Organize activities for efficiency
11.12 Outline data for use

11.31 Use drafting equipment
11.32 Draw objects so as to describe their shape through orthographic, pictorial, sectional, and/or auxilary view techniques
11.33 Use scales to describe the size of an object
11.34 Do lettering and dimensioning
11.51 Prepare charts and graphs
11.53 Develop maps, pictures, and/or drawings
12.32 Perform advanced operations in trigonometry
12.52 Perform advanced operations
15.24 Make measurements to determine tensile strength
15.25 Apply terms relating to properties of materials
15.26 Calculate density, specific gravity, and specific heat
15.28 Relate densities to buoyancy and flotation
15.51 Determine the efficiency of a light fixture
15.52 Layout a simple lighting system
15.53 Predict the results of additive color mixing
15.54 Predict the results of subtractive color mixing
15.55 Determine the reverberation time of a room
15.56 Analyze the performance of a loud speaker

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APPENDIX J

SUGGESTED

AIR CONDITIONING, HEATING, AND REFRIGERATION

TASKS BY QUARTER

This task list has been used as the working base for identifying curriculum content by course for the air conditioning, heating, and refrigeration curriculums.

The suggested air conditioning, heating, and refrigeration tasks by quarters have been derived from the task by job level response from industry and from review and evaluation by instructors. Tasks are arranged by quarter to help students develop a background of skills that will enable their entry to progressive levels of employment as they proceed through the curriculum.

Tasks are identified for additional instruction beyond the diploma level program (typically four quarters) for institutions that have advanced level programs. However, the manual provides suggested curriculum and instructional materials for the recommended diploma program only.

All items with an "X" indicate the quarter in which initial instruction is recommended to be provided on the topic. Some tasks require additional practice and/or advanced instruction to develop sufficient skill to perform at the level expected for progressively higher job levels. These tasks are keyed for additional practice, "O", and advanced instruction, "□". A few tasks are included that may be taught as an elective. These are marked with an "E".

SUGGESTED
AIR CONDITIONING, HEATING AND REFRIGERATION TASKS
BY EDUCATIONAL LEVEL

	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
1.00 I. Heating						
1.10 A. Oil						
1.11. Install storage tank above or below ground..........	X					
1.12. Run oil line with filter and valves.................	X					
1.13. Run vent and fill lines.............................	X					
1.14. Select equipment to be installed....................	X					
1.15. Install equipment....................................	X					
1.16. Connect to prefabricated or job erected flue.........	X					
1.17. Service equipment....................................	X					
1.20 B. Gas						
1.21. Install piping for gas line..........................	X					
1.22. Select equipment.....................................			X			
1.23. Install equipment....................................	X					
1.24. Connect to prefabricated or job erected vents and flues....................................	X					
1.25. Service equipment....................................	X					
1.30 C. Electric						
1.31. Size conductors......................................			X			
1.32. Run conduit from disconnect to equipment.............			X			
1.33. Select equipment.....................................			X	□		
1.34. Install equipment....................................			X			
1.35. Service equipment selected and installed.............			X			
1.40 D. Heat Loss Calculations						
1.41. Calculate air heating heat loss and heat gain........			X	□		
1.42. Calculate hydronic heat loss.........................			X			

X Instruction

O Additional Practice

□ Advanced Instruction

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
1.00 I. Heating						
1.50						
1.51. Match proper oil/gas and heating equipment..........	X					
1.[illegible] Select heating medium..............................	X					
1.53. Select heating equipment...........................	X					
1.54. Select and evaluate draft and combustion equipment....	X					
1.55. Determine combustion air requirements...............	X					
1.56. Determine combustion by-products..................	X					
1.57. Choose burner shape and nozzle to match heat exchanger						
1.58. Obtain peak operating efficiency using test instruments................................	X					
2.00 II. Air Conditioning and Heat Pumps						
2.10 A. Mechanical Diagnosis and Servicing						
2.11. Locate job site....................................			X			
2.12. Locate system trouble..............................			X			
2.13. Correct problem....................................			X			
2.20 B. Electrical Diagnosis and Servicing						
2.21. Locate and repair or replace defective components in low voltage control circuits.........................			X			
2.22. Locate and replace components in line voltage circuits			X			
2.30 C. Hand Tools						
2.31. Use basic hand tools..............................	X					
2.32. Use specialized tools..............................	X					

X Instruction

O Additional Practice

□ Advanced Instruction

SUGGESTED
AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS
BY EDUCATIONAL LEVEL

		1st Qtr.- CC/TI	2nd Qtr.- CC/TI	3rd Qtr.- CC/TI	4th-Qtr.- CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
2.40	D. Electrical Instruments						
	2.41. Use electrical instruments to determine voltage, current, and resistance	X	□				
	2.42 Use electrical instruments to determine power	X	□		O		
2.50	E. System Cleanup after Burnout						
	2.51. Disconnect a tube and flush		X				
	2.52. Tear down TEV and flush		X				
	2.53. Pump cleaner through condenser		X				
	2.54. Pump cleaner through evaporator		X				
	2.55. Clean all refrigerant piping		X				
	2.56. Replace compressor and put system into operation		X				
2.60	F. Heat Pumps						
	2.61. Install outdoor unit on concrete pad with consideration given for snow and ice accumulation				X		
	2.62. Install indoor unit with proper sound baffling				X		
	2.63. Install supplemental heat section in indoor unit				X		
	2.64. Install indoor thermostat				X		
	2.65. Install outdoor thermostat (if used)				X		
	2.66. Install all low voltage wiring from schematic wiring diagram			X			
	2.67. Install refrigeration lines			X			
	2.68. Use pressure-temperature methods to check out reversing valve				X		
	2.69. Use steel tool to check magnetism of reversing valve solenoid				X		
	2.610. Check defrost timer clock for operation				X		
	2.611. Check defrost control sensing bulb for good contact with outdoor coil				X		
	2.612. Test check valves with magnet (unit off)				X		

X Instructior

O Additional Practice

□ Advanced Ir struction

SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

Task	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
2.613. Test for temperature difference across check valve (unit on)				X		
2.614. Check refrigerant pressures				X		
2.615. Check electric resistance elements for proper operation				X		
2.616. Test complete system for refrigerant leaks				X		
3.00 III. Refrigeration						
3.10 A. Tools and Materials						
3.11. Use hand tools (flaring, swaging, bending)	X	0	0			
3.12. Work with materials (tubing, refrigerants)	X	0	0			
3.13. Use test instruments (gauges, thermometers)	X	0	0			
3.20 B. Mechanical Compression Systems						
3.21. Recognize cycle components	X					
3.22. Connect cycle components to form a complete cycle	X	0				
3.23. Operate a cycle using a capillary tube, an AEV, a TEV.	X	0				
3.24. Record pressures and temperatures	X	0				
3.25. Observe cycle component behavior	X	0				
3.26. Leak test a system using three methods of detection	X					
3.27. Evacuate a system using a vacuum pump	X					
3.28. Charge a system	X	0				
3.30 C. Motors and Controls						
3.31. Recognize various types of motors	X		□			
3.32. Install and wire (connect) an electric motor (use unit diagram)	X					
3.33. Wire in different types of starting relays (use diagram)	X		□			

X Instruction

0 Additional Practice

□ Advanced Instruction

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SUGGESTED AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY EDUCATIONAL LEVEL	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
3.34. Install a thermostat	X		0			
3.35. Have a knowledge of various defrost systems	X	□				
3.36. Connect a defrost system	X					
3.37. Install an ice maker	X	0				
3.40 D. Refrigerated Cabinets						
3.41. Recognize key features of different styles and models	X					
3.42. Check and service a cabinet	X					
3.50 E. Repair of Cabinets and Mechanisms - Mechanical						
3.51. Replace a compressor	X	0		□		
3.52. Repair a condenser	X	0		□		
3.53. Repair leaking evaporator	X	0		□		
3.54. Replace a defrost heater	X					
3.55. Replace a defrost timer	X	0				
3.56. Repair a system leak and recharge	X					
3.57. Repair a restricted capillary tube	X	0				
3.58. Diagnose a system that has an inefficient compressor	X					
3.60 F. Troubleshoot and Repair Cabinets and Mechanisms - Electrical						
3.61. Check and replace a defective start relay	X					
3.62. Check and replace a defective hermetic compressor	X					
3.63. Check and replace defective run and start capacitors	X					
3.64. Check and repair a defective ice maker	X	0	0			
3.65. Check and replace a hermetic compressor after a burn-out	X	0	0			

X Instruction

0 Additional Practice

□ Advanced Instruction

SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr. - CC/TI	7th/8th Qtr. - CC/TI
III. Refrigeration						
3.70 G. Commercial Refrigeration Systems						
3.71. Diagram an electrical wiring system from the disconnect switch		X	□			0
3.72. Select wire size for each circuit		X	0	0		
3.73. Locate motor control and electrical troubles		X	0	0	□	
3.74. Read trouble analysis charts						
3.75. Recognize and correct compressor troubles, low charge, overcharge, high heat, and high head pressure	X	0	0	0	□	
3.76. Know purpose and application of multiple evaporator systems		X	0	0	□	
3.77. Select major components and arrangements of multiple evaporator systems		X				
3.78. Install and adjust evaporator pressure regulator, EPR valves and refrigerant controls		X	0	0		
3.79. Select and know when to use internal equalizer, external equalizer, and pressure limiter thermostatic expansion valves					0	
3.710. Install and adjust heat pressure controls if condensors are exposed to outdoor weather temperature		X			0	
3.711. Know types and purpose of heat exchangers		X				
3.712. Know where and when heat exchangers should and should not be installed		X				
3.713. Know advantages of accumulators and where to install	X	0	0			
3.714. Know type and purpose of oil separators, their location, and installation requirements		X	0			
3.715. Determine the correct storage life, temperature, and humidity of various commodities		X				
3.716. Know reason for evacuating a refrigeration system	X					

X Instruction

0 Additional Practice

□ Advanced Instruction

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SUGGESTED

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
3.717. Know evacuating procedures	X	O	O			
3.718. Know charging procedures and determine correct charge.	X	O	□			
3.719. Charge a comfort cooling unit		X				
3.80 H. Refrigeration Servicing						
3.81. Adhere to safety rules pertaining to handling of refrigerants and electrical circuits	X					
3.82. Read and follow piping blueprints and electrical schematics	X	□				
3.83. Be able to service or suitably replace electrical and mechanical refrigeration components	X	O	O	□		
3.84. Locate malfunctioning components in a refrigeration system	X					
3.85. Organize a systematic method of repair of the malfunctioning component	X	O	O			
3.86. Install refrigeration systems		X				
4.00 IV. Air Distribution						
4.10 A. Air Handler						
4.11. Set air handler			X	□		
4.12. Level air handler			X			
4.13. Tighten screws and bolts			X			
4.14. Install air filters			X			
4.15. Install and align drive system		X				
4.16. Wire motor		X				
4.17. Start and check rotation and RPM		X				
4.18. Check amperage and voltage		X				
4.19. Install condensate drain piping		X				
4.110. Check for proper drainage		X				
4.111. Install vibration eliminators		X				

X Instruction

O Additional Practice

□ Advanced Instruction

SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

Task	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
4.20 B. Duct System						
4.21. Properly design duct system				X		
4.22. Install duct system from working drawings	X					
4.23. Check all hangers, joints, and dampers	X					
4.24. Insulate duct system	X					
4.25. Cut openings for ducts, diffusers, and grills	X					
4.26. Install diffusers and grills	X					
4.27. Balance system for proper quantity and direction of air flow				X		
4.28. Adjust mechanical and electric controls				X		
4.29. Apply good safety rules	X					
4.30 C. Exhaust and Make-up Air System						
4.31. Cut proper openings	X					
4.32. Set fan and/or louvers	X					
4.33. Check and adjust air quantities				X		
5.00 V. Air Treatment						
5.10 A. Checking Condition of Air						
5.11. Use psychrometer			X			
5.12. Use psychrometric charts and tables		X	O	O	□	
5.13. Check volume of air (to determine make-up)			X		□	
5.14. Determine enthalpy			X		□	
5.20 B. Humidification						
5.21. Install humidifier			X			
5.22. Service humidifier			X			
5.23. Size and select humidifier			X		□	

X Instruction

O Additional Practice

□ Advanced Instruction

SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

		1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
5.30	C. Dehumidifying Air						
	5.31. Install dehumidifier	X					
	5.32. Service dehumidifier			X			
	5.33. Size and select dehumidifier			X			
5.40	C. Cleaning Air						
	5.41. Install and service filters	X		□			
	5.42. Install or service electrostatic filters	X		□			
	5.43. Install and service electronic air cleaners	X		□			
	5.44. Install viscous filters	X					
6.00 VI.	Controls						
6.10	A. Wiring Diagrams						
	6.11. Recognize and use the symbols of a control diagram		X				
	6.12. Compose a schematic diagram of control systems		X				
	6.13. Compare mechanical control elements		X				
	6.14. Illustrate the differences between mechanical, electrical, electronic, and pneumatic controls			X			
	6.15. Use schematic diagrams in the process of diagnosing control problems in equipment			X			
6.20	B. Test Equipment						
	6.21. Use test equipment for checking controls	X				□	
	6.22. Diagnose problems in control circuits		X			□	
	6.23. Test and replace oil burner controls			X	□		
	6.24. Test and replace gas burner controls			X	0		
	6.25. Test and replace electric heat controls and elements			X	0		
	6.26. Diagnose zone control systems			X			

X Instruction

0 Additional Practice

□ Advanced Instruction

SUGGESTED AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY EDUCATIONAL LEVEL	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
6.30 C. Components						
6.31. Recognize the different types of relays and their applications		X				
6.32. Identify the types of unit-heater control systems, unit-ventilator control methods, outdoor thermostat controls			X			
6.33. Install and calibrate a thermostat			X			
6.34. Determine component coordination and operational sequence			X			
6.35. Install electric pneumatic controls for domestic and commercial heating and cooling			X			
6.36. Identify the types of controls and their function in domestic and commercial refrigeration			X			
6.40 D. Refrigerant Controls						
6.41. Replace and repair refrigerant controls for refrigeration and air conditioning	X	O	O			
6.42. Use solenoid valves, modulating controls, and three-way valves to control the distribution of refrigerant		X	O			
6.50 E. Wiring and Controls						
6.51. Determine ampere draw and install proper relay to control fractional horsepower motors		X				
6.52. Determine ampere draw and install proper contactor for larger horsepower motors			X			
6.53. Install electric solenoid valve for pump down control on commercial refrigeration system		X				
6.54. Wire electric solenoid from wiring schematic		X				
6.55. Install motor overload on domestic freezer or refrigerator	X					
6.56. Wire internal motor overload on air conditioner			X			

X Instruction

O Additional Practice

☐ Advanced Instruction

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SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
6.57. Wire external motor overload on air conditioner......			X			
6.58. Mount bi-metallic thermostat in proper location for air conditioner....................................			X			
6.59. Wire bi-metallic thermostat into control system using wiring schematic....................................			X			
6.510. Install temperature type thermostat on domestic refrigerator or freezer..............................	X					
6.511. Install pressure type thermostat on commercial refrigeration system..................................		X				
6.512. Wire high-low pressure switch on commercial refrigeration system from wiring schematic..................		X				
7.00VII. Duct Fabrication and Installation						
7.10 A. Fabrication						
7.11. Interpret ductwork on plans and working drawings....				X		
7.12. Use fabricating tools and machinery................		X				
7.13. Lay out and make square and round fittings..........				X		
7.14. Insulate ducts - interior and exterior..............				X		
7.20 B. Installation						
7.21. Hang ducts..				X		
7.22. Use devices for fastening and joining ducts..........				X		
7.23. Seal and insulate joints and seams.................				X		
7.24. Install duct accessories, grills, registers, dampers, boots, and take offs...............................				X		
7.25. Apply duct insulation..............................				X		
8.00VIII. Costing and Estimating						

X Instruction

0 Additional Practice

☐ Advanced Instruction

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8.10 A. Cost Factors

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SUGGESTED AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY EDUCATIONAL LEVEL	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
8.11. Interpret construction prints for all types of construction for cost estimating purposes					X	
8.12. Calculate time and labor costs					X	
8.13. Calculate overhead					X	
8.14. Calculate travel time and lodging					X	
8.15. Calculate profit required					X	
8.20 B. Procurement						
8.21. Know where to procure materials					X	
8.22. Determine lead time for materials					X	
8.30 C. Pricing Factors						
8.31. Know advertising procedure for bids					X	
8.32. Calculate contract price of turnkey job					X	
8.33. Procure and contract with subcontractors					X	
8.34. Procure cost of permits					X	
8.40 D. Specification Factors						
8.41. Must understand codes for pricing purposes					X	
8.42. Determine costs of bid bonds and performance bond					X	
9.00 IX. Energy Conservation						
9.10 A. Mechanical Systems						
9.11. Use applicable equipment to maintain peak operating efficiency	X					
9.12. Clean air cooled condenser	X					
9.13. Clean water cooled condenser		X				
9.14. Treat circulating water		X				

X Instruction

0 Additional Practice

□ Advanced Instruction

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SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

Task	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
9.15. Clean furnace heat exchangers			X			
9.16. Lubricate moving parts where required	X					
9.17. Inspect and replace belts	X					
9.18. Clean boilers				X		
9.19. Clean and replace air/fuel filters				X		
9.110. Clean and replace fuel jets				X		
9.111. Evaluate source of air supply for heating system				X		
9.112. Charge air conditioning systems				X		
9.113. Evaluation system for retrofit				X		
9.114. Determine feasibility of adding heat recovery system					X	
9.115. Locate equipment for maximum energy efficiency				X		
9.116. Adjust primary air to obtain proper CO_2 and flue gas temperature				X		
9.117. Adjust blower for proper cfm				X		
9.20 B. Electrical Systems						
9.21. Clean controls	X					
9.22. Install thermostats and timers	X					
9.23. Explain energy efficiency ratios	X					
9.24. Compute power used by a system		X				
9.25. Measure power used by a system		X				
9.26. Advise owner of benefits of additional controls		X				
9.30 C. Records						
9.31. Maintain system performance records		X				
9.32. Maintain system maintenance records		X				
9.33. Record system variables for evaluating energy utilization		X				
9.34. Analyze charts to determine system efficiencies		X				

X Instructiona

0 Additional Practice

☐ Advanced Instruction

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AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
9.40 D. Public Relations						
9.41. Explain energy conservation features of systems to customers		X				0
9.42. Inform owner of saving method		X				□
9.43. Discuss features of alternative energy systems		X				0
9.50 E. Insulation Materials						
9.51. Evaluate existing insulation			X			
9.52. Determine additional requirements to meet energy efficiency standards			X			0
9.53. Determine building orientation, shading, landscaping for new construction			X			
9.54. Evaluate new insulation type and installation procedures			X		0	□
9.60 F. Oil Burner - Efficiencies						
9.61. Determine the heat content of each type of oil		X				
9.62. Evaluate the advantages and disadvantages of the oil by the grade of oil			X			
9.63. Determine the components needed to handle a certain grade of oil				X		
9.64. Identify the type of burner being used and those things required to burn the oil completely				X		
9.65. Determine the advantage of each type of burner				X		
9.66. Determine the size nozzle to use and how much fuel can be burned in the combustion chamber		X				
9.67. Determine the amount of air required to burn the oil		X				
9.68. Determine the proper ventilation for the furnace or boiler room				X		

X Instruction

0 Additional Practice

□ Advanced Instruction

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SUGGESTED AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY EDUCATIONAL LEVEL	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
9.69. Know the chemicals needed for complete combustion and why excess air is required..........................				X		
9.610. Know the by-products of combustion and how to use instruments to measure the CO_2 level..................		X				
9.611. Determine from the shape of the combustion chamber the angle of the nozzle needed..........................		X				
9.612. Place the burner in proper location in the combustion chamber..		X				
9.613. Adjust the burner oil pressure and adjust the air supply so that the proper CO_2 can be reached...........			X			
9.614. Use the smoke spot tester to determine if any sooting is taking place..			X			
9.615. Determine if the blast tube and turbulator are properly set...			X			
9.616. Measure combustion draft and make changes necessary for proper draft....................................			X			
9.70 G. Gas Burner - Efficiencies						
9.71. Calculate heat load....................................			X			
9.72. Size chimney for draft and combustion..................			X			
9.73. Install gas burner according to code..................			X			
9.74. Size fuel piping to match pressure and BTU...........				X		
9.75. Install electrical wiring and controls for maximum conservation..				X		
9.76. Troubleshoot and service gas burners to optimize performance...				X		
10.00 X. Design						
10.10 A. Hydronic Distribution Systems						
10.11. Design four different types of hydronic systems......						X

X Instruction

O Additional Practice

□ Advanced Instruction

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SUGGESTED AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY EDUCATIONAL LEVEL	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
10.12. Estimate water temperature requirements for a given application						X
10.13. Select all equipment and components for a given application						X
10.14. Choose the correct size chiller and/or boiler						X
10.15. Estimate hot water requirements for domestic or potable purposes						X
10.16. Select the type of domestic or potable water heating system best suited for a particular application						X
10.17. Estimate pipe sizes for entire system						X
10.18. Select proper pipe insulation						X
10.19. Design a cooling tower installation						X
10.110. Select pump capacity and types						X
10.111. Estimate all pipe sizes, including valves and accessories						X
10.112. Evaluate all work done against industry standards and various codes						X
10.20 B. Hydronic Systems Balance						
10.21. Measure water temperatures in various sections of systems						X
10.22. Measure water flow in specified sections of systems						X
10.23. Use a wide variety of instruments in testing, adjusting, and balancing a properly designed and installed system						X
10.24. Compare several designs and applications						X
10.25. Choose the best design for a specific system						X
10.26. Evaluate effect on operation and efficiency of a specific system, with possible revision to maximize efficiency						X

X Instruction

O Additional Practice

☐ Advanced Instruction

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SUGGESTED AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY EDUCATIONAL LEVEL.	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
10.27. Measure water temperature at various terminal units to determine BTU output						X
10.28. Construct a system curve based on water flow						X
10.29. Use pump curves to estimate flow rate and head						X
10.210. Evaluate overall efficiency of a system under test, both before and after test and balance has been performed to assure optimum performance						X
10.30 C. Gas Piping						
10.31. Demonstrate a knowledge and understanding of the American Gas Association (A.G.A.). Recommended procedures for gas piping and appliance installation and the N. C. State Building Code, Volume III, Chapter XIV, Section 1400-1415	X					
10.32. Select the proper size gas piping for any specified application	X					
10.33. Correctly estimate the size, type and quantity of fittings required	X					
10.34. Select the correct vent material and size for any given application	X					
10.35. Estimate the correct amount of combustion and ventilation air for any given application	X					
10.36. Evaluate a given system and specify the net clearances required by code	X					
10.40 D. Transport Refrigeration						
10.41. Choose the best type system for a specified application						E
10.42. Compare various methods of air distribution used in transport refrigeration						E

- X Instruction
- 0 Additional Practice
- □ Advanced Instruction
- E Elective

SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

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	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
10.43. Select all special equipment and controls required to meet the needs of various types of transport refrigeration..........						E
10.44. Accurately estimate or calculate the load requirements of a specified transport refrigeration application..........						E
10.45. Select the correct size system for the application specified..........						E
10.46. Analyze and solve theoretical and practical design problems in existing and proposed systems..........						E
10.50 E. Commercial Refrigeration Systems						
10.51. Calculate the refrigeration load requirements for commercial refrigeration applications..........			X			
10.52. Choose the proper condensing unit..........				X		
10.53. Select the correct evaporator coil assembly..........				X		
10.54. Select the proper operating and safety controls for a given application..........		X				
10.55. Inspect, test and analyze existing systems..........		X				
10.56. Estimate the materials required to construct a given walk-in cooler..........		X				
10.57. Measure the internal volume of a given unit and estimate the actual storage capacity of various products.		X	0			
10.58. Design a proper refrigerant piping system..........		X	0			
10.59. Diagram the piping system illustrating all components thereof..........		X	0			
10.510. Estimate the average compressor running time for any given commercial refrigeration application..........			X	0		

X Instruction

0 Additional Practice

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E Elective

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AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

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10.60	F. Industrial Refrigeration Systems						
10.61.	Estimate the cooling load requirements for industrial refrigeration applications					X	0
10.62.	Differentiate between various types of refrigeration equipment and systems					X	0
10.63.	Demonstrate a working knowledge of the fundamentals of industrial refrigeration theory and application					X	0
10.64.	Analyze the pressure-temperature relationship					X	0
10.65.	Compare and select the best refrigerant for specified applications						
10.66.	Compare theoretical and actual capacities					X	0
10.67.	Design a refrigerant piping system for a specified application					X	0
10.68.	Select all system components, including all operating and safety controls					X	□
10.69.	Evaluate the function of condensing systems, heat rejection systems, and the components thereof					X	0
10.610	Plan the duties of a plant operating engineer						X
10.70	G. Residential Air Conditioning Systems						
10.71.	Calculate the heating and cooling needs of a residence			X			
10.72.	Select the proper equipment to meet the estimated needs			X			
10.73.	Choose operating and safety controls			X			
10.74.	Prepare data for load calculations to be made by computer			X			
10.75.	Calculate the humidity requirements for a residence			X			
10.76.	Select humidifier and controls			X			

X Instruction

0 Additional Practice

□ Advanced Instruction

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AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

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10.77. Analyze existing systems for alterations to conserve energy			X			
10.80 H. Residential Air Distribution						
10.81. Demonstrate an understanding of air movement in a distribution system				X		
10.82. Measure and calculate air volume				X		
10.83. Measure and calculate air velocities				X		
10.84. Estimate blower capacity and air quantities required.				X		
10.85. Estimate and measure friction loss				X		
10.86. Correctly size and lay out an air distribution system						
10.87. Balance an existing residence system				X		
10.88. Appraise a residential air distribution system and distinguish between good and bad systems				X		
10.89. Make recommendations as may be indicated for improving an unsatisfactory residential air distribution system				X		
10.90 I. Commercial Air Conditioning Systems						
10.91. Calculate the heating and/or cooling requirements of a commercial type structure				X		
10.92. Select the correct size and type of heating and/or cooling equipment to meet these requirements				X		
10.93. Interpret a psychrometric chart to measure the state of mixture of two (or more) air streams					X	
10.94. Use various engineering data in the form of charts, tables and graphs to evaluate specific heat, humidification and dehumidification					X	
10.95. Calculate humidity requirements and select humidifier with control system for type of heating system employed					X	

X Instruction

0 Additional Practice

☐ Advanced Instruction

SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

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	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
10.96. Evaluate a commercial air conditioning system for maximum energy utilization and conservation..........				X		
10.97. Determine air flow requirements......................				X		
10.100 J. Commercial Air Distribution Systems						
10.101. Accurately calculate air flow requirements...........				X		
10.102. Demonstrate knowledge and understanding of air and its behavior in a commercial air distribution system.						
10.103. Design a simple constant velocity system.............				X		
10.104. Design a simple velocity reduction system...........				X		
10.105. Design a simple equal friction system...............				X		
10.106. Design a simple static regain system................				X		
10.107. Compare the four systems and evaluate each..........				X		
10.108. Select the best system for a specific application....				X		
10.109. Calculate individual room air volume requirements....				X		
10.1010. Select proper diffusers, registers and grills........				X		
10.1011. Design a complex equal friction system..............				X		
10.1012. Calculate air requirements for each outlet..........				X		
10.1013. Calculate air volume and velocity in each section of duct..				X		
10.1014. Calculate friction loss for each component and all ductwork..				X		
10.1015. Determine blower capacity requirements..............				X		
10.1016. Use instruments in testing, adjusting and balancing various air distribution systems for commercial use..				X		
10.1017. Evaluate air motion within a conditioned commercial area using modern instrumentation..................				X		
10.1018. Make recommendations as may be indicated for improving a unsatisfactory commercial air distribution system..				X		☐

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0 Additional Practice

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10.110 K. Electric Heat Systems						
10.111. Calculate the heat loss in wattage on a room basis for a structure				X		
10.112. Select the most appropriate type of system of a particular application				X		
10.113. Choose the correct operating and safety controls for the system selected				X		
10.114. Design and lay out the complete system				X	0	
10.115. Demonstrate the ability to inspect and test systems and components for safe and proper operation				X		
10.116. Correct problems with electric heat system, its design or any component thereof				X		
10.117. Compare and evaluate various systems				X	0	
10.118. Estimate approximate annual operating cost				X		
10.119. Measure efficiency of any electric heat system				X		
10.1110. Make recommendations as may be indicated for greater energy conservation and/or comfort				X	0	
10.120 L. Solar Heating and Cooling Systems						
10.121. Demonstrate an understanding of terminology associated with solar energy						E
10.122. Determine promising applications of solar energy						E
10.123. Evaluate the economics and performance of solar systems						E
10.124. Estimate average energy availability at the earth's surface						E
10.125. Differentiate between climatic constants in different areas						E
10.126. Select collectors						E
10.127. Select storage medium						E

X Instruction

0 Additional Practice

□ Advanced Instruction

E Elective

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AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

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10.128. Determine collector orientation						E
10.129. Compare concentration systems						E
10.1210. Evaluate solar water heating						E
10.1211. Compare solar air conditioning and dehumidification systems						E
10.1212. Assess types of solar power generation						E
10.1213. Perform F-chart analysis						E
10.1214. Solve design problems in existing and proposed solar heating/cooling systems						E
10.130 M. Automotive Air Conditioning						
10.131. Install gauge manifold						E
10.132. Interpret pressure readings						E
10.133. Determine correct refrigerant level						E
10.134. Identify component failure						E
10.135. Use sling psychrometer to obtain wet bulb temperature						E
10.136. Know oil type and amount required for system lubrication						E
10.137. Know how to replace components, evacuate, and recharge systems						E
10.138. Use electrical schematics						E
10.139. Check fuses						E
10.1310. Check for open circuits						E
10.1311. Check for grounding (shorts)						E
10.1312. Demonstrate air by-pass and diversion from outside vents to bi-level, defrost, heating, and cooling						E
10.1313. Perform miscellaneous service, i.e., drains, belts, vibration, drives, bolts and nuts, and cleaning process						E

X Instruction

O Additional Practice

☐ Advanced Instruction

E Elective

SUGGESTED

AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS

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	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr. - CC/TI	7th/8th Qtr. - CC/TI
11.00 XI. Drafting and Blueprint Reading						
11.10 A. Planning						
11.11. Organize activities for efficiency		X				
11.12. Outline data for use		X				
11.20 B. Sketching						
11.21. Sketch objects	X					
11.22. Sketch working drawings		X				
11.30 C. Technical Drawing						
11.31. Use drafting equipment						X
11.32. Draw objects so as to describe their shape through orthographic, pictorial, sectional, and/or auxilary view techniques						X
11.33. Use scales to describe the size of an object						X
11.34. Do lettering and dimensioning						X
11.40 D. Blueprint Reading						
11.41. Visualize shapes of objects	X					
11.42. Determine dimensions		X				
11.43. Interpret specifications		X				
11.44. Know meanings of lines and symbols		X				
11.50 E. Graphics						
11.51. Prepare charts and graphs						X
11.52. Develop diagrams		X				
11.53. Develop maps, pictures, and/or drawings						X

X Instruction

O Additional Practice

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12.00 XII. Mathematics						
12.10 A. General Math						
12.11. Perform basic operations	X					
12.12. Perform operations involving fractions, decimals, and percentages	X					
12.20 B. Measurement						
12.21. Use English system	X					
12.22. Use Metric system	X					
12.30 C. Algebra						
12.31. Perform basic operations	X					
12.32. Perform advanced operations	X					
12.40 D. Geometry						
12.41. Use plain and solid figures		X				
12.42. Determine area and volume		X				
12.50 E. Trigonometry						
12.51. Peform basic operations				X		
12.52. Perform advanced operations				X		
13.00 XIII. Safety and First Aid						
13.10 A. Safety						
13.11. Use safety equipment	X					
13.12. Know and abide by safety rules and regulations	X					
13.13. Locate and switch off the master power switch	X					

X Instruction

0 Additional Practice

☐ Advanced Instruction

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AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS

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13.14. Perform safe evacuation from shop	X					
13.15. Protect equipment and personnel from unsafe conditions	X					
3:20 B. First Aid						
13.21. Perform simple first aid procedures	X					
13.22. Know location of first aid kit	X					
XIV. Welding						
14.10 A. Oxyacetelyne						
14.11. Perform soldering operations			X			
14.12. Perform brazing operations			X			
14.13. Perform welding operations			X			
14.14. Perform cutting operations			X			
14.20 B. Arc						
14.21. Set up equipment			X			
14.22. Select electrode			X			
14.23. Perform welding operation			X			
XV. Science						
15.10 A. Units and Measurements						
15.11. Identify units of length, weight and volume	X					
15.12. Estimate the length and weight of objects in metric units	X					
15.13. Convert from inches to mm or cm and from lb. to kg.	X					
15.14. Convert from in^3 to cm^3	X					
15.15. Perform measurements using British or metric machinist rules	X					

X Instruction

0 Additional Practice

□ Advanced Instruction

SUGGESTED AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY EDUCATIONAL LEVEL

Task	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr. - CC/TI	7th/8th Qtr. - CC/TI
15.16. Perform measurements using British or metric micrometer calipers	X					
15.17. Perform measurements using British or metric venier calipers	X					
15.18. Use the correct number of significant figures		X				
15.19. Estimate error in measurements and calculations		X				
15.20 B. Properties of Materials						
15.21. Use tables of density, specific gravity, and specific heat			X			
15.22. Read gauges and meters	X					
15.23. Make measurements to determine density or specific gravity			X			
15.24. Measurements to determine tensile strength		X				
15.25. Apply terms relating to properties of materials			X			
15.26. Calculate density, specific gravity, and specific heat			X			
15.27. Calculate temperature, volume, and pressure changes in a gas	X					
15.28. Relate densities to buoyancy and flotation			X			
15.29. Follow directions, both oral and written, from lab experiences	X					
15.210. Graph and interpret graphs			X			
15.30 C. Mechanics						
15.31. Measure the power output of a rotating shaft			X			
15.32. Determine the efficiency of a machine			X			
15.33. Determine the energy required to do a given job			X			
15.34. Calculate velocity, distance or time			X			

X Instruction

0 Additional Practice

☐ Advanced Instruction

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15.35. Calculate acceleration, change in velocity or time..			X			
15.36. Identify all forces acting on a body...............			X			
15.37. Determine force required to start or stop a body....			X			
15.38. Identify causes of inefficiency in a machine........			X			
15.40 D. Heat						
15.41. Select correct thermometric device..................	X	□				
15.42. Use a thermometeric device to determine temperature..	X					
15.43. Calibrate thermometer...............................	X					
15.44. Calculate linear expansion and apply to job at hand..	X					
15.45. Calculate volume expansion of materials and apply to job at hand..	X					
15.46. Calculate or estimate heat absorbed and given up due to a temperature change............................	X	□				
15.47. Calculate or estimate heat produced in a mechanical operation..	X	□				
15.50 E. Light and Sound						
15.51. Determine the efficiency of a light fixture..........						
15.52. Lay out a simple lighting system....................						
15.53. Predict the results of additive color mixing.........						
15.54. Predict the results of subtractive color mixing......						
15.55. Determine the reverberation time of a room..........						
15.56. Analyze the performance of a loud speaker...........						
15.57. Measure and evaluate noise level....................			X			
15.58. Calculate BTU gain or loss from a structure.........			X			
15.60 F. Electricity and Magnetism						
15.61. Install meters and take readings....................	X	0	□			

X Instruction

0 Additional Practice

□ Advanced Instruction

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15.62. Set up simple circuits	X	0				
15.63. Test with an ohmeter	X					
15.64. Convert joules to foot-pounds	X					
15.65. Convert joules to calories	X					
15.66. Convert watts to horsepower	X					
15.67. Determine cost of electrical energy used	X					
15.68. Replace blown fuses	X					
15.69. Determine wire size	X					
15.610. Use an electromagnet	X					
15.611. Use an induction coil	X					
15.612. Charge a lead storage battery	X					
15.613. Use a transformer	X					
15.614. Build an induction heater (furnace)						
15.615. Rectify alternating current	X					
15.616. Use a capacitor to produce phase shift	X					
15.617. Use a variable resistor to control current	X					
15.618. Use an oscilloscope	X					
15.619. Determine charge of lead battery with a hydrometer	X					
15.620. Use Ohm's law to find resistance	X					
15.621. Use a relay	X					
15.622. Use generator	X					
15.623. Use an electric motor	X					
15.624. Build a copper-wire cell	X					
15.625. Ground an electrical device	X					
15.626. Determine the impedance of a coil	X					
15.627. Show lines of force of a magnet	X					
15.628. Determine compound resistances	X					
15.629. Determine how voltages combine	X					
15.630. Determine how currents combine	X					
15.631. Determine that like charges repel, etc.	X					

X Instruction

0 Additional Practice

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15.632. Determine the power used by a lamp, etc.	X					
15.633. Find the resistivity of a metal	X					
15.634. Determine the electrical equivalent of heat	X					
15.635. Find the horsepower of a motor	X					
15.636. Use the laws of transformers	X	0	0	0		
15.637. Explain the operation of a voltmeter or ammeter	X	0	0	0		
15.638. Find the field lines around a current-carrying wire	X					
15.639. Use the National Electric Code Handbook				X		
15.70 G. Auxillary						
15.71. Plot a graph			X			
15.72. Read a graph					X	
15.73. Read diagrams and charts (pie charts and histograms, for example)	X					
15.74. Perform the four basic arithmetic functions	X					
15.75. Extract a square root	X					
15.76. Add inverses	X					
16.00 XVI Communications						
16.10 A. Reading						
16.11. Read manuals, workbooks, work orders and memos	X	0	0	0		
16.12. Read books in the field	X	0	0	0		
16.13. Read the bulletin board and company publications	X					
16.14. Look up words in the dictionary	X					
16.15. Read articles in trade journals	X					
16.16. Read and interpret written instructions	X					
16.20 B. Writing						
16.21 Write reports, work orders, memos and instructions		X				

X Instruction

0 Additional Practice

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AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

Task	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
16.22. Make written application for employment - include resume		X				
16.23. Fill out a job application form		X				
16.24. Write a business letter		X				
16.25. Spell major terms related to job		X				
16.26. Write legibly		X				
16.27. Complete requisitions and purchase orders		X				
16.28. Make out a bill for goods sold		X				
16.30 C. Talking						
16.31. Give oral directions		X				
16.32. Speak to a small group		X				
16.33. Solve problems by asking questions		X				
16.34. Make suggestions to superiors - constructively		X				
16.35. Talk on the telephone in a job setting		X				
16.36. Participate in discussions		X				
16.37. Report orally on work		X				
16.38. Show conversational courtesy to others		X				
16.40 D. Listening						
16.41. Listen for correct meaning	X					
16.42. Listen for information and directions	X					
16.43. Listen to understand a person	X					
16.44. Listen to share feelings	X					
16.50 E. Visual Interpretation						
16.51. Be aware of surroundings	X					
16.52. Recognize problems and dangers	X					
16.53. Interpret signs, symbols, posters, and other visuals	X					
16.54. Interpret freehand sketches and diagrams	X					
16.55. Interpret graphs and maps		X				

X Instruction

0 Additional Practice

☐ Advanced Instruction

SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
17.00 XVII Professional Practice						
17.10 A. Business Management						
17.11. Maintain good relations with other employees.......	X		0	0		
17.12. Keep records of customers on file.................		X	0			
17.13. Maintain good public relations....................	X		0			
17.14. Compute overhead cost of each job.................		X		0		
17.15. Know local, state, and federal regulations pertaining to equipment to be used.......................				X		0
17.20 B. Ethics						
17.21. Respect competitors in same field.................	X		0		0	
17.22. Feel obligation to public to do a good job........	X	0	0		0	0
17.23. Have obligation to employee to give fair treatment..		X		0		
17.24. Know the value of work competently done...........	X		0		0	0
17.25. Respect laws, rules, and regulations which must be observed..		X			0	0
17.30 C. Standards						
17.31. Keep up-to-date records of changes................		X		0	0	
17.32. Keep in touch with manufacturer's recommendations..		X		0	0	
17.33. Know laws pertaining to equipment.................		X		0	0	
17.34. Keep informed.....................................						
17.35. Does those "plus" jobs............................						
17.40 D. Marketing						
17.41. Aware of total cost of equipment..................	X			0	0	
17.42. Know overhead cost to deliver and/or install material..		X	0			
17.43. Maintain list of available supplies to choose from.		X				
17.44. Aware of alternate systems to be used.............		X	0			

X Instruction

0 Additional Practice

☐ Advanced Instruction

SUGGESTED AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY EDUCATIONAL LEVEL	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
17.45. Can explain health benefits related to installation of job			X		0	0
17.46. Analyzes what could be done to decrease cost of installation and operation without sacrificing quality			X		0	0
17.47. Can compute first cost of job relative to operational cost			X	0	0	
XVIII Cultural Attributes						
.10 A. Values						
18.11. Interested in being informed	X					
18.12. Interested in becoming a better employee	X					
18.13. Interested in concerns of employer	X					
18.14. Careful in use of salary	X					
18.15. Committed to personal and professional goals	X					
18.16. Concerned for standard of living	X					
18.17. Has desire to learn	X					
.20 B. Attitudes						
18.21. Has desire to please	X					
18.22. Understands others' problems	X		0			
18.23. Is willing to work hard to improve	X		0			
18.24. Wants to fit into scheme of things	X					
.30 C. Philosophy						
18.31. Interested in all persons benefiting from improved working conditions by performing quality work efficiently	X					
18.32. Consistent attitude toward all phases of work and private life	X					

X Instruction

0 Additional Practice

☐ Advanced Instruction

SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
18.33. Has a definite purpose for working	X					
18.40 D. Humanistic and Social Skills						
18.41. Is dependable	X					
18.42. Understands all people	X					
18.43. Has aggressiveness to get the job done	X					
18.44. Is thorough in work habits	X	0	□			
18.45. Is thoughtful of others' problems	X					
19.00 XIX Interpersonal-Interacting Skills						
19.10 A. Leadership						
19.11. Is able to coordinate different phases of jobs				X	□	
19.12. Is able to take as well as give clear, concise instructions in a business-like manner		X	0			
19.13. Completes job in a professional manner so company is complimented			X	□	□	□
19.14. Motivates co-workers and helpers to accomplish objectives in least amount of time with quality retained			X	□	□	□
19.15. Insures company equipment and supplies are not misused	X	0	0	□	□	□
19.20 B. Teamsmanship						
19.21. Works well with other employees	X					
19.22. Respects views and opinions of others	X					
19.23. Does not openly discriminate	X					
19.24. Is concerned with total company objectives	X	0				
19.30 C. Personnel Management						
19.31. Understands and appreciates need for rules and regulations that are a function of good management practices.		X	0			

X Instruction

0 Additional Practice

□ Advanced Instruction

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SUGGESTED AIR CONDITIONING, HEATING AND REFRIGERATION TASKS BY EDUCATIONAL LEVEL	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
19.32. Understands and follows chain of command..............						
19.33. Decides who is to be assigned to job and how to best effect completion..................................	X	0	0	□		
19.40 D. Group Interaction						
19.41. Enjoys participation in group activities............		X				
19.42. Has something to contribute to group................		X				
19.43. Understands that the good of the group should come first..		X				
19.44. Aware of responsibilities of relating to individuals who are not as involved as they might be............	X					
19.50 E. Salesmanship						
19.51. Understands and has knowledge of product and services to be sold..				X	0	□
19.52. Attentive to customer's "signals", moods, etc., and analyzing these, adjusts sales pitch to benefit sale.				X		
19.53. Attempts to get best reasonable price for company....				X		
19.54. Understands and appreciates fact that the better financial condition company is in, the better one's position...				X		
20.00 XX Information Retrieval						
20.10 A. Recall						
20.11. The recall of basic ideas by memory games, word/object associations, and other techniques...........		X				
20.12. Takes notes to help recall technical facts..........				X	0	0
20.13. Keeps log books for all jobs or installations that are not of the ordinary design......................				X	0	0

X Instruction

0 Additional Practice

□ Advanced Instruction

SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

Task	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
20.20 B. Data Collecting						
20.21. Reads technical manuals and trade journals, then files according to predetermined system			X			
20.22. Keeps personal technical library					X	
20.23. Collects manufacturers' releases and files in library					X	
20.24. Requests engineering data from related manufacturers' files for future use.				X	0	
20.25. Removes installer's information sheets from new equipment and files under area and customer				X		
20.30 C. Self Instruction						
20.31. Obtains subscriptions to trade journals				X		
20.32. Collects and files trade releases for new products for study and evaluation				X		
20.33. Attends service schools sponsored by both industry and educational institutions				X	0	0
20.34. Checks "junk mail" sent by manufacturing companies for new or improved products or designs or performance changes				X		
21.00 XXI Personal Skills and Traits						
21.10 A. Reliability						
21.11. Arrives on time	X	0	0			
21.12. Keeps promises	X	0	0			
21.13. Follows orders intelligently	X	0	0			
21.20 B. Thoroughness						
21.21. Willing to finish the job	X		0		0	
21.22. Listens carefully for complete instructions	X	0	0			
21.23. Uses best information and tools available for job	X	0	0			

X Instruction

0 Additional Practice

☐ Advanced Instruction

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SUGGESTED AIR CONDITIONING, HEATING, AND REFRIGERATION TASKS BY EDUCATIONAL LEVEL	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
21.30 C. Neatness						
21.31. Always cleans up after job is done	X	0	0			
21.32. Keeps tools in proper shape	X	0	0			
21.33. Dresses appropriately for the job	X	0	0			
21.34. Keeps hair well groomed and uniform clean	X	0				
21.40 D. Efficiency						
21.41. Looks for ways to save time and labor	X			0		0
21.42. Completes tasks in appropriate period of time	X	0	0			
21.43. Looks for ways to save materials, use less expensive materials and not waste materials	X					
21.44. Looks for ways to decrease non-productive work	X					
21.50 E. Integrity						
21.51. Can be trusted at all times	X	0	0			
21.52. Provides accurate information about the job	X				0	0
21.60 F. Honesty						
21.61. Can handle money safely	X	0	0			
21.62. Is careful and honest with time allotted	X	0	0			
21.70 G. Receptivity						
21.71. Accepts authority easily	X					
21.72. Accepts job assignments willingly	X					
21.73. Understands reason for job						
21.74. Takes time to get proper instructions and asks when there is doubt						

- X Instruction
- 0 Additional Practice
- □ Advanced Instruction

SUGGESTED

AIR CONDITIONING, HEATING AND REFRIGERATION TASKS

BY EDUCATIONAL LEVEL

	1st Qtr. - CC/TI	2nd Qtr. - CC/TI	3rd Qtr. - CC/TI	4th Qtr. - CC/TI	5th/6th Qtr.-CC/TI	7th/8th Qtr.-CC/TI
21.80 H. Sensitivity						
21.81. Has a feel for human relations	X		0		0	
21.82. Responds to other's feelings constructively		X		0		0
21.83. Explains that overall needs must be met despite some difference of opinion		X				
21.90 I. Practicability						
21.91. Has ability to keep proper perspective of job relations	X		0		0	
21.92. Uses good judgement in work decisions		X		0		0
21.100 J. Friendliness						
21.101. Willing to accept other's viewpoints	X		0	0		
21.102. Meets new people easily		X		0		0
21.103. Helps new personnel become productive		X				
21.110 K. Altruism						
21.111. Can place oneself in another's shoes	X		0			0
21.112. Interested in employer, employee, and customer's concerns		X		0		0

X Instruction

0 Additional Practice

☐ Advanced Instruction

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AIR CONDITIONING, HEATING, AND REFRIGERATION

COMPETENCIES AND CRITERION MEASURES

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This list of competencies identifies major abilities expected of a person working in the air conditioning, heating, and refrigeration field. One competency statement is given for each major task area, along with suggested criteria for evaluating the persons ability to perform the stated competency. For general competency statements by job level refer to the section titled Job Descriptions/Job Competencies. For specific performance and instructional objectives by educational level refer to the course outline section of the manual.

APPENDIX K

AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
1.1 Oil Heat	• Given an oil furnace requirement, select tank, and piping, and install.	• Installation to meet requirements as to size, code requirements as to oil piping and venting. • Start up and check out to include tests for efficiency of operation and safety of operation.
1.2 Gas Heat	• Given gas furnace tubing, valves, and fittings, connect lines with valves and regulator so as to be neat, safe, and meet all codes.	• Installation to meet requirements as to size, code requirement as to gas piping and venting. • Start up procedures to include test of inlet gas pressure, proper input, and safety controls.
1.3 Heat Pumps and Electric Heat	• Given the need for an electric heating system, select and install equipment.	• System to be installed to meet all codes. Size and select wiring, disconnects, breakers, and heating equipment. • Be able to start up and test equipment for proper operation, safety, and efficiency.
1.4 Heat Loss Calculations	• Given house plans and specifications, compute amount of heat loss and heat gain, giving size of equipment needed to do the job at hand.	• Proper sizing of equipment to insure energy conservation and customer satisfaction.
1.5 Combustion	• Given draft and combustion requirements, select the fuel and match the equipment after learning the availability and storage/delivery requirements. • Plan and complete installation of equipment and work with codes and building construction.	• Calculate heat load. • Calculate cost per million BTU • Evaluate annual fuel consumption from design conditions.

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AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
2.1 Mechanical Diagnosis and Servicing	• Given the location and customer complaint, the student will arrive at the job site promptly, locate cause of mechanical trouble, and correctly repair trouble.	• Time consumed will be as little as possible. • System will operate properly upon completion. • Customer satisfied if possible.
2.2 Electrical Diagnosis and Servicing	• Given a malfunctioning heat pump or air conditioning system, systematically diagnose by using the proper test equipment, find the cause of trouble, and repair or replace defective electrical controls or components.	• The defective control or component will be located by systematic testing using the proper test equipment and unit schematic wiring diagram. • The defective control or component will be repaired or replaced. • The system will be checked for proper operation.
2.3 Hand Tools	• Given hand and specialized tools, demonstrate proper use.	• Tools are clean. • Tools are not damaged. • Parts are not damaged (use correct tool). • Safety precautions are used.
2.4 Electrical Instruments	• Given electrical instruments, properly use them to check electrical circuits.	• Faulty circuits will be correct. • System will operate properly.
2.5 System Cleanup After Burnout	• Given a system which needs a compressor replaced, determine cause of failure if system is acid. • Give proper cleaning as recommended by manufacturer	• Compressor is replaced. • Systme is free of acid. • System operates properly.
2.6 Heat Pumps	• Given units of a complete heat pump assembly, install and service according to specifications.	• Installation and service follows a logical sequence with a minimum of time involved.

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AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
3.1 Tools and Materials	Use tools, instruments, and materials to install and service refrigeration systems.	Tools used correctly and safely. Materials used efficiently. Instruments used properly.
3.2 Mechanical Compression Systems	Observe, test, evacuate, and charge a refrigerant compression system.	Compression system properly evacuated and charged.
3.3 Motors and Controls	To recognize motor and control types for proper application.	Able to apply new or replacement motor.
3.4 Refrigerated Cabinets	Given a refrigerator, the student will service or clean a component until it is serviceable or acceptable in appearance to the owner.	Be competent in matching finish, hardware, and general cycle of cooling and defrosting. Be aware of insulation migrating and vapor barriers.
3.5 Repair of Cabinets and Mechanisms-Mechanical	The student will, from memory, remove, install (replace), braze, and add oil and refrigerant so that a component functions according to manufacturer's specifications.	Use meters to obtain flow rate and temperature range and to obtain desired pressure and temperatures.
3.6 Troubleshoot and Repair Cabinets and Mechanisms-Electrical	Given an HVAC system, the student will test from memory the continuity of devices, circuitry, and components using a VOM or Amprobe instrument.	Sequence and correct method to make equipment operational.
3.7 Commercial Refrigeration Systems	To determine type of system for specified type of food storage.	Unit must maintain proper temperature as specified.
3.8 Servicing	Given proper equipment and parts, approach a problem with a knowledge of operation of equipment and components, locate malfunction, and	Unit will operate correctly and efficiently.

AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
	establish reasons for failure using test equipment.	
4.1 Air Handler	• Recognize air handling equipment, blowers, drivers, and electrical components. • Be able to adjust, measure, identify, and service complaints of air handling components.	• Cubic feet per minute (CFM) will be determined by measuring psychrometrics of entering and leaving air. • Balance the make-up and recirculated air for temperature and humidity control.
4.2 Duct Systems	• Given a set of blueprints and specifications, fabricate duct in shop then install the duct. • Balance air in ducts by means of dampers.	• The duct system will supply proper BTU's to each room for comfort cooling and heating without disturbing drafts or noise.
4.3 Exhaust and Make-up Air Systems	• Know the function, total exhaust, and make-up air change of system.	• Relative humidity, CFM, and temperature will comply with architect's specifications as determined by instruments.
5.1 Checking Condition of Air	• Given a sling psychrometer, wet the sack, sling properly, and read the resulting dry bulb and wet bulb temperatures. Locate same on the psychromatic chart.	• Identify and determine the values of the other properties of air on the psychromatic chart by using the WB and DB values of sample of air as determined when using the sling psychrometer. Determine air quantity.
5.2 Humidification	• Given a humidifier, install in the correct location, wire correctly, put into operation, and/or service properly.	• Relative humidity of the air from the conditioned area would be within the limits. • Repair non-operable unit so that it will function properly.

AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
5.3 Dehumidifying Air	• Given a dehumidifier, select location, install or service, and put into/or return to operation.	• Humidity in conditioned area will be reduced to tolerable or specified conditions.
5.4 Cleaning Air	• Given an air filter (porous, viscous, or electrostatic), install, connect, or service.	• Proper cleanliness of air, accessibility for service after installation, and testing for repair are essential for competency. • Customer satisfaction and economy of performance are also required.
6.1 Wiring Diagrams	• Given a schematic (electrical or pneumatic), identify, connect, service, and maintain system along with components.	• Proper identification of equipment related controls, problems, adjustment setting for performance, and preventative maintenance.
6.2 Test Equipment	• Given an assortment of test equipment, choose proper test piece and use to gather necessary data.	• Proper application and use as well as maintenance and care of equipment.
6.3 Components	• Recognize and call each component by name.	• The function of each component and its relationship to the entire unit is described.
6.4 Refrigerant Controls	• Given a blueprint, know proper controls (metering devices) by size and type of refrigerant, their function, adjustment problems and servicing procedures.	• Identification of various types of metering devices. • Install and adjust for proper metering of refrigerant • Adjust and control for superheat in system.
6.5 Wiring and Controls	• To be able to select, install, and wire electrical or mechanical controls.	• Sequence of operating is determining factor of a good control installer.

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AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
7.1 Fabrication	• Be able to read, interpret, and lay out metal for fabrication.	• Follow blueprint for proper tolerance. • Duct work fabricated in the shop should fit space requirements of the installation with a minimum of alterations from blueprints and specifications.
7.2 Installation	• To recognize all component parts and system components that are needed to complete a particular installation.	• System is assembled in a determined amount of time.
8.1 Cost Factors	• Given plans and specifications, price all cost items.	• All cost items will be properly listed and priced.
8.2 Procurement	• Given list of materials, place all orders with correct suppliers.	• Purchase orders will be issued. • Receiving date for all materials will be verified. • Materials bought for correct cost.
8.3 Pricing Factors	• Given plans and specifications, know bid requirements and sub-contracts needed.	• List bonds and permits required. • List all sub-contracts. • Price complete job. • Price permits.
8.4 Specification actors	• Given specifications, know which codes apply and cost of bonds.	• Know the codes. • Know bond requirements and cost.
9.1 Mechanical Systems	• Given a specific mechanical system, analyze all components in relation to achieving energy conservation.	• The student will define scientific recommendations to facilitate substantial energy savings from any or all of the components and their related condition.

AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
9.2 Electrical Systems	• Interpret and explain all electrical systems associated with air conditioning, heating, and refrigeration systems.	• Given any specific set of energy depleting symptoms, isolate and identify a component that is malfunctioning.
9.3 Records	• Interpret gauges, meters, and recorders and keeps records of information.	• Determine, interpret, and/or extract operational characteristics from past records.
9.4 Public Relations	• Talk with customer about the energy conservation features of a specific unit.	• Deliver a talk on the energy features of a system to a group in a concise and informative manner.
9.5 Insulation Materials.	• Compute "R" value of existing construction and proposed buildings.	• Make calculation and determine heat transfer ratio of sq. ft. of a specific wall.
9.6 Oil Burner Efficiencies	• Select, install, and service oil furnaces according to code to maximize efficiencies.	• Installation meets all code requirements for fuel, chimneys, wiring, and operation. • Efficiencies meet manufacturer's specifications.
9.7 Gas Burner Efficiencies	• Select, install, and service gas furnaces according to code to maximize efficiencies.	• Installation meets all code requirements for fuels, chimneys, wiring, and operation • Efficiencies meet manufacturer's specifications.
10.1 Hydronic Distribution Systems	• Given a blueprint of a building and heat loss/gain calculations design and correctly size complete hydronic distribution systems.	• The design will be easy to follow. • The system will meet all space requirements. • The system will fit space allotted. • The system will be economical to install and operate.

AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
10.2 Hydronic Systems Balance	• Given system layout, design location and type of hydronic system balancers required.	• Balancing devices will be sized and located properly.
10.3 Gas Piping and Venting	• Given blueprints and equipment specifications, calculate gas piping size, estimate the size and type fittings needed, select and size the vent system, calculate the required amount of ventilation and combustion air, and specify clearances as outlined in AGA Recommendations and N. C. Building Code, Vol. III.	• The piping will be sized in accordance with AGA Recommendations and N. C. Building Code, Vol. III. The required amount of ventilation and combustion air will be supplied to unit according to code. The vent system will be selected and sized in accordance with the code. The clearances of equipment shall conform to AGA Recommendations and code requirements.
10.4 Transport Refrigeration	• Identify types of transport refrigeration systems and methods of powering the systems. • Employ maintenance procedures for proper operation.	• Set controls, superheat, charge, and set control devices for proper operation. • Will know drive types, component service, and coordination.
10.5 Commercial Refrigeration Systems	• Design and layout a commercial refrigeration system for given products. • Select high and low side equipment. • Calculate equipment load.	• Equipment is sized properly. • System design is correct. • Operational costs are optimum.
10.6 Industrial Refrigeration Systems	• Apply basic refrigeration principles as applicable to industrial refrigeration, but be aware of sophistication of controls.	• Identify the relationship of the four (4) basic components plus adjustment of controls and charges.

AIR CONDITIONING, HEATING, AND REFRIGERATION COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
10.7 Residential Air Conditioning Systems	• Design a properly sized, balanced, and competively priced residential air conditioning system.	• The system will be complete with equipment list, layout sketch for heating and cooling units, distribution and return duct system, appropriate control system.
10.8 Residential Air Distribution	• Calculate, design, size, and price complete residential air distribution system	• From blueprint install and balance as required for air conditioning and heating. • Service air handling components (both electrical and mechanical).
10.9 Commercial Air Conditioning Systems	• Design a commercial air conditioning system that meets design criteria and budget.	• Calculate heating and cooling loads. • Select equipment. • Design air and hydronic system components.
10.10 Commercial Air Distribution Systems	• Given a set of blueprints and specifications, compute heat gain and loss and select project equipment for commercial air distribution system.	• When properly installed, system will provide comfort conditions within the comfort zone.
10.11 Electric Heat Systems	• Given a set of blueprints and specifications, design an electric heat system to conform to design conditions according to ASHRAE guide.	• System will perform correctly for comfort heating and cooling when properly installed.
10.12 Solar Heating and Cooling Systems	• Design and sketch out all components and associated equipment for total solar heating and cooling system.	• The system will be practical, feasible, and easily installed. • It will supply all needs for heating and cooling without sacrifice of comfort to the occupants.

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AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
10.13 Automotive Air Conditioning	• Given an automobile with factory installation or add-on air conditioning, the student must from memory be able to approach service problem for a correct trouble diagnosis.	• Name auto manufacture, year, component or system failure, then correct problem using manufacturer's specifications.
11.1 Planning	• Given a job order, develop preliminary sketches, evaluations, and measurements. From these, develop plans and working drawings to scale	• Plans and specifications to be accurate, to scale, dimensioned, clear and concise with necessary elevations, sections, and enlargements so as to give a true picture of job requirements.
11.2 Sketching	• Given a job order, develop sketches showing required elevations and preliminary plan.	• Sketches of elevations and floor plan to be developed to scale showing required detail.
11.3 Technical Drawing	• Lay out duct plans and drawings of various apparatus.	• Neat plans provided with details, notes, etc., that skilled mechanic could understand and fabricate.
11.4 Blueprint Reading	• Given a job order with a blueprint, develop plan and specifications.	• Draw plan to scale, develop elevations, and make required dimensions. • Develop charts and schedules of equipment and symbols used.
11.5 Graphics	• Develop graphs and fuel consumption for specific fuel using equipment.	• Know and interpret energy use using known wattage/BTU for all fuels desired.
12.1 General Math	• Solve problems in heat gain and loss, estimating, duct sizing, areas, volumes, and velocities.	• Be able to arrive at correct heat loss and gain values from a blueprint. • Determine cost, overhead, selling price of job, and interest and percentages.

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AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
12.2 Measurements	· Lay out and size components in all systems by applying math involved in time, rate, distance as related to volume, weights, and energy demands.	· From job specifications, be able to calculate size of equipment and system components for a given job.
12.3 Algebra	· Solve equations for unknowns with air movement problems such as duct size, velocity, volume mixtures desired.	· Lay out duct systems using algebraic principles. · Solve for temperatures, pressures, and volumes as used in the refrigeration process.
12.4 Geometry	· Prepare good duct fitting layout. · Calculate compressor capacity.	· Be proficient in sheetmetal layout. · Be able to do application engineering.
12.5 Trigonometry	· Use trigonometry to solve problems related to duct fabrication and installation.	· Solve right angle trigonometry problems for unknowns. · Uses trigonometry in laying out and joining ducts.
13.1 Safety	· Determine correct safety measures for various locations.	· Know local, state, and federal laws pertaining to storage of compressed gases. · Use correct safety measures for protection to eyes. · Have proper ventilation for soldering and brazing. · Use OSHA approved equipment and tools.
13.2 First Aid	· Administer first aid to accident victim using life saving techniques.	· Be able to stop flow of blood, administer mouth to mouth resusitation; cpr, and prevent or treat for shock. · Be able to describe treatment to proper medical authorities.

Subject (Task)	Competency	Criterion Measure
14.1 Oxyacetylene	• Select a soldering project, prepare the surface, select the flux, select filler material, and solder the project. • Select a brazing project, prepare the surface, select the flux, select filler material, and braze the project. • Select a welding project, prepare the workpiece, select rod, and weld the project. • Cut object according to print specifications.	• Inspect flow of filler materials for adherence, excessive build-up, weak spots, and appearance. • The student will set up torch for cutting operation, cut, and prepare weld test plates. • Inspect weld test plates for correct angles, size, and finish. • Inspect tightness for fitting, setting of gauges, size of tip, and lighting the torch. • Take project apart and inspect for cleanliness of parts, pits in filler material, and amount of filler material used. • Inspect for flow of filler material, adherence of filler material to part, and test project for strength. • The student will select a project, prepare the material, select filler material, and weld the part.
14.2 Arc Welding	• Set the welding machine for correct current, ensure positive ground connection, wear proper clothing, take safety precautions, strike an arc, and weld a part. • The student will select the proper electrode by using a print with welding specifications as to size and grade.	• Inspect electrode as to specifications, size and grade. • The student will prepare material for weld test plate, weld plate, clean slag, remove backup strip, saw coupons, grind surfaces, and chamfer. • Inspect for pits, slag, and form coupons to specifications. • Inspect for cracks and penetration of filler material to parent metal.

AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
15.1 Units and Measurements	• Be able to accurately measure and calculate from instruments, tables, and graphs.	• Takes accurate measurements in English and metric units. • Computes conversions from English to metric.
15.2 Properties of Materials	• Know properties of materials used in air conditioning, heating, and refrigeration field.	• Measure density, melting point, tensile strength, and specific heat.
15.3 Mechanics	• Develop the ability to perform tests on machinery.	• Field test and compare the manufacturer's specifications for accuracy.
15.4 Heat	• Measure temperature of materials or objects and their surroundings. • Given a specific material and a means of adding heat to it, determine expansion and quantity of heat absorbed.	• Proper record and calculation of heat measurements.
15.5 Light and Sound	• Interpret effect of sound as related to physical comfort. • Recommend construction practices that use sunlight to an advantage in heating and cooling a structure.	• Be able to make accurate sound measurements. • Describe how sunlight affects heating/cooling needs of a structure.
15.6 Electricity and Magnetism	• Given electrical measurement instruments, demonstrate proper use to isolate and correct electrical problems	• Proper meter (instrument) selected and connected to circuit properly. • Power "on" or "off" as appropriate or proper measurement and to prevent damage to instrument. • Isolate troubles in transformers and controls (magnetic) to low voltage or operating voltage problem.

AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
		• Determine if a motor is working within its capabilities. • Use National Electric Code (NEC) to determine conductor size, fuse, or circuit breaker size.
15.7 Auxiliary	• Develop the ability to graphically illustrate functions or data.	• Can perform simple data analysis techniques. • Does work accurately.
16.1 Reading	• Read chapter of textbook giving time required and how much was retained.	• Understands what is read.
16.2 Writing	• Given a trade journal, outline a topic.	• Outline should be legible
16.3 Talking	• Given a project from major areas, give a talk explaining the different parts, how they function, and what purpose each plays with the total project.	• Understood by others.
16.4 Listening	• Given verbal instructions or information, understands what is said.	• Makes appropriate response to instructions or information.
16.5 Visual Interpretation	• Showing a film, individual should summarize what was viewed.	• Understands what was seen.
17.1 Business Management	• Manage a business.	• Continue as a profitable business.

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AIR CONDITIONING, HEATING, AND REFRIGERATION COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
17.2 Ethics	• Gain respect of others.	• Has respect of competitors, public, employer and other employees.
17.3 Standards	• Interpret manufacturer's bulletins and disseminate information of changes involving operation, costs, efficiencies, and codes.	• Maintain and be able to give information as to operational characteristics, performance, mortality, and past records.
17.4 Marketing	• Calculate the job overhead, labor, material, tax, etc., including miscellaneous costs such as using subcontractors.	• Ability to bid a job and answer pertinent customer questions.
18.1 Values	• Exhibits commitment toward self and field of employment.	• Performs expected duties willingly and competently. • Demonstrates good work habits.
18.2 Attitudes	• Adapts and responds to concerns of others.	• Has a good attitude. • Satisfies customers • Pleases employer.
18.3 Philosophy	• Function consistently in everyday situations	• Shows promptness, cheerfulness, interest in goals of the company, and respect for his industry.
18.4 Humanistic and Social Skills	• Pleasant associations within the company	• Character reflects the attitude and respect an individual has for himself, his fellow employees, and management.

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Subject (Task)	Competency	Criterion Measure
19.1 Leadership	• Able to motivate people.	• Gets desired results.
19.2 Teamsmanship	• Works well with others to get a job done.	• Problems originating from one source is an indication of incompatibility. • Good team groups accomplish their goals with little help from management.
19.3 Personnel Management	• Good employee management relationships.	• Employees willingly bring problems for assistance. • Employees confident in management. • Employees express their views.
19.4 Group Interaction	• Interacts within group to get job done.	• Advancement in leadership and/or responsibility
19.5 Salesmanship	• Makes sales	• Has satisfied customers.
20.1 Recall	• Able to use knowledge of previous job.	• Be able to use previous problems to solve new ones.
20.2 Data Collecting	• Will have the various business technical information and knowledge to meet job needs.	• Demonstrate ability to cope with many varied problems. • Apply the latest trade methods to work.
20.3 Self Instruction	• Increases technical knowledge through self-study.	• Individual job advancement.
21.1 Reliability	• Acts in reliable manner.	• Arrives at job on time. • Keeps promises. • Follows instructions.

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AIR CONDITIONING, HEATING, AND REFRIGERATION
COMPETENCIES AND CRITERION MEASURES

Subject (Task)	Competency	Criterion Measure
21.2 Completes Job.	· Is thorough and persistant.	· Successful use of labor-saving information and tools. · Completes job.
21.3 Neatness	· Sees job site neatness as a desirable goal.	· Job area is free from clutter and clean. · Appearance is neat and appropriate for the job.
21.4 Efficiency	· Works in an efficient manner.	· Minimum time on the job.
21.5 Integrity	· Answers truthfully and accurately at all times.	· Statements are truthful and accurate at all times.
21.6 Honesty	· Accounts for monies and time.	· Makes change carefully and keeps time records accurately.
21.7 Receptivity	· Accepts various job assignments from those in authority.	· Does not complain at changes in job assignments.
21.8 Sensitivity	· Treats others as he wants to be treated.	· Gentle with others.
21.9 Practicability	· Maintains good job relations.	· Exhibits job stability. · Makes effective decisions.
21.10 Friendliness	· Understands basic psychology in the art of getting along with others and in following desires and wishes of employers.	· Follow and be able to discuss personal skills, traits, and mental attitudes that are harmonious.
21.11 Altruism	· Devoted to interests of Air Conditioning, Heating, and Refrigeration field.	· Attentive, positive, and knowledgeable as to aims and emphases of the AHR field task with alternatives.

AIR CONDITIONING, HEATING, AND REFRIGERATION

TASK ANALYSES

AND

COMPETENCIES

TASK AREA: Heating

TASK # 1.1: Oil Heat

COMPETENCY: Given an oil furnace requirement, select equipment, tank, and piping, and install.

CRITERION: Installation to meet requirements as to size, code requirements as to oil piping and venting.

Start up and check out to include tests for efficiency of operation and safety of operation.

SKILL/PROCESS:
1. Install storage tank above or below ground.
2. Run oil line with filter and valves.
3. Run vent and fill lines.
4. Select equipment to be installed.
5. Install equipment.
6. Connect to prefabricated or job erected flue.
7. Service equipment.

KNOWLEDGE/THEORY:
1. Installing storage tank
   a. Code requirements
      1. Depth
      2. Distance from building
      3. Pitch
      4. Archimedes law
   b. Piping
      1. Fill
      2. Vent
      3. Oil lines
         a. One pipe
         b. Two pipes
2. Run oil lines, etc.
   a. Piping, one pipe, two pipes
      1. Sizing
      2. Materials
   b. Filters
      1. Sizing
      2. Media
      3. Positioning
   c. Safety valves
      1. Code pertaining to safety
      2. Sizing
      3. Materials
3. Run vents and fill lines
   a. Code pertaining to same
      1. Sizing
      2. Materials
      3. Location

4. Select equipment to be installed
   a. Manufacturer's specifications
   b. Size requirements
   c. Style (upright-horizontal, etc.)
5. Install equipment
   a. Handling during delivery
   b. Code requirements
      1. Clearances
      2. Location
      3. Supporting materials
6. Connect to flue
   a. Prefabricated flue
      1. Clearances
      2. Materials for connection
      3. Size (diameter and length) of connection
   b. Masonry flue
      1. Clearances
      2. Materials for connection
      3. Size (diameter and length) of connection
   c. Code requirements
7. Service equipment
   a. Select test equipment
      1. Oil gauge
      2. Smoke tester
      3. CO_2 tester
      4. Stack thermometer
      5. Duct thermometer
      6. Hand tools
   b. Troubleshoot
   c. Remove
   d. Repair
   e. Replace
   f. Adjust
   g. Test
   h. Operate

VALUE/ATTITUDE

CONCEPTS:

1. Systematic analyses of procedures
2. Safety on job
3. Quality and workmanship
4. Care of owner's property
5. Treatment and care of equipment
6. Testing and checkout
7. Housekeeping and job cleanup
8. Owner's education in operation
9. Reason for tank selection
   a. Cost comparison
   b. Soil conditions
   c. Terrain
   d. Owner's requirement
10. Adaptability of equipment: Size (physical), quality, safety, operational qualities

11. Analysis of burner
    a. Efficiency of combustion
    b. Wiring
    c. Check out of blower
    d. Quietness
    e. Speed
12. Proper use of tools, testing equipment

TASK AREA: Heating

TASK # 1.2: Gas Heat

COMPETENCY: Given gas furnace tubing, valves, and fittings, connect lines with valves and regulator so as to be neat, safe, and meet all codes.

CRITERION: Installation to meet requirements as to size, code requirement as to gas piping and venting.

Start up procedures to include test of inlet gas pressure, proper input, and safety controls.

SKILL/PROCESS:
1. Install piping for gas line.
2. Select equipment.
3. Install equipment.
4. Connect to prefabricated or job erected vents and flues.
5. Service equipment selected and installed

KNOWLEDGE/THEORY:
1. Installing gas piping
   a. Sizing
      1. Diameters
      2. Lengths
      3. Schedule
   b. Materials
      1. Steel
      2. Aluminum
      *3. Copper
   c. Code requirements
   d. Pressure testing
      1. Low pressure
      2. High pressure
2. Equipment selection
   a. Manufacturer's specifications
   b. Size requirements
   c. Style
3. Equipment installation
   a. Handling during delivery
   b. Code requirements
      1. Clearances
      2. Location
      3. Supporting materials
4. Connect to flue
   a. Prefabricated flue
      1. Clearances
      2. Materials for connection
      3. Size (diameter and length) of connection
   b. Masonry flue
      1. Clearances
      2. Materials for connection
      3. Size (diameter and length) of connection

* Not recommended for Natural Gas

c. Code requirements
5. Service equipment
   a. Select test equipment
      1. CO tester
      2. CO_2 tester
      3. "U" tube manometer
      4. Stock thermometer
      5. Duct thermometer
      6. Gas gauges
      7. Hand tools
   b. Troubleshoot
   c. Remove
   d. Repair
   e. Replace
   f. Adjust
   g. Test
   h. Operate

VALUE/ATTITUDE
CONCEPTS:
1. Systematic analysis of procedures
2. Safety on job
3. Quality and workmanship
4. Care of owner's property
5. Treatment and care of equipment
6. Testing and checkout
7. Housekeeping and job cleanup
8. Owners education in operation
9. Reason for tank selection (LP gas)
   a. Cost comparison
   b. Soil condition
   c. Terrain
   d. Owner's requirement
10. Adaptability of equipment
   a. Size (physical)
   b. Quality
   c. Safety
   d. Operational quality
11. Analysis of burner
   a. Efficiency of
   b. Wiring
   c. Check out of blower for quietness and speed
12. Proper use of tools and testing equipment

TASK AREA: Heating

TASK # 1.3: Electric Heat

COMPETENCY: Given the need for an electric heating system, select and install equipment.

CRITERION: System to be installed to meet all codes. Size and select proper wiring, disconnects, breakers, and refrigerant piping.

Be able to start up and test equipment for proper operation, safety, and efficiency.

SKILL/PROCESS:
1. Size conductors.
2. Run conduit from disconnect to equipment.
3. Select equipment.
4. Install equipment.
5. Service equipment selected and installed.

KNOWLEDGE/THEORY:
1. Conductors
   a. Size
   b. Ampacity
   c. Conduits
   d. Materials
      1. Copper
      2. Aluminum
   e. Grounding
   f. Insulations
   g. Code requirements
2. Service from disconnect to equipment
   a. Disconnects
      1. Size
      2. Style (fuse, circuit breaker, etc.)
      3. Location
      4. Code requirement
   b. Conduits
      1. Size
      2. Materials
      3. Code requirements
      4. Location
3. Equipment selection
   a. Manufacturer's specifications
   b. Size requirements
   c. Style
4. Equipment installation
   a. Handling during delivery
   b. Code requirements
      1. Clearances
      2. Location
      3. Supporting materials

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5. Service equipment
    a. Selected
        1. Voltmeter
        2. Clamp-on ammeter
        3. Ohmmeter
        4. Compound gauges with manifold and connecting lines
    b. Installed
        1. None

VALUE/ATTITUDE CONCEPTS:

1. Reason for proper sizing of electrical components
    a. Safety
    b. Equipment protection
    c. Protection of property and person
        1. Electrical fire
        2. Electrical shock
2. Same as (1)
3. Selecting
    a. Capacity for job requirements
    b. Adaptable to space
    c. Cost requirements
    d. Safety
4. Installing
    a. Appearance
    b. Quality of Work
5. Systematic testing and analysis of operation
    a. Check-out and start-up
    b. Capacity check
    c. Test equipment
    d. Proper use of test equipment
    e. Housekeeping
    f. Customer instruction concerning operation

TASK AREA: Heating

TASK # 1.4: Heat Loss Calculations

COMPETENCY: Given house plans and specifications, compute amount of heat loss and heat gain, giving size of equipment needed to do the job at hand.

CRITERION: Proper sizing of equipment to insure energy conservation and customer satisfaction.

SKILL/PROCESS:
1. Calculate air heating heat loss and heat gain.
2. Calculate hydronic heat loss.

KNOWLEDGE/THEORY:
1. Heat loss calculation for air
   a. Manual J-NESCA
   b. ARI
   c. ASHRAE
2. Hydronic heat losses (IBR Manual H-Z1)
   a. Detailed method
   b. Modern method

VALUE/ATTITUDE
CONCEPTS:
1. Systematic analysis of building
2. Orientation of building
3. Comparison of two types of insulation
4. Local code requirement
   a. State
   b. Federal

TASK AREA: Heating

TASK # 1.5: Combustion

COMPETENCY: Given draft and combustion requirements, select the fuel and match the equipment after learning the availability and storage/delivery requirements.

Plan and complete installation of equipment and work with codes and building construction.

CRITERION: Calculate heat load.

Calculate cost per million BTU.

Evaluate annual fuel consumption from design conditions.

SKILL/PROCESS:

1. Match proper oil/gas and heating equipment.
2. Select heating medium.
3. Select heating equipment.
4. Select and evaluate draft and combustion equipment.
5. Determine combustion air requirements.
6. Determine combustion by-products.
7. Choose burner shape and nozzle to match heat exchange.
8. Obtain peak operating efficiency using test instruments.

KNOWLEDGE/THEORY:

1. Choosing type heater
   a. Heat content of the fuel
   b. Limits of equipment
2. Selecting means of transferring heat
   a. Cooling/heating medium
   b. Air
   c. Water
3. Heating equipment
   a. Air handling
   b. Boiler
   c. Hydronics
4. Draft and combustion equipment
   a. Forced or gravity flues
   b. Chimneys
5. Combustion air requirements
   a. Cubic feet of air required to support combustion
   b. Complete vs. incomplete combustion
6. Combustion by-products
   a. Reduce contamination
   b. Filter and clean
7. Burners and nozzles
   a. Combustion required
   b. Nozzle configuration to fit combustion chamber
8. Maximum efficiency
   a. Use CO_2-O-analyzer
   b. Other indicators

VALUE/ATTITUDE
CONCEPTS:

1. Heating requirements
2. Types available
3. Quantity required to satisfy demand
4. Equipment available
5. Service available
6. Contamination level
7. Customer check and maintenance
8. Annual cost and life expectancy
9. Duty requirements
10. Practice safety

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TASK AREA: Air Conditioning and Heat Pumps

TASK # 2.1: Mechanical Diagnosis and Servicing

COMPETENCY: Given the location and customer complaint, the student will arrive at the job site promptly, locate cause of mechanical trouble, and correctly repair trouble.

CRITERION: Time consumed will be as little as possible.

System will operate properly upon completion.

Customer satisfied if possible.

SKILL/PROCESS:
1. Locate job site.
2. Locate system trouble.
3. Correct problem.

KNOWLEDGE/THEORY:
1. Getting to job location
   a. Knowledge of streets in location of work
   b. Read maps
2. Finding problem area
   a. Good communication skills
   b. Know the type of questions to ask the customer
   c. From information supplied be able to determine general trouble area
   d. Use test procedures of elimination to pinpoint trouble spot
3. Correcting problem
   a. Repair part if practical
   b. Replace part
   c. Test for proper operation

VALUE/ATTITUDE
CONCEPTS:
1. Value of travel time and distance cost
   a. Diagnosis of problem
   b. Render proper service by adjustment or replacement
2. Systematic testing and procedure
3. Parts changers
4. Cost comparison of part repair and/or replacement
5. Safety

TASK AREA: Air Conditioning and Heat Pumps

TASK # 2.2: Electrical Diagnosis and Servicing

COMPETENCY: Given a malfunctioning heat pump or air conditioning system, systematically diagnose by using the proper test equipment, find the cause of trouble, and repair or replace defective electrical controls or components.

CRITERION: The defective control or component will be located by systematic testing using the proper test equipment and unit schematic wiring diagram.

The defective control or component will be repaired or replaced.

The system will be checked for proper operation.

SKILL/PROCESS:
1. Locate and repair or replace defective components in low voltage control circuits.
2. Locate and replace defective components in line voltage circuits.

KNOWLEDGE/THEORY:
1. Low voltage control circuits
   a. Have basic knowledge of electricity
   b. General knowledge of all types of controls (how and what they operate)
   c. Use test equipment to trace out trouble
   d. Repair or replace control or wiring
   e. Test for proper operation
2. Line voltage circuits
   (Same as a through e above)

VALUE/ATTITUDE
CONCEPTS:
1. How safe working with electricity can be when properly understood
2. Shock
3. Ease of troubleshooting when proper methods are used
4. Prevention of damage to controls and components by connecting to improper voltage
5. Overload
6. Shorts
7. Grounds

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TASK AREA: Air Conditioning and Heat Pumps

TASK # 2.3: Hand Tools

COMPETENCY: Given hand and specialized tools, demonstrate proper use.

CRITERION: Tools are clean.
Tools are not damaged.
Parts are not damaged (use correct tool).
Safety precautions are used.

SKILL/PROCESS:
1. Use basic hand tools.
2. Use specialized tools.

KNOWLEDGE/THEORY:
1. Using basic hand tools
   a. Know the tools used in this trade
   b. Properly use these tools
   c. How to care for tools
   d. Cost of tools
   e. What tool to use for each procedure
2. Using specialized tools
   (Same as a through e above)

VALUE/ATTITUDE
CONCEPTS:
1. Proper tool for the job.
2. Why tools should be cared for
3. Pride in tools
4. Safety
5. Need for specialized tools
6. Speed
7. Workmanship
8. Why use of damaged or wornout tools should be avoided.

TASK AREA: Air Conditioning and Heat Pumps

TASK # 2.4: Electrical Instruments

COMPETENCY: Given electrical instruments, properly use them to check electrical circuits.

CRITERION: Faulty circuits will be correct.

System will operate properly.

SKILL/PROCESS:
1. Use electrical instruments to determine current, voltage, and resistance.
2. Use electrical instrument to determine power.

KNOWLEDGE/THEORY:
1. Determining current, voltage, and resistance
   a. Know which instruments are used for each test
   b. Know the difference between volt, amp and ohm meters
   c. Understand basic electricity
   d. Know how to test each type of circuit
   e. Know what current, voltage and resistance is required
2. Determining power
   (Same as a through e above)

VALUE/ATTITUDE
CONCEPTS:
1. Why the use of the proper meter can save time and life
2. Reasons why we should understand what the circuit is doing before we start testing
3. Understand:
   What-
   Why-
   When-
4. Answer questions:
   Is the control functioning correctly?

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TASK AREA: Air Conditioning and Heat Pumps

TASK # 2.5: System Cleanup After Burnout

COMPETENCY: Given a system which needs a compressor replaced, determine cause of failure if system is acid.

Give proper cleaning as recommended by manufacturer.

CRITERION: Compressor is replaced

System is free of acid.

System operates properly.

SKILL/PROCESS:
1. Disconnect a tube and flush.
2. Tear down TEV and flush.
3. Pump cleaner through condenser.
4. Pump cleaner through evaporator.
5. Clean all refrigeration piping.
6. Replace compressor and put system into operation.

KNOWLEDGE/THEORY:
1. Disconnecting a tube and flushing
   a. Know what and where a tube is
   b. Know how to remove tube
   c. Know how to flush
   d. Know what cleaner to use
2. Tearing down TEV and flushing
   (Same as a through d above)
3. Pumping through condenser
   (know how to flush condenser)
4. Pumping through evaporator
   (know how to flush evaporator)
5. Cleaning all refrigeration piping
   a. Flush refrigeration piping
   b. Remove cleaner from system
6. Evacuation

VALUE/ATTITUDE
CONCEPTS:
1. Importance of acid-free system
2. Dangers of acid
   a. Equipment
   b. Mechanical
3. Understanding type of compressor failure
4. Reasons for keeping the system clean and dry
5. Leak Testing
6. Removal of moisture and noncondensables

TASK AREA: Air Conditioning and Heat Pumps

TASK # 2.6: Heat Pumps

COMPETENCY: Given units of a complete heat pump assembly, install and service according to specifications.

CRITERION: Installation and service follows a logical sequence with a minimum of time involved.

SKILL/PROCESS:

1. Install outdoor unit on concrete pad with consideration given for snow and ice accumulation.
2. Install indoor unit with proper sound baffling.
3. Install supplemental heat section in indoor unit.
4. Install indoor thermostat.
5. Install outdoor thermostat (if used).
6. Install all low voltage wiring from schematic wiring diagram.
7. Install refrigeration lines.
8. Use pressure-temperature methods to check out reversing valve.
9. Use steel tool to check magnetism of reversing valve solenoid.
10. Check defrost timer clock for operation.
11. Check defrost control sensing bulb for good contact with outdoor coil.
12. Test check valves with magnet (unit off).
13. Test for temperature difference across check valve (unit on).
14. Check refrigerant pressures.
15. Check electric resistance elements for proper operation.
16. Test complete system for refrigerant leaks.

KNOWLEDGE/THEORY:

1. Installing outdoor unit on concrete pad
   a. Economy considerations
   b. Orientation in relation to sun and wind directions
   c. Roof overhang
2. Installing indoor unit
   a. Use of isolation noise vibrators
   b. Sound control by use of duct liner on return duct
   c. Make condensation drain accessible
3. Installing supplemental heat section
   a. Proper location in downstream air section of duct or air handler
   b. Type
   c. Installation
   d. Code
4. Installing indoor thermostat
   a. Where to install to sense average return air temperatures
   b. Types of thermostats
   c. Energy conservation
5. Installing outdoor thermostat
   a. Where and how to install so that control will not be affected by sun and weather conditions
   b. Types of thermostats
6. Installing all low voltage wiring
   a. Makes lines as short as possible and isolated from rattles and pulsating sounds

b. Uses of low voltage systems
c. Installation techniques
7. Installing refrigeration lines
   a. Makes lines as short as possible and isolated from rattles and pulsating sounds
   b. Insulating
8. Using pressure-temperature methods
   a. One method of determining if a valve is operational
   b. Function
9. Using steel tool to check magnetism
   a. Steel tool will react to electrical magnetism of solenoid
   b. Function of solenoid
10. Checking defrost timer clock
   a. Use of ohmmeter to see if timer motor is operating
   b. Function
11. Checking defrost control sensing bulb
   a. Visually check copper strap to see if it has worked loose due to vibration
   b. Function
12. Testing check valves with magnet (unit off)
   a. Method of determining position of check valve
   b. Function
13. Testing for temperature difference (unit on)
   a. How to test for leaky valve
   b. Replacement
14. Checking refrigerant pressures
   a. How to install and read gauges and determine proper operation from gauge readings
   b. Charging a system
15. Checking electric resistance elements
   a. How to check continuity
   b. Replacing elements
16. Testing complete system for refrigerant leaks
   a. Methods of leak check
   b. How to identify system operating without enough refrigerant

VALUE/ATTITUDE
CONCEPTS:
1. Hold down installation costs
2. Minimum operating cost
3. Eliminates recirculating heat and dripping from rain
4. Makes indoor unit quiet in operation
5. Assured positive drainage and eliminates overflow
6. Conforms with codes and good installation practices
7. Results in control of temperature overshoot and comfort conditions
8. Will control supplemental heat in low outdoor temperature conditions
9. Correct installation makes operation of system completely automatic
10. Makes an economical and sound-proof installation
11. If valve is in good condition, changeover from heating to cooling can be accomplished
12. Takes guesswork out of servicing
13. Logical procedure for servicing saves time
14. Make outdoor unit defrost without malfunction

15. Servicing technique
16. Efficient operation
17. Method of determining internal system troubles
18. Loss of heat may be result of defective heating element
19. Insures future performance of heat pump

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TASK AREA: Refrigeration

TASK # 3.1: Tools and Materials

COMPETENCY: Use tools, instruments, and materials to install and service refrigeration systems.

CRITERION: Tools used correctly and safely.

Materials used efficiently.

Instruments used properly.

SKILL/PROCESS:
1. Use hand tools (flaring, swagging, bending).
2. Work with materials (tubing, refrigerants).
3. Use test instruments (gauges, thermometers).

KNOWLEDGE/THEORY:
1. Using hand tools
2. Working with materials
3. Using test instruments

TASK AREA: Refrigeration

TASK # 3.2: Mechanical Compression Systems

COMPETENCY: Observe, test, evacuate, and charge a refrigerant compression system.

CRITERION: Compression system properly evacuated and charged

SKILL/PROCESS:

1. Recognize cycle components.
2. Connect cycle components to form a complete cycle.
3. Operate a cycle using a capillary tube, an AEV, a TEV.
4. Record pressures and temperatures.
5. Observe cycle component behavior.
6. Leak test a system using three methods of detection.
7. Evacuate a system using a vacuum pump.
8. Charge a system.

KNOWLEDGE/THEORY:

1. Recognizing cycle components
   a. Install and adjust the component
   b. Know what purpose it serves
2. Connecting cycle components
   a. Install and adjust the components
   b. Determine its purpose
3. Operating a cycle
   a. Install and service all metering devices
   b. Know what would be involved to substitute one with another
4. Recording pressures and temperatures
   a. Know the instrument
   b. Where the sensing element should be located
   c. How long the recording should be made
5. Observing cycle component behavior
   a. Be able to test the performance of pressure and temperature valves to determine if they are operating normally
   b. Operation of components in standard cycle
6. Leak testing in system
   a. Determine if the instrument is working properly
   b. Know what reaction will take place if a leak is detected
7. Evacuating a system
   a. Why evacuation is necessary
   b. How much evacuation has been sufficient
8. Charging a system
   a. Refrigerant should be determined
   b. Determine charging method and how to determine when adequate charge has been completed

VALUE/ATTITUDE

CONCEPTS:

1. Each component should be needed or removed
2. Performance is determined by how well it is installed and maintained
3. Understand the instrument before using it
4. Know what the component should do

5. Understand the safety and time necessary
6. Know that time is well spent in proper evacuation
7. Importance of correct charge

TASK AREA: Refrigeration

TASK # 3.3: Motors and Controls

COMPETENCY: To recognize motor and control types for proper application.

CRITERION: Able to apply new or replacement motor.

SKILL/PROCESS:

1. Recognize various types of motors.
2. Install and wire (connect) an electric motor (use unit diagram).
3. Wire in different types of starting relays (use diagram).
4. Install a thermostat.
5. Have a knowledge of various defrost systems.
6. Connect a defrost system.
7. Install an ice maker.

KNOWLEDGE/THEORY:

1. Recognizing various types of motors
   a. Shaded pole
   b. PSC
   c. CS
   d. CSR
   e. Belt driven
   f. Direct driven
2. Installing and wiring
   a. Wire from reading schematic wiring diagram
   b. Install according to good installation practices
3. Wiring in different types of starting relays
   a. Determine type and load
   b. Current relay
   c. Potential relay
   d. Hot wire
   e. Solid state
4. Installing a thermostat
   a. Select proper location
   b. Importance of being level, away from vibration, drafts, and heat generation equipment
5. Having a knowledge of various defrost systems
   a. How a hot gas defrost is used
   b. How a resistance heater is used
   c. Why the drain is part of the defrost system
6. Connecting a defrost system
   a. Install necessary piping and drains
   b. Install frost detector method
   c. Install defrost termination control
7. Installing an ice maker
   a. Know variables that indicate the proper location
   b. Run proper electrical service to machine
   c. Have adequate water supply and water drain
   d. Have proper ventilation

VALUE/ATTITUDE CONCEPTS:

1. Proper and efficient operation is dependent on motor selection
2. Good sequence of operation
3. Good sequence of operation
4. Where the thermostat is located determines how well the temperature is maintained
5. Good defrost improves efficiency of equipment
6. Defrost is a necessary part of the system
7. Be sure the machine works properly

TASK AREA: Refrigeration

TASK # 3.4: Refrigerated Cabinets

COMPETENCY: Given a refrigerator, the student will service or clean a component until it is serviceable or acceptable in appearance to the owner.

CRITERION: Be competent in matching finish, hardware, and general cycle of cooling and defrosting.

Be aware of insulation migrating and vapor barriers.

SKILL/PROCESS:
1. Recognize key features of different styles and models.
2. Check and service a cabinet.

KNOWLEDGE/THEORY:
1. Recognizing key features
   a. Cabinets, finish, and trims
   b. Interior and exterior
2. Checking and servicing
   a. Compressor
   b. Evaporator
   c. Condenser
   d. Metering Devices

VALUE/ATTITUDE CONCEPTS:
1. Be able to follow factory or manufacturer's procedures
2. Safety to operator
3. Safety to equipment
4. Safety to product

TASK AREA: Refrigeration

TASK # 3.5: Repair of Cabinets and Mechanisms - Mechanical

COMPETENCY: The student will, from memory, remove, install (replace), braze, and add oil and refrigerant so that a component functions according to manufacturer's specifications.

CRITERION: Use meters to obtain flow rate and temperature range and to obtain desired pressure and temperatures.

SKILL/PROCESS:
1. Replace a compressor.
2. Repair a condenser.
3. Repair leaking evaporator.
4. Replace a defrost heater.
5. Replace a defrost timer.
6. Repair a system leak and recharge.
7. Repair a restricted capillary tube.
8. Diagnose a system that has an inefficient compressor.

KNOWLEDGE/THEORY:
1. Replacing a compressor
   a. Removal of silver (brazing)
   b. Evacuation
   c. Add oil and refrigerant
   d. Service - by repair or replacement
2. Repairing a condenser
3. Repairing leaking evaporator
   a. Locate
   b. Repair
4. Replacing a defrost heater
   a. Test procedure in order to ascertain condition
   b. Replace
5. Replacing a defrost timer
   a. Test procedure
   b. Removal
   c. Replace
6. Repairing a system leak and recharging
   a. Drop charge
   b. Make repair
   c. Test procedures
   d. Evacuation
   e. Recharge
7. Repairing a restricted capillary tube
   a. Inspection
   b. Repair
8. Diagnosing a system
   a. Test the symptoms
   b. Repair or replace
   c. Determine whether electrical or mechanical

VALUE/ATTITUDE CONCEPTS:

1. Importance of correct replacement procedures
2. Same as above
3. Using electronic or halide liquid solution to locate leak
4. Identify heater problem
5. Follow manufacturer's instructions
6. Follow acceptable manufacturer's instructions
7. Repair by service or replacement
8. Test, diagnose, and use corrective procedure

TASK AREA: Refrigeration

TASK # 3.6: Troubleshoot and Repair Cabinets and Mechanisms - Electrical

COMPETENCY: Given an HVAC system, the student will test from memory the continuity of devices, circuitry, and components using a VOM or Amprobe instrument.

CRITERION: Sequence and correct method to make equipment operational.

SKILL/PROCESS:
1. Check and replace a defective start relay.
2. Check and replace a defective hermetic compressor.
3. Check and replace defective run and start capacitors.
4. Check and repair a defective ice maker.
5. Check and replace a hermetic compressor after a burnout.

KNOWLEDGE/THEORY:
1. Checking and replacing a defective start relay
   a. Identify correctly from memory voltage, current, solid state, or hot wire relay
   b. Check relay
   c. Replace relay
2. Checking and replacing a defective hermetic compressor
   a. Identify make, type, size, etc.
   b. Check operation
   c. Replace
3. Checking and replacing defective run and start capacitors.
4. Checking and repairing a defective ice maker
5. Checking and replacing a hermetic compressor after a burnout
   a. Evacuation
   b. Recharge
   c. Reset controls

VALUE/ATTITUDE CONCEPTS:
1. Safety
2. Be able to correctly classify relay problems created by defective relays
3. Cut system out, refabricate replacement, justify type of failure following test procedure
4. Mechanical and electrical knowledge
5. Removing, adjusting, installing, and cleaning
6. Equipment and system cleaning according to manufacturer's recommendations
7. Component cleaning and testing for acid and foreign materials

TASK AREA: Refrigeration

TASK # 3.7: Commercial Refrigeration Systems

COMPETENCY: To determine type of system for specified type of food storage.

CRITERION: Unit must maintain proper temperature as specified.

SKILL/PROCESS:

1. Diagram an electrical wiring system from the disconnect switch.
2. Select wire size for each circuit.
3. Locate motor control and electrical troubles.
4. Read trouble analysis charts.
5. Recognize and correct compressor troubles, low charge, overcharge, high heat, and high head pressure.
6. Know purpose and application of multiple evaporator systems.
7. Select major components and arrangements of multiple evaporator systems.
8. Install and adjust evaporator pressure regulator, EPR valves, and refrigerant controls.
9. Select and know when to use internal equalizer, external equalizer, and pressure limiter thermostatic expansion valves.
10. Install and adjust head pressure controls if condensors are exposed to outdoor weather temperature.
11. Know types and purpose of heat exchangers.
12. Know where and when heat exchangers should and should not be installed.
13. Know advantages of accumulators and where to install.
14. Know type and purpose of oil separators, their location, and installation requirements.
15. Determine the correct storage life, temperature, and humidity of various commodities.
16. Know reason for evacuating a refrigeration system.
17. Know evacuating procedures.
18. Know charging procedures and determine correct charge.
19. Charge a comfort cooling unit.

KNOWLEDGE/THEORY:

1. Diagramming an electrical wiring system
   a. Wiring diagrams
   b. Schematic diagrams
2. Selecting wire size
   a. Know circuit voltage
   b. Know circuit amps
   c. Know wattage at start-up
   d. Knowledge of code
3. Locating motor control and electrical troubles
   a. Visual inspection
   b. Electrical meters
   c. Electrical/electronic malfunctions
   d. Mechanical malfunctions
   e. Test of correction

4. Reading trouble analysis charts
   a. Be knowledgeable of charts of all companies
   b. Keep a file on companies normally used
5. Recognizing and correcting compressor troubles, etc.
   a. Noisy (oil low, gas sludging)
   b. Not pumping.
   c. Low charge (low head pressure, low back pressure)
   d. Overcharge, high heat, high head pressure
6. Knowing purpose and application of multiple evaporator systems
   a. Two temperature applications
   b. More than one fixture used with one condensing unit
7. Selecting major components
   a. Size and temperature range of evaporators
   b. Multiple evaporators
8. Installing and adjusting evaporator pressure regulator, etc.
   a. Thermostatic expansion valves
   b. EPR valves
9. Selecting and knowing when to use internal equalizer, external equalizer, etc.
   a. Pressure drop through coil
   b. Use manufacturer's data
10. Installing and adjusting head pressure controls
    a. Knowledge of conditions when required
    b. Know gas charge will be different
    c. Set correct head pressure
11. Knowing types and purpose of heat exchangers
    a. Increase capacity of refrigerant controls
    b. Increase capacity of system
12. Knowing where and when heat exchangers should and should not be installed
    a. Install near evaporator
    b. Do not install without manufacturer's approval
    c. Could cause motor-compressor-burn-out
13. Knowing advantages of accumulators and where to install
    a. Protect compressors from liquid slugging
    b. Install suction line near compressor
14. Knowing type and purpose of oil separators, their location, and installation requirements
    a. Keeps oil in compressor where needed
    b. Makes total system more efficient
    c. Install in discharge line near compressor
    d. Make sure no refrigerant condenses in separator
15. Determining the correct storage life, etc.
    a. From available material compile data for best storage of various commodities
    b. Set controls for best storage
16. Knowing reason for evacuating
    a. Prevent high head pressure
    b. Acid formation
    c. Motor burn-out
    d. Reduces moisture

17. Knowing evacuating procedures
    a. Deep vac. 100 microns
    b. Triple vac.
    c. Three times to 500 microns
18. Knowing charging procedures
    a. Sight glass method
    b. Frost line method
    c. Weight method
    d. Liquid charging
    e. Vapor charging
19. Charging comfort cooling unit
    a. Use of R22 refrigerant
    b. Measurements specified by manufacturer (high side)
    c. Suction pressures

VALUE/ATTITUDE CONCEPTS:

1. Think of purpose of total system
2. Take pride in safety
    a. Fire hazards
    b. Equipment damage
3. Think of function; do not be a parts changer
4. Take pride in a good file system
5. Make sure system is kept clean and dry
6. Knowledge of cost and savings to owner
7. Pride in correct sizing
8. Take pride in neat, leakproof, and correctly sized job
9. Know value of proper selection
10. Unit that will work winter and summer
11. A more efficient, complete system
12. Compressor life increased
13. Better operating system
14. More profit by operator-less cost to consumer
15. System life increase
16. System that is ready to charge
17. System that will operate trouble free for a long time

TASK AREA: Refrigeration

TASK # 3.8: Servicing

COMPETENCY: Given proper equipment and parts, approach a problem with a knowledge of operation of equipment and components, locate malfunction, and establish reasons for failure using test equipment.

CRITERION: Unit will operate correctly and efficiently.

SKILL/PROCESS:

1. Adhere to safety rules pertaining to handling of refrigerants and electrical circuits.
2. Read and follow piping blueprints and electrical schematics.
3. Be able to service or suitably replace electrical and mechanical refrigeration components.
4. Locate malfunctioning components in a refrigeration system.
5. Organize a systematic method of repair of the malfunctioning component.
6. Install refrigeration systems.

KNOWLEDGE/THEORY:

1. Banding refrigerants and electrical circuits
   a. OSHA regulations
   b. Local and state codes
   c. Company policies and standards
2. Piping blueprints and electrical schematics
   a. Electrical and blueprint symbols
   b. Abbreviations of parts and components
   c. Pipe sizes, etc.
   d. Suitable materials
3. Servicing electrical and mechanical refrigeration components
   a. Replace the function, not the part
   b. Proper electrical connections
   c. Clean copper joints
   d. Use of fluxs
   e. Select proper fittings
   f. Use of swedging tools
   g. Use of flaring tools
   h. Use of various solder and brazing agents
   i. Use of oxyacetylene welding, brazing, and soldering
4. Locating malfunctioning components in refrigeration system
   a. Understanding of refrigeration cycle
   b. Use of testing equipment (volt meter, amp meter, cable tracer, etc.)
   c. Use of compound gauges
   d. Function of each component part and how to check it
   e. Use of pressure temperature charts
   f. Flushing and cleaning of the system
   g. Proper refrigerant and charge
   h. Use of thermometers and gauges to set superheat

5. Repairing malfunctioning components
   a. Take proper equipment to job (ladder, extension cord, flashlight, cleaning materials, etc.)
   b. Have a representative inventory on service truck of controls and parts organized in an orderly fashion
   c. Have proper instruments, supplies, and tools on the truck in good repair.
   d. Knowledge of concepts
   e. Knowledge of components
   f. Knowledge of failure reasons
   g. Testing
   h. Process of elimination
   i. Repair or replace component
   j. Procedure for handling warranty defects (i.e., nature of defect, model, and serial number of unit removed)
6. Installing refrigeration systems

VALUE/ATTITUDE CONCEPTS:

1. Life-Death
2. Physical Injury
3. Equipment and site safety
4. Word picture
5. Record for refrigeration
6. Meet requirements
7. Systematic analysis
8. Hand skills
9. Selection of supplies and materials
10. Understand concepts
11. Positive approach
12. Sure method
13. Time saving
14. Less expensive

TASK AREA: Air Distribution

TASK # 4.1: Air Handler

COMPETENCY: Recognize air handling equipment, blowers, drivers, and electrical components.

Be able to adjust, measure, identify, and service complaints of air handling components.

CRITERION: Cubic feet per minute (CFM) will be determined by measuring psychrometrics of entering and leaving air.

Balance the make-up and recirculated air for temperature and humidity control.

SKILL/PROCESS:
1. Set air handler.
2. Level air handler.
3. Tighten screws and bolts.
4. Install air filters.
5. Install and align drive systems.
6. Wire motor
7. Start and check rotation and RPM.
8. Check amperage and voltage.
9. Install condensate drain pipe.
10. Check for proper drainage.
11. Install vibration eliminators.

KNOWLEDGE/THEORY:
1. Set air handler
   a. Blueprints
   b. Locations
   c. Special considerations
   d. Measurements
   e. Sizes
2. Leveling air handler
   a. Method of mounting
   b. Vertical, horizontal, down-flow, and suspended types
3. Tightening screws and bolts
   a. Code requirements
   b. Safety
4. Installing air filters
   a. Air directions
   b. Provisions for our precipitators
5. Installing and aligning drive system
   a. Pulley alignment
   b. Belt tightness
   c. Bearings
   d. Lubrication
   e. Sound and rattles prevention (shipping bolts and screws removed)
6. Wiring motor
   a. Electrical schematics

- b. Voltage, phase, cycle conductor ampacity
- c. Motor protections
- d. Code
- e. Grounding requirements
- f. Ambient temperature

7. Checking rotation and RPM
   - a. Start-up procedures
   - b. Determining rotation and RPM
8. Checking amperage and voltage
   - a. Use electrical instruments to determine current, voltage, resistances, and grounding
   - b. Read under-load-conditions
9. Installing condensate drain pipe
   - a. Correct pitch
   - b. Open drainage
   - c. Code
10. Check for proper drainage
    - a. Code
    - b. Testing
11. Installing vibration eliminators
    - a. Pad
    - b. Springs
    - c. Felt
    - d. Canvas connectors in all supply ducts

VALUE/ATTITUDE
CONCEPTS:

1. Purpose
2. Application
   - a. Heating
   - b. Cooling
   - c. Ventilation
   - d. Exhaust
3. Air movement equipment
   - a. Forward
   - b. Backward
   - c. Propeller
4. Drives
   - a. Belt
   - b. Direct
5. Filter accessibility
6. Equipment service spacing
7. Name plate data (conform to available power)
8. Use of instrumentation
   - a. VOM test meters
   - b. Current (clamp on)
   - c. Ampmeters
9. Open drainage (condensate)
   - a. Drainage
   - b. Trapping
   - c. Venting
10. Overhead systems
    - a. Double pan
    - b. Separate drains

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TASK AREA: Air Distribution

TASK # 4.2: Duct Systems

COMPETENCY: Given a set of blueprints and specifications, fabricate duct in shop then install the duct.

Balance air in ducts by means of dampers.

CRITERION: The duct system will supply proper BTU's to each room for comfort cooling and heating without disturbing drafts or noise.

SKILL/PROCESS:
1. Properly design duct systems.
2. Install duct systems from working drawings.
3. Check all hangers, joints, and dampers.
4. Insulate duct system.
5. Cut openings for ducts, diffusers, and grills.
6. Install diffusers and grills.
7. Balance system for proper quantity and direction of air flow.
8. Adjust mechanical and electrical controls.
9. Apply good safety rules.

KNOWLEDGE/THEORY:
1. Designing duct systems
   a. Heat load calculations
   b. Air requirements for each outlet
   c. Air velocity
   d. Type of system
   e. Location of duct system
2. Installing duct systems
   a. Check for accuracy using codes from blueprint (double check it)
   b. Check for obstructions and incidentals that may conflict with blueprint
   c. Check work orders (materials check)
3. Checking hangers, joints, and dampers
   a. Materials check against work order
   b. Check for proper construction and assembly
4. Insulating duct system
   a. Types of insulation
   b. Check against specifications for thickness, density, and vapor barrier
5. Cutting openings
   a. Work as close to working plans and blueprints as possible
   b. Go to general contractor for deviations from blueprints
6. Installing diffusers and grills
   a. Follow working plans and blueprints
   b. For deviations go to general contractor
7. Balancing system
   a. Check outlets with velometer
   b. Convert to CFM
8. Adjusting controls
   a. Follow system cycle

   b. Use gauges (pressure), thermometers (temp.), and electrical instruments for overload protection (safety)
   c. Set range, differential, anticipation, tolerances, leveling, and location
   d. Working media, pressure-metic, hydromatic electrical, and mechanical
9. Applying safety rules
   a. Applicable in all phases of installation
   b. To operator
   c. To equipment
   d. To product

VALUE/ATTITUDE
CONCEPTS:
1. Follow engineering design
   a. Equal friction
   b. Velocity pressure
   c. Velocity reduction
2. Location survey (obstruction)
   a. Piping
   b. Electrical wiring
   c. Offsets
   d. Odors
   e. Heat sources
3. Check for lintels
4. Obstruction
5. Follow blueprints and specifications
6. Air drop
7. Air balancing instruments
   a. Velocities
   b. Free grill area
8. Noise control
9. Dampers
10. Contactors and relays
   a. Primary
   b. Secondary
11. Mechanical components
   a. Pulleys
   b. Bolts
   c. Rotation
   d. Bearings/shaft
   e. Vibration eliminators
12. Safety practices
   a. Clothing
   b. Guards
   c. Electrical
13. First aid
   a. Electrical shock
   b. Burn
   c. Respiratory
   d. Physical handicaps

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TASK AREA: Air Distribution

TASK # 4.3: Exhaust and Make-up Air Systems

COMPETENCY: Know the function, total exhaust, and make-up air change of system.

CRITERION: Relative humidity, CFM, and temperature will comply with architect's and/or engineer's specifications as determined by instruments.

SKILL/PROCESS:
1. Cut proper openings.
2. Set fan and/or louvers.
3. Check and adjust air quantities.

KNOWLEDGE/THEORY:
1. Cutting openings
   a. Selection of tools to be used
   b. Tools available when needed and in good operable condition
   c. Have blades, bits, etc. for replacement
2. Setting fans and/or louvers
   a. Adjust fan RPM by adjusting pulley
   b. Manual or motorized
3. Checking and adjusting air quantities
   a. Use velocitymeter times area of supply to convert to CFM
   b. Close or open for quantity required

VALUE/ATTITUDE
CONCEPTS:
1. Follow manufacturer's specifications
   a. Clamp ampmeters (max. load)
   b. Mathematics (ratio and proportion)

TASK AREA: Air Treatment

TASK # 5.1: Checking Condition of Air

COMPETENCY: Given a sling psychrometer, wet the sack, sling properly, and read the resulting dry bulb and wet bulb temperatures. Locate same on the psychromatic chart.

CRITERION: Identify and determine the values of the other properties of air on the psychromatic chart by using the WB and DB values of a sample of air as determined when using the sling psychrometer. Determine air quantity.

SKILL/PROCESS:
1. Use psychrometer.
2. Use psychrometric charts and tables.
3. Check volume of air (to determine make-up).
4. Determine enthalpy.

KNOWLEDGE/THEORY:
1. Use of psychrometer
   a. Wet bulb reading
   b. Dry bulb reading
   c. Relation to comfort and % of humidity in the air
2. Charts and tables
   a. Grain of moisture per lb. of air
   b. Dewpoint
   c. Plotting of unknowns on charts using references from the psychrometer readings.
3. Air volume, use approved air measuring device to determine cubic feet of air per minute
4. Enthalpy, BTU/lb. of dry air

VALUE/ATTITUDE
CONCEPTS:
1. Easy and quick
2. Simple, approved method
3. Comfort and conditions
4. Equipment operation
5. Process conditions

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TASK AREA: Air Treatment

TASK # 5.2: Humidification

COMPETENCY: Given a humidifier, install in the correct location, wire correctly, put into operation, and/or service properly.

CRITERION: Relative humidity of the air from the conditioned area would be within the limits.

Repair non-operable unit so that it will function properly.

SKILL/PROCESS:
1. Install humidifier.
2. Service humidifier.
3. Size and select humidifier.

KNOWLEDGE/THEORY:
1. Install humidifier
   a. Location
   b. Wiring
   c. Size
   d. Type
   e. Operation
   f. Water supply hook ups
   g. Drains
2. Servicing humidifier
   a. Repair float assembly
   b. Clean and replace nozzles
   c. Clean or replace filters
   d. Check air flow and temperature across humidifier
   e. Check or install (humidistats and relays)
   f. Check operation cycle
3. Humidifier selection

VALUE/ATTITUDE
CONCEPTS:
1. Comfort conditions
2. Manufacturing conditions
3. Energy conservations
4. Rain
5. Static electricity
6. Dew point
7. Dry structure and furnishings

TASK AREA: Air Treatment

TASK # 5.3: Dehumidifying Air

COMPETENCY: Given a dehumidifier, select location, install or service, and put into/or return to operation.

CRITERION: Humidity in conditioned area will be reduced to tolerable or specified conditions.

SKILL/PROCESS:
1. Install dehumidifier.
2. Servicing dehumidifier.
3. Size and select dehumidifier.

KNOWLEDGE/THEORY:
1. Install dehumidifier
   a. Size
   b. Location
   c. Application
2. Servicing dehumidifier
   a. Check dew point temperature
   b. Check air condition
   c. Check control circuits
   d. Check blower and damper motors and controls
   e. Check chemical content
   f. Add or replace chemicals
3. Dehumidifier selection

VALUE/ATTITUDE
CONCEPTS:
1. Mold-mildew
2. Condensation (dew)
3. Clammy discomfort
4. Machinery condition (maintenance)
5. Manufacturing supplies (powders-chemicals)

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TASK AREA: Air Treatment

TASK # 5.4: Cleaning Air

COMPETENCY: Given an air filter (porous, viscous, or electrostatic), install, connect, or service.

CRITERION: Proper cleanliness of air, accessibility for service after installation, and testing for repair are essential for competency.

Customer satisfaction and economy of performance are also required.

SKILL/PROCESS:

1. Install or service filters (porous media).
2. Install or service electrostatic filters.
3. Install and service electronic air cleaners.
4. Install viscous filters.

KNOWLEDGE/THEORY:

1. Filters (porous media)
   a. Selection
   b. Installation and location
   c. Cleaning
2. Installing or servicing electrostatic filters
   a. Selection of filter
   b. Location for installation
   c. Electrical controls
   d. Wiring
   e. Use proper test instruments for checking defective filter
   f. Proper cleaning process
3. Electronic air cleaner
   a. Selection
   b. Installation
   c. Service
4. Viscous filters
   a. Selection
   b. Installation
   c. Replacing

VALUE/ATTITUDE

CONCEPTS:

1. Dust
2. Health and safety
3. Cleaning cost
4. Manufacturing (clean rooms)
5. Surgery
6. Filter quality

TASK AREA: Controls

TASK # 6.1: Wiring Diagrams

COMPETENCY: Given a schematic (electrical or pneumatic), identify, connect, service, and maintain system along with components

CRITERION: Proper identification of equipment related controls, problems, adjustment setting for performance, and preventative maintenance.

SKILL/PROCESS:

1. Recognize and use the symbols of a control diagram.
2. Compose a schematic diagram of control systems.
3. Compare mechanical control elements.
4. Illustrate the differences between mechanical, electrical, electronic, and pneumatic controls.
5. Use schematic diagrams in the process of diagnosing control problems.

KNOWLEDGE/THEORY:

1. Recognizing and using the symbols of control diagram
    a. Relate symbol to parts
    b. Electric
    c. Electronic
    d. Pneumatic
2. Composing a schematic diagram of control systems
    a. Function of system
    b. Use of symbols
    c. Draw straight lines
3. Comparing mechanical control elements
    a. Temperature control
    b. Pressure control
    c. Humidity control
4. Mechanical, electrical, electronic, and pneumatic control
    a. Mechanical
        1. Use
        2. Type
    b. Electrical
        1. Type
        2. Use
    c. Electronic
        1. Use in heat pumps
        2. Use in oil and gas
    d. Pneumatic
        (Use in industrial control)
5. Schematic diagrams to diagnose control problems
    a. To trace circuits
    b. To check voltages
    c. To check parts in control system 609
    d. To check current

VALUE/ATTITUDE
CONCEPTS:

1. Reason for use of schematic
   a. Adjustment
   b. Service
2. Reason for use of wiring diagrams
   a. Troubleshooting
   b. Expedite repairing
3. If diagram not available determine need to construct one
4. File diagrams where they can be found
5. Safety on job
6. Equipment for physical, equipment, and property protection

TASK AREA: Controls

TASK # 6.2: Test Equipment

COMPETENCY: Given an assortment of test equipment, choose proper test piece and use to gather necessary data.

CRITERION: Proper application and use as well as maintenance and care of equipment.

SKILL/PROCESS:
1. Use test equipment for checking controls.
2. Diagnose problems in control circuits.
3. Test and replace oil burner controls.
4. Test and replace gas burner controls.
5. Test and replace electric heat controls and elements.
6. Diagnose zone control systems.

KNOWLEDGE/THEORY:
1. Use test equipment for checking
   a. Ohms
   b. Amps
   c. Volts
   d. Microfarads
   e. Milliamps
   f. Temperature
   g. Humidity
   h. CFM
2. Diagnose problems in control circuits
   a. VOM use
   b. Amprobe use
   c. Appropriate recording equipment
3. Test and replace oil burner controls
   a. Heat anticipator
   b. Thermostat
   c. Flame controls
   d. Fan and pump controls
4. Test and replace gas burner controls
   a. Thermostat
   b. Flame safety controls
   c. Gas controls
5. Test and replace electric heat controls and elements
   a. Thermostats
   b. Safety controls
   c. Elements
6. Diagnose zone control systems
   a. Thermostats
   b. Damper motors
   c. Damper types
   d. Valves

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VALUE/ATTITUDE
CONCEPTS:
1. Safety of meters
2. Safety of people

3. Safety of equipment
4. Comfort of people
5. Function
6. Use of test and measuring equipment
7. Balancing

TASK AREA: Controls

TASK # 6.3: Components

COMPETENCY: Recognize and call each component by name.

CRITERION: The function of each component and its relationship to the entire unit is described.

SKILL/PROCESS:

1. Recognize the different types of relays and their applications.
2. Identify the types of unit heater control systems, unit ventilator control methods, outdoor thermostat controls.
3. Install and calibrate a thermostat.
4. Determine component coordination and operational sequence.
5. Install electric and pneumatic controls for domestic and commercial heating and cooling.
6. Identify the types of controls and their function in domestic and commercial refrigeration.

KNOWLEDGE/THEORY:

1. Different types of relays, starters, and contactors and their application
2. Types of unit heater control systems, unit ventilator control methods, outdoor thermostats
   a. Fan controls
   b. Basic rate controls
   c. Hot water controls
   d. Steam controls
   e. Damper controls
   f. Building controls using outdoor controller
3. Installing and calibrating a thermostat
   a. Correct location
   b. Adjust heat anticipant
   c. Check calibration
   d. Not in draft
   e. Not near electric appliance
   f. Seal hole in back of thermostat
   g. Level correctly
   h. Mount properly
4. Component coordination and operational sequence
   a. Thermostat call for heat
   b. Ignition
   c. Flame
   d. Flame out
   e. Safety control
   f. Must be reset
5. Electric and pneumatic controls for domestic and commercial heating and cooling
   a. Air sources
   b. Air lines
   c. Air valves
   d. Air relays
   e. Air motors

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f. Wiring
g. Voltages

6. Types of controls and their function in domestic and commercial refrigeration
   a. Relays
   b. Thermostats
   c. Safety controls

VALUE/ATTITUDE
CONCEPTS:
1. Function of components
2. Select replacement parts
3. Don't be a parts changer
4. Identifying problem
5. Best solution
6. Think safety

TASK AREA: Controls

TASK # 6.4: Refrigerant Controls

COMPETENCY: Given a blueprint, know proper controls (metering devices) by size and type of refrigerant, their function, adjustment problems and servicing procedures.

CRITERION: Identification of various types of metering devices.

Install and adjust for proper metering of refrigerant.

Adjust and control for superheat in system.

SKILL/PROCESS:
1. Replace and repair refrigerant controls for refrigeration and air conditioning.
2. Use solenoid valves, modulating controls, and three way valves to control the distribution of refrigerant.

KNOWLEDGE/THEORY
1. Refrigerant controls for refrigeration and air conditioning
   a. Thermostatic expansion valve
   b. Automatic expansion valve
   c. Hi-side float
   d. Low-side float
   e. Capillary tube
   f. Electric expansion valve
2. Solenoid valves, modulating controls, and three way valves used to control the distribution of refrigerant
   a. Modulating thermostats
   b. Modulating valves
   c. Thermostats
   d. Solenoid valves
   e. Check valves

VALUE/ATTITUDE
CONCEPTS:
1. Have knowledge of refrigerants
   a. Temperatures
   b. Pressures
2. Safety to service man
3. Moisture problems
4. Superheats

TASK AREA: Controls

TASK # 6.5: Wiring and Controls

COMPETENCY: To be able to select, install, and wire electrical or mechanical controls.

CRITERION: Sequence of operating is determining factor of a good control installer.

SKILL/PROCESS:

1. Determine ampere draw and install proper relay to control fractional horsepower motors.
2. Determine ampere draw and install proper contactor for larger horsepower motors.
3. Install electric solenoid valve for pump down control on commercial refrigeration system.
4. Wire electrical solenoid from wiring schematic.
5. Install motor overload on domestic freezer or refrigerator.
6. Wire internal motor overload on air conditioner.
7. Wire external motor overload on air conditioner.
8. Mount bi-metallic thermostat in proper location for air conditioner.
9. Wire bi-metallic thermostat into control system using wiring schemati
10. Install temperature type thermostat on domestic refrigerator or freezer.
11. Install pressure type thermostat on commercial refrigeration system.
12. Wire high-low pressure switch on commercial refrigeration system from wiring schematic.

KNOWLEDGE/THEORY

1. Determining ampere draw and installing proper relay
   a. Control relay in relation to motor horsepower
   b. Installation
2. Determining ampere draw and installing proper contactor
   a. Ampere draw of motor
   b. Installation of comparable contactor
3. Installing electric solenoid valve
   a. Mechanical and electrical methods of installation
   b. Selection
4. Wiring electric solenoid
   a. Schematics
   b. Wiring
5. Installing motor overload
   a. Follow wiring diagram
   b. Install proper size overload
6. Wiring internal motor overload
   a. Determine if overload is to be used in line or low voltage
   b. Wire overload
7. Wiring external motor overload
   a. Determine from wiring schematic how overload is wired in system
   b. Wire overload
8. Mounting bi-metallic thermostat for air conditioner
   a. Return air sensing and effect of radiant heat on bi-metal contro
   b. Mount thermostat

9. Wiring bi-metallic thermostat in control system.
    a. Read schematic wiring diagram
    b. Wire thermostat
10. Installing temperature type thermostat on domestic refrigerator or freezer.
    a. Determine length of capillary tube (external/internal location) in capillary tube well
    b. Install thermostat
11. Installing pressure type thermostat on commercial refrigeration system
    a. Determine length of capillary tube and internal and external installation
    b. Install
12. Wiring high-low pressure switch
    a. Read schematic wiring diagram
    b. Wire switch

VALUE/ATTITUDE
CONCEPTS:
1. Motor may be severly damaged as result of improper application
2. Undersized contactor would heat and burn out
3. Moveable parts of valve may be damaged from overheating
4. Sequence of operation
5. Overload gives proper motor protection
6. Overload gives proper motor protection
7. Overload gives proper motor protection
8. Results of proper location may determine comfort and efficiency
9. Assures proper operation
10. Convenience of control adjustment by operator
11. Convenience of control adjustment by operator
12. Determines compressor protection

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TASK AREA: Duct Fabrication and Installation

TASK # 7.1: Fabrication

COMPETENCY: Be able to read, interpret, and lay out metal for fabrication.

CRITERION: Follow blueprint for proper tolerance.

Duct work fabricated in the shop should fit space requirements of the installation with a minimum of alterations from blueprints and specifications.

SKILL/PROCESS
1. Interpret duct work on plans and working drawings
2. Use fabricating tools and machinery.
3. Lay out and make square and round fittings.
4. Insulate ducts (interior and exterior).

KNOWLEDGE/THEORY:
1. Interpreting plans and drawings
   a. Basic blueprint reading
   b. Duct symbols
   c. Duct sizing methods and guidelines
   d. Use of different scales
   e. Determine when prefab duct will be cheaper
2. Using fabrication tools and machinery
   a. Duct board cutters and techniques
   b. Cornice brake
   c. Press brake
   d. Bar folder
   e. Shear
   f. Pittsburg lock machine
   g. Forming machine
   h. Electric shears
   i. Aviation snips
   j. Notcher
   k. Hand seamer
   l. Hand benders
   m. Pin spotter
3. Layout
   a. Know no. 1 and 2
   b. Templates, know how to make them
   c. Overhead projector layout
   d. Use of square, scriber, compass, trammel points
   e. Make maximum use of metal (scraps)
   f. Joint techniques
4. Insulate ducts (interior and exterior)
   a. Duct lines attachment techniques
   b. Duct board, proper grooving
   c. Thermaflex
   d. 2" foil duct wrap now required
   e. Use of outward clinch stapler
   f. Taping joints

g. Importance of complete vapor barrier
h. Proper adhesive technique for duct liner and knowledge of code requirement for interior fasteners (pin spotters, etc.)

VALUE/ATTITUDE
CONCEPTS:
1. Plans and drawings
   a. Safety attitude
   b. Imagination
   c. Neatness
   d. Communication
   e. Accuracy
   f. Cost awareness
2. Tools and machinery
   a. Safety
   b. Lost time due to accident
   c. Limitations
   d. Replacement cost
   e. Adjustment and maintenance
   f. Use tools for what they are designed only
3. Layout
   a. Safety
   b. Drafting
      1. Parallel lines
      2. Triangulation
      3. Radial lines
   c. Rectangular and round
4. Insulation
   a. Codes
      1. Local
      2. State
   b. Methods
   c. Neatness
   d. Craftsmanship
   e. Knowledge of heat transfer (dew point determination)

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TASK AREA: Duct Fabrication and Installation

TASK # 7.2: Installation

COMPETENCY: To recognize all component parts and system components that are needed to complete a particular installation.

CRITERION: System is assembled in a determined amount of time.

SKILL/PROCESS:

1. Hang ducts.
2. Use devices for fastening and joining ducts.
3. Seal and insulate joints and seams.
4. Install duct accessories, grills, registers, dampers, boots, and takeoffs.
5. Apply duct insulation.

KNOWLEDGE/THEORY:

1. Hanging ducts
   a. Duct holders (tool)
   b. Duct hangers (different types)
   c. Hanger spacing
   d. Importance of keeping square and level
2. Fastening and joining ducts
   a. "S" and drive locks
   b. Snap locks
   c. Drill-in screws
   d. Pop rivets
   e. Round pipe crimping
   f. Cutting take off holes
3. Sealing and insulating joints and seams
   a. Vinyl duct tape (not approved)
   b. Foil duct tape
      1. Pressure sensitive
      2. Heat sensitive
4. Installing duct accessories
   a. Location of dampers, (according to plan)
   b. Turning vanes
   c. Cutting methods for holes in ceiling, walls, floors
   d. How to box in closets and joist panning
   e. Selection and location of grills and registers (as per plan)
   f. Checking for hidden obstructions before cutting holes
   g. Tools, drop cords, etc.
5. Application of duct insulation
   a. Use of staple gun
   b. How to measure and cut duct insulation
   c. The use of duct tape

VALUE/ATTITUDE CONCEPTS:

1. Use of established methods
2. Know regulatory agency

3. Code conformity
   a. Fire, dampers, regulations
   b. Breakway duct connections
   c. Fresh air make up
4. Safety
   a. Grounding
   b. Double insulated
   c. Periodic inspection
5. Permissable noise db. level
6. Precautionary inspection of structured limitations
   a. Hidden utilities
   b. Communicating about damage
   c. Proper cleanup
   d. Coordinate any change from plan with person doing design

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TASK AREA: Costing and Estimating

TASK # 8.1: Cost Factors

COMPETENCY: Given plans and specifications, price all cost items.

CRITERION: All cost items will be properly listed and priced.

SKILL/PROCESS:
1. Interpret construction prints for cost estimating purposes.
2. Calculate time and labor cost.
3. Calculate overhead.
4. Calculate travel time and lodging.
5. Calculate profit required.

KNOWLEDGE/THEORY:
1. Reading construction drawings
   a. Secure correct drawings
   b. Understand construction materials
   c. Know which materials can and cannot be cut
   d. Understand drawing symbols
2. Calculating time and labor cost
   a. Know hourly labor rate for each type job
   b. Know amount of time required for each item
   c. History of past labor used for similar item
   d. Know amount of labor required
   e. Fringe benefits paid on labor cost
3. Calculating overhead
   a. Know past overhead cost in relation to sales
   b. Know which items are included under overhead
   c. Know projected overhead cost in relation to sales
4. Calculating travel time and lodging
   a. Know distance to job site
   b. Know cost of lodging available
   c. Estimate number of trips required and mileage cost
5. Use of accounting procedures

VALUE/ATTITUDE-
CONCEPTS:
1. Understand need for good drawings
2. Know what type system is best
3. Understand what types of equipment, materials, and labor are available and required
4. What is overhead?
5. What is direct cost?
6. When should travel and lodging be included?
7. Why is this quantity of labor needed?
8. Why is profit necessary?

TASK AREA: Costing and Estimating

TASK # 8.2: Procurement

COMPETENCY: Given list of materials, place all orders with correct suppliers.

CRITERION: Purchase orders will be issued.

Receiving date for all materials will be verified.

Materials bought for correct cost.

SKILL/PROCESS:
1. Know where to purchase materials.
2. Determine lead time for materials.

KNOWLEDGE/THEORY:
1. Purchasing materials
    a. Types of materials needed
    b. List of places materials may be secured
    c. Cost and availability of materials
    d. Quality of different materials
    e. Time required to secure delivery of material
2. Determining lead time for materials
    a. Know when materials will be needed.
    b. Check with suppliers as to lead
    c. Place order as soon as possible for price and delivery protection

VALUE/ATTITUDE
CONCEPTS:
1. Reasons for picking material vendors
2. Know why lead time is needed in estimating a job
3. Need for early ordering for price and timely delivery

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TASK AREA: Costing and Estimating

TASK # 8.3: Pricing Factors

COMPETENCY: Given plans and specifications, know bid requirements and sub-contracts needed.

CRITERION: List bonds and permits required.

List all sub-contracts.

Price complete job.

Price permits.

SKILL/PROCESS:
1. Know advertising procedure for bids.
2. Calculate contract price for turn-key job.
3. Locate and contract with sub-contractors
4. Determine cost of permits.

KNOWLEDGE/THEORY
1. Knowing bid procedure
   a. Know items required in bidding procedure
   b. Know bonding and insurance cost
   c. Know U. S. labor rates, if required
2. Calculating price of contract
   a. Know cost of all materials
   b. Know cost of all labor
   c. Know cost of all overhead
   d. Know how much profit wanted
   e. Know cost of sales commission
   f. Know amount of service reserve needed
3. Hiring sub-contractors
   a. Know which sub-contractors are available
   b. Know quality and price of sub-contractor's work
4. Determining cost of permits
   a. Check with government offices as to types of permits required
   b. Calculate cost of permits
   c. Know penalties for securing permits late
   d. Know cost for re-inspection

VALUE/ATTITUDE
CONCEPTS:
1. Know why bid requirements are important
2. What is a turn-key job?
3. Advantages of a turn-key job
4. Use of bid forms and estimate sheets
5. Why and how to use sub-contracts
6. Why license and permits

TASK # 8.4: Specification Factors

COMPETENCY: Given specifications, know which codes apply and cost of bonds.

CRITERION: Know the codes.

Know bond requirements and cost.

SKILL/PROCESS:

1. Must understand codes for pricing purposes.
2. Determine cost of bid bond and performance bond.

KNOWLEDGE/THEORY:

1. Understanding codes for pricing purposes
   a. Know code requirements for work to be performed
   b. Know which codes apply to job location
   c. Know how local inspector will interpret and enforce the codes
2. Determining cost of bid bond and performance bond
   a. Know you are bondable
   b. Know your bonding company's charges
   c. Know which bonds are required

VALUE/ATTITUDE

CONCEPTS:

1. Know how code may effect job cost in the locality
2. Advantage of codes
3. Good inspector relations
4. Use care in determining bid and bond cost
5. Why bonds are required
6. Good relationship with bonding agency

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TASK AREA: Energy Conservation

TASK # 9.1: Mechanical Systems

COMPETENCY: Given a specific mechanical system, analyze all components in relation to achieving energy conservation.

CRITERION: The student will define scientific recommendations to facilitate substantial energy savings from any or all of the components and their related condition.

SKILL/PROCESS:

1. Use applicable equipment to maintain peak operating efficiency.
2. Clean air cooled condenser.
3. Clean water cooled condenser.
4. Treat circulating water.
5. Clean furnace heat exchangers.
6. Lubricate moving parts where required.
7. Inspect and replace belts.
8. Clean boiler.
9. Clean and replace air/fuel filter.
10. Clean and replace fuel jets.
11. Evaluate source of air supply for heating system.
12. Change air conditioning systems.
13. Evaluate system for retrofit.
14. Determine feasibility of adding heating recovery system.
15. Locate equipment for maximum energy efficiency.
16. Adjust primary air to obtain proper CO_2 and flue gas temperature.
17. Adjust blower for proper CFM.

KNOWLEDGE/THEORY

1. Peak operating efficiency
   a. Oil and gas combination efficiency tests
   b. Use of instruments to measure system dewpoint, air flow, pressure, carbon dioxide, and nitrogen
2. Cleaning air cooled condenser
   a. Fin combs
   b. Chemical cleaners
   c. Compressed air
3. Cleaning water cooled condenser
   a. Use of tube brusher
   b. Chemicals
4. Treating circulating water
   a. Testing procedures
   b. Correction by chemical addition
5. Cleaning furnace heat exchangers
6. Lubricating moving parts
   a. Proper amount and type of lubricant
   b. Lubrication methods
7. Inspecting and replacing belts
   a. Check belt alignment, tension, condition
   b. Replacing

8. Cleaning boiler
   a. How to disassemble
   b. Proper cleaning methods
   c. How to purge and return to service
9. Cleaning and replacing air/fuel filters
   a. Air
      1. Measure pressure drop
      2. Filter types
   b. Fuel
      1. Check pressure drop
      2. Disassemble, clean, replace
      3. Bleed and return to service
10. Cleaning and replacing fuel jets
   a. Oil nozzle
      1. Identify malfunctioning nozzle
      2. Select correct GPH, spray nozzle pattern
      3. Use of nozzlewrench
   b. Gas orifice
      1. Check for obstruction
      2. Clean or replace
      3. Size properly
11. Evaluating air source for heating system
   a. Location of heating system
   b. Warmed air or outside air supply
   c. Infiltration
   d. Supplemental air supply
   e. Preheating techniques
   f. Improved efficiencies
12. Charging air conditioning systems
   a. Check for proper charge
   b. Use of gauges
   c. Charging methods
   d. Safety precautions
   e. How to determine proper charge
13. Retrofit evaluation
14. Heat recovery systems
   a. Knowledge of types
      1. Heat pump
      2. Heat reclaim
      3. Heat pipes and wheels
      4. Run around systems
15. Locating equipment for maximum energy efficiency
   a. Orientation to run
   b. Orientation to prevailing winds
   c. Adjacent obstructions and shading
16. Adjusting primary air
   a. Types of air adjustments
   b. Use of smoke tester, CO_2 gauge, and stack thermometer
17. Adjusting blower
   a. Check temperature rise
   b. Adjustable pulleys
   c. Check motor current

VALUE/ATTITUDE

CONCEPTS:

1. Operating time
2. Heat transfer ration
3. Insulating effect of dirt, scale metal plating, O_2 films, soot
4. Actual operating cost vs. design cost
5. Disassemble used heating unit
6. Why dirty filters cost money
7. Increased cost of incorrect nozzle (correct rating)
8. Time saved in use of proper tools
9. Appreciate cost of improper adjustment of primary air, CO_2 content, stack temperature
10. Cost of lost refrigerant
11. Dangers incurred when systems are overcharged
12. Conter flow coils
13. How much heat (money) could be saved thru proper adjustment
14. Balance orifice to venturi

TASK AREA: Energy Conservation

TASK # 9.2: Electrical Systems

COMPETENCY: Interpret and explain all electrical systems associated with air conditioning, heating, and refrigeration systems.

CRITERION: Given any specific set of energy depleting symptoms, isolate and identify a component that is malfunctioning.

SKILL/PROCESS:
1. Clean controls.
2. Install thermostats and timers.
3. Explain energy efficiency ratios (EER).
4. Compute power used by a system.
5. Measure power used by a system.
6. Advise owner of benefits of additional controls.

KNOWLEDGE/THEORY
1. Cleaning controls
   a. Know of sensitive parts
   b. How to clean
2. Installing thermostats and timers
   a. Sizing wire
   b. Selecting suitable control to do the job
3. Explaining energy efficiency ratios
   a. Understand formula
   b. Types equipment on which used
4. Computing power
   a. Use voltmeter, ammeter, wattmeter, and power factors
   b. Computations
5. Measuring power
   a. Instruments
   b. Measurements
6. Benefits of additional controls
   a. Recognize energy losses
   b. Selection of remedial controls

VALUE/ATTITUDE CONCEPTS:
1. Initial cost (refer to amortization of cost against savings methods of manufacturer)
2. Demonstrate inoperative controls due to undersized transformer
3. Use tapes and slides to explain power factor and local balancing
4. Use electronic equipment to show where and how much heat is being lost or gained

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TASK AREA: Energy Conservation

TASK # 9.3: Records

COMPETENCY: Interpret gauges, meters, and recorders and keep records of information.

CRITERION: Determine, interpret, and/or extract operational characteristics from past records.

SKILL/PROCESS:
1. Maintain system performance records.
2. Maintain system maintenance records.
3. Record system variables for evaluating energy utilization.

KNOWLEDGE/THEORY:
1. Performance records
   a. Compare performance to degree days
   b. Read temperature and humidity records charts
2. Maintaining system maintenance records
   a. Record model and serial number and manufacturer
   b. Keep accurate log of all service rendered to equipment
3. Recording system variables
   a. Permanent equipment file
   b. Service and material
   c. Operational log

VALUE/ATTITUDE
CONCEPTS:
1. Explain how degree days allows for fuel computation
2. Demonstrate recorders
3. Show how records can prove need for new updated equipment and indicate which type

TASK AREA: Energy Conservation

TASK # 9.4: Public Relations

COMPETENCY: Talk with customer about the energy conservation features of a specific unit.

CRITERION: Deliver a talk on the energy conservation features of a system to a group in a concise and informative manner.

SKILL/PROCESS:
1. Explain energy conservation features of systems to customer.
2. Inform owner of savings methods.
3. Discuss features of alternative energy systems.

KNOWLEDGE/THEORY:
1. Explaining energy conservation features of systems to customer
2. Informing owner of savings methods. (Demonstrate techniques for maximizing system effectiveness to customer)
3. Discussing features of alternative energy systems
   a. Have knowledge of other systems
   b. Know advantages and disadvantages of other systems

VALUE/ATTITUDE
CONCEPTS:
1. Have student sell unit to class
2. Have student demonstrate unit to class
3. Have student salesman discuss other alternatives to class

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TASK AREA: Energy Conservation

TASK # 9.5: Insulation Materials

COMPETENCY: Compute "R" value of existing construction and proposed buildings.

CRITERION: Make calculation and determine heat transfer ratio of sq. ft. of a specific wall.

SKILL/PROCESS:
1. Evaluate existing insulation.
2. Determine additional requirements to meet energy efficiency standards (EES).
3. Determine building orientation, shading, landscaping for new construction.
4. Evaluate new insulation type and installation procedures.

KNOWLEDGE/THEORY:
1. Evaluating insulation
   a. Calculate "R" value
   b. Identification of types
   c. Methods of checking
2. Requirements to meet EES
   a. Know EES
   b. Compare to results from evaluation of insulation (Section 1, above)
3. Determining building orientation
   a. How to read compass
   b. Understands relationship of sun to heat transfer
   c. Appreciate need for deciduous trees near heat pump or solar collector
4. Installation of insulation
   a. Know all available types of insulation
   b. Understand correct installation procedures
   c. Advantages of each type

VALUE/ATTITUDE
CONCEPTS:
1. Field trips with each student calculating "R" value
2. Purpose of EES
3. Ask student to pick units for different uses and find EES and how they apply
4. Have student calculate loads for same units with varying orientation
5. Field trips to distributors
6. Calculate BTU gain/loss using "R" factor

TASK AREA: Energy Conservation

TASK # 9.6: Oil Burner Efficiencies

COMPETENCY: Select, install, and service oil furnaces according to code to maximize efficiencies.

CRITERION: Installation meets all code requirements for fuel, chimneys, wiring, and operation.

Efficiencies meet manufacturer's specifications.

SKILL/PROCESS:

1. Determine the heat content of each type of oil.
2. Evaluate the advantages and disadvantages of the oil by the grade of oil.
3. Determine the components needed to handle a certain grade of oil.
4. Identify the type of burner being used and those things required to burn the oil completely.
5. Determine the advantage of each type of burner.
6. Determine the size nozzle to use and how much fuel can be burned in the combustion chamber.
7. Determine the amount of air required to burn the oil.
8. Determine the proper ventilation for the furnace or boiler room.
9. Know the chemicals needed for complete combustion and why excess air is required.
10. Know the by-products of combustion and how to use instruments to measure the CO_2 level.
11. Determine from the shape of the combustion chamber the angle of the nozzle needed.
12. Place the burner in the proper location in the combustion chamber.
13. Adjust the burner oil pressure and adjust the air supply so that the proper CO_2 can be reached.
14. Use the smoke spot tester to determine if any sooting is taking place.
15. Determine if the blast tube and turbulator are properly set.
16. Measure combustion draft and make changes necessary for proper draft.

KNOWLEDGE/THEORY:

1. Heat content of oils
   a. API tables and charts
   b. BTU's
2. Grades of oil
   a. BTU's per unit
   b. Cost per unit
   c. Pollution aspects
3. Components required for a given grade of oil
   a. Preparation
   b. Delivery
   c. Storage
4. Combustion
   a. Burners
   b. Ignition assemblies
   c. Oxygen and supply

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5. Burner advantages
   a. Design features
   b. Efficiencies
6. Nozzles
   a. Product specifications
   b. Fuel consumption
7. Air supply to combustion chamber
   a. Products of combustion
   b. Complete/incomplete combustion
8. Ventilation
   a. Calculate air requirement based on BTU input
   b. Venting techniques
9. Complete combustion
   a. Principles of efficient combustion
   b. Fuel supply
   c. Vibration and pulsation
   d. Excessive oil consumption
   e. Contaminant
10. Combustion by-product
    a. Combustion test instruments
    b. Smoke and soot
11. Nozzles
    a. Product specifications
    b. Services
12. Burners
    a. Install
    b. Adjust
13. Oil pressure and air supply
    a. Testing and adjusting
    b. Vibration and pulsation
14. Smoke spot tester
15. Blast tube and turbulator
16. Combustion draft
    a. Draft gauge adjustments
    b. Adjusting draft

TASK AREA: Energy Conservation

TASK # 9.7: Gas Burner Efficiencies

COMPETENCY: Select, install, and service gas furnaces according to code to maximize efficiencies.

CRITERION: Installation meets all code requirements for fuels, chimneys, wiring, and operation.

Efficiencies meet manufacturer's specifications.

SKILL/PROCESS:
1. Calculate the heat load.
2. Size chimney for draft and combustion.
3. Install gas burner according to building code.
4. Size fuel piping to match pressure and BTU.
5. Install electrical wiring and controls for maximum conservation.
6. Troubleshoot and service gas burners to optimize performance.

KNOWLEDGE/THEORY:
1. Heat loads
   a. Match design condition to calculated heating demand
   b. Compute heat loss load
2. Chimneys and flues
   a. Calculate and design chimney and flue piping to furnace size
   b. Variations
3. Gas burners
   a. Mount or install as per print or form rating
   b. Code requirements
4. Use piping charts
   a. Pressure
   b. Gas type
      1. Natural
      2. Propane
      3. Manufactured
5. Wiring
   a. Controls according to codes
   b. Wiring according to codes
6. Troubleshooting
   a. Use meters, gauges, and charts
   b. Service, making necessary adjustments
   c. Establish correct combustion and efficiencies

VALUE/ATTITUDE
CONCEPTS:
1. Sizing and design conditions
2. Air make up and exhaust (chimney)
3. Equipment installation
   a. Serviceability
   b. Permanency
   c. Codes
4. Fuel types

5. Wiring
   a. Required sizes
   b. Required controls
   c. Required voltages
6. Use gauges and charts for establishing efficiency

TASK AREA: Design

TASK # 10.1: Hydronic Distribution Systems

COMPETENCY: Given a blueprint of a building and heat loss/gain calculations, design and correctly complete hydronic distribution system.

CRITERION: The design will be easy to follow.

The system will meet all space requirements.

The system will fit space allotted.

The system will be economical to install and operate.

SKILL/PROCESS:

1. Design four different types of hydronic systems.
2. Estimate water temperature requirements for a given application.
3. Select all equipment and components for a given application.
4. Choose correct size chiller and/or boiler.
5. Estimate hot water requirements for domestic or potable purposes.
6. Select the type of domestic or potable water heating system best suited for a particular application.
7. Estimate pipe sizes for entire systems.
8. Select proper pipe insulation.
9. Design a cooling tower installation.
10. Select pump capacity and types.
11. Estimate all pipe sizes, valves, and accessories.
12. Evaluate all work done against industry standards and various codes.

KNOWLEDGE/THEORY:

1. Types of hydronic systems
   a. What is a hydronic system
   b. What makes one system different from another
   c. How heat is transferred
   d. Which components are used for each system
   e. Types of controls required
2. How water temperature affects size and price of materials
   a. What temperature range is available
   b. What temperature will best do the job required
   c. How temperature affects noise level
   d. Know equipment ratings
   e. Piping capacity
3. What types of materials are required and available
   a. What is best source of heat
   b. What type radiation should be used
   c. Piping and valves used or needed
   d. Pumps and traps used or needed
   e. Expansion and balancing devices
   f. Control system to be used
4. Chiller and/or boiler requirements
   a. Calculate load requirements
   b. How is equipment rated

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c. Will physical size fit space available
5. Hot water needed for domestic and other uses
   a. How much hot water is used per person and use
   b. How much hot water is required for machines
6. Water heaters
   a. Fuel available
   b. Distance of water travel
   c. Types of heaters available
   d. Booster heaters
7. How to size piping
   a. Use pipe sizing charts
   b. How different materials affect flow
   c. How components affect flow
8. How much piping insulation is required
   a. Required insulation value
   b. Material available
   c. Cost of insulation
9. How to design a tower installation
   a. Size tower
   b. Size pump and piping
   c. Size fan and motor
10. Know pump capacity and type required
   a. Climate conditions
   b. Compressor requirements
   c. Piping restrictions
11. Size pipes, valves, and accessories
   a. Know length and equipment length of pipes and accessories
   b. Use pipe sizing charts
   c. Use valve and accessories sizing charts
12. Know industry standards and codes
   a. Design system to meet standards and codes
   b. Evaluate work

VALUE/ATTITUDE
CONCEPTS:
1. Hydronic systems
   a. Advantages of hydronic system
   b. Wide variety of systems and equipment
   c. Space requirements
   d. Industry standards and codes
   e. Why use tower in place of wasting water
   f. Know effects of basic rate control
2. Initial
   a. Cost vs. pay-back period
3. Demand calculation
4. Fuel cost levels
5. Flow rates-heat/gain-loss
6. Insulation pay back
7. Requirements
8. Affecting conditions and serviceability
9. Bill of materials
10. Code requirements

TASK AREA: Design

TASK # 10.2: Hydronic Systems Balance

COMPETENCY: Given system layout, design location and type of hydronic system balancers required.

CRITERION: Balancing devices will be sized and located properly.

SKILL/PROCESS:

1. Measure water temperatures in various sections of systems.
2. Measure water flow in specified sections of system.
3. Use a wide variety of instruments in testing, adjusting, and balancing a properly designed and installed system.
4. Compare several designs and applications.
5. Choose the best design for a specific system.
6. Evaluate effect on operation and efficiency of a specific system with possible revision to maximize efficiency.
7. Measure water temperature at various terminal units to determine BTU output.
8. Construct a system curve based on water flow.
9. Use pump curves to estimate flow rate and head.
10. Evaluate overall efficiency of a system under test, both before and after test and balance has been performed to assure optimum performance.

KNOWLEDGE/THOERY:

1. Water temperature
   a. Measure water temperature at boiler supply tapping
   b. Measure water temperature at boiler return tapping
   c. Measure water temperatures and inlet and outlet of convectors or coils (temperature drop of water leaving convector)
2. Water flow
   a. Determine GPM flow thru various sections to include zones, mains, branches, and individual convectors
   b. Instruments and calculations
3. Reading instruments and interpreting the information to make necessary adjustments
4. Selecting the most suitable design for a particular application taking into consideration initial cost, operating cost, and maintenance
5. Sizing
   a. Proper size piping
   b. Most compatible system for building
6. Complete check out
   a. Combustion
   b. Venting
   C. Pipe insulation and pitch
7. Heat output
   a. Temperature differences
   b. Determine amount of flow and energy being delivered to offset load
8. How to plot delivery of booster pump
9. Relate values of being able to interpret performance to effect flow rate adjustments

10. Determine maximum efficiency
    a. Check out system on start-up
    b. Make needed adjustments
    c. Determine efficiency to measure increase

VALUE/ATTITUDE
CONCEPTS:
1. Know temperatures at important areas in the system
2. Know design flow rates
3. Know flow rates at specific points in system
4. Make proper selection of equipment and materials
5. Know and realize the values of proper sizing
6. Recognize the value of adjustments to attain best possible system
7. Know the relationship of temperatures to efficient operation
8. Know overall results of gallons per minute (GPM)
9. Know why and how flow rate benefits operation
10. Know at what point conditions and operating data indicates maximum efficiency

TASK AREA: Design

TASK # 10.3: Gas Piping and Venting

COMPETENCY: Given blueprints and equipment specifications, calculate gas piping size, estimate the size and type fittings needed, select and size the vent system, calculate the required amount of ventilation and combustion air, and specify clearances as outlined in AGA Recommendations and N. C. Building Code, Vol. III.

CRITERION: The piping will be sized in accordance with AGA Recommendations and N. C. Building Code, Vol. III. The required amount of ventilation and combustion air will be supplied to unit according to code. The vent system will be selected and sized in accordance with the code. The clearances of equipment shall conform to AGA Recommendations and code requirements.

SKILL/PROCESS:

1. Demonstrate a knowledge and an understanding of the AGA Recommended procedures for gas piping and appliance installation and N. C. Building Code, Vol. III, Chap. XIV, Sec. 1400-1415.
2. Select the proper size gas piping for any specified application.
3. Correctly estimate the size, type, and quantity of fittings required.
4. Select the correct vent material and size for any given application.
5. Estimate the correct amount of combustion and ventilation air for any given application.
6. Evaluate a given system and specify the net clearances required by code.

KNOWLEDGE/THEORY:

1. Installing gas piping
   a. Basic knowledge of recommended procedures for gas piping
   b. Use N. C. Building Code and AGA Recommendations to design gas piping
   c. Know where to find information in the code and how to interpret the code.
2. Sizing gas pipe
   a. Follow N. C. Building Code and AGA Recommendations in sizing gas piping
   b. Calculate equivalent length of all piping and fittings used.
3. Fittings
   a. From blueprints or job sketch estimate the type and number of fittings needed for the job
   b. List the type and number of fittings needed
4. Vents
   a. Follow manufacturer's specifications, AGA Recommendations, and N. C. Building Code for designing vent system

   b. Select the proper vent material for the building application and equipment type
5. Combustion of ventilation air
   a. Calculate the combustion air requirement according to BTU input of appliance and code requirements
   b. Calculate the ventilation air requirement according to the BTU input of appliance and code requirements
6. Evaluation of installed system
   a. Clearances from combustible materials for appliance vent materials
   b. Clearances from noncombustible materials for appliance and vent materials
   c. Applications of zero clearance vent materials

VALUE/ATTITUDE
CONCEPTS:
1. Follow AGA Recommendations and N. C. Building Code in design of gas piping and installation of gas appliances
2. Follow AGA Recommendations and N. C. Building Code
3. Use drawings or blueprints to estimate fittings
4. Use AGA Recommendations and N. C. Building Code to select and size vent system user safety
5. Use AGA Recommendations, N. C. Building Code and equipment name plate information
6. Follow AGA Recommendations and N. C. Building Code requirements
7. User safety
8. Structure safety

TASK AREA: Design

TASK # 10.4: Transport Refrigeration

COMPETENCY: Identify types of transport refrigeration systems and methods of powering the systems.

Employ maintenance procedures for proper operation.

CRITERION: Set controls, superheat, charge, and set control devices for proper operation.

Will know drive types, component service, and coordination.

SKILL/PROCESS:
1. Choose the best type system for a specified application.
2. Compare various methods of air distribution used in transport refrigeration.
3. Select all special equipment and controls required to meet the needs of various types of transport refrigeration.
4. Accurately estimate or calculate the load requirements of a specified transport refrigeration application.
5. Select the correct size system for the application specified.
6. Analyze and solve theoretical and practical design problems in existing and proposed systems.

KNOWLEDGE/THEORY:
1. System types
   a. Mechanical drives
   b. Gasoline combustion
   c. Diesel
   d. Electric
2. Air distribution
   a. Expendable
   b. Reclaim systems
3. Control functions
4. Load requirements
   a. Specific latent heat
   b. Respiration tables
   c. Load calculations
5. Sizing system
   a. Balance load calculations
   b. Time requirements
6. Design adjustment
   a. Control settings
   b. Amounts involved by latent heat method

VALUE/ATTITUDE CONCEPTS:
1. Know manufacturer's specifications and adjustments
2. Nitrogen and carbon dioxide (expendable)
3. Compression (mechanical)
4. Be knowledgeable in component service and operation
5. Hold over characteristics
   a. Requirements
   b. Cost

TASK AREA: Design

TASK # 10.5: Commercial Refrigeration Systems

COMPETENCY: Design and layout a commercial refrigeration system for given products.

Select high and low side equipment.

Calculate equipment load.

CRITERION: Equipment is sized properly.

System design is correct.

Operational costs are optimum.

SKILL/PROCESS:
1. Calculate the refrigeration load requirements for commercial refrigeration applications.
2. Choose the proper condensing unit.
3. Select the correct evaporator.
4. Select the proper operating and safety controls for a given application.
5. Inspect, test, and analyze existing systems.
6. Estimate the materials required to construct a given walk-in cooler.
7. Measure the internal volume of a given unit and estimate the actual storage capacity of various products.
8. Design a proper refrigerant piping system.
9. Diagram the piping system illustrating all components thereof.
10. Estimate the average compressor running time for any given commercial refrigeration application.

KNOWLEDGE/THEORY:
1. Refrigerator load
   a. Product load metabolic rate
   b. Insulation, properties, and performance
   c. Infiltration and exfiltration
2. Condensing unit
   a. Theory of and selection of proper refrigerant
   b. Required operating temperatures
   c. How and why the manufacturer's ratings are cataloged as they are
   d. Why compressor running time is selected
3. Evaporator coil assembly
4. Controls
   a. Capabilities of different controls
   b. Economics
   c. Safety codes (local and national)
   d. Know how to use necessary test equipment
5. Analyze existing system
   a. Knowledge of test instrumentation
   b. Calculation of equipment operating capacity at test conditions

6. Estimate materials
   a. Basic mathematics
   b. Blueprint reading and measurement
7. Volume and storage capacity
   a. Basic mathematics
   b. Source location and knowledge of product packaging and storage temperatures
8. Design and layout
   a. Graphics and drafting
   b. Accessory selection
9. Diagramming piping system
10. Computing compressor running time
    a. Basic mathematics
    b. Product load before and after freezing
    c. Door use factor
    d. Product turnover

VALUE/ATTITUDE
CONCEPTS:
1. Importance of product load
2. Importance of part-load performance vs. full-load performance
3. Pay load weight limitations
4. The importance of good control systems

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TASK AREA: Design

TASK # 10.6: Industrial Refrigeration Systems

COMPETENCY: Apply basic refrigeration principles as applicable to industrial refrigeration, but be aware of sophistication of controls.

CRITERION: Identify the relationship of the four (4) basic components plus adjustment of controls and charges.

SKILL/PROCESS:
1. Estimate the cooling load requirements for industrial refrigeration and applications.
2. Differentiate between various types of refrigeration equipment and systems.
3. Demonstrate a working knowledge of the fundamentals of refrigeration theory and application.
4. Analyze the pressure-temperature relationship.
5. Compare and select the best refrigerant for specified applications.
6. Compare theoretical and actual capacities.
7. Design a refrigerant piping system for a specified application.
8. Select all system components, including all operating and safety controls.
9. Evaluate the function of heat condensing systems, rejection systems, and the components thereof.
10. Plan the duties of a plant operating engineer.

KNOWLEDGE/THEORY:
1. Cooling load requirements for industrial refrigeration
   a. Calculate heat load
   b. Insulation properties ("R" Factor)
   c. Infiltration and exfiltration
2. Industrial refrigeration features
   a. Operating pressures
   b. Capacity
   c. Electrical controls
   d. Product
   e. Refrigerant controls
3. Refrigeration theory and applications
   a. Pressure-temperature relationship
   b. Pressure-evaporating relationship of a liquid
   c. Superheat
   d. Heat of compression
   e. Mechanical cycle
4. Pressure-temperature relationship
   a. Read pressure-temperature charts
   b. Calculate heat pressure to corresponding ambient temperature
5. Refrigerants
   a. Properties of refrigerants
   b. Safety precautions
   c. Economics
   d. Operating range use

6. Capacities
   a. Mathematical formulas
   b. Understand compression ratio
7. Piping systems
   a. Read piping tables
   b. Compute pressure drops
   c. Properly size components to other components
   d. Noise factors
8. System components
   a. Control systems
   b. Safety codes (local and national)
   c. Temperature applications
   d. Understand and know capabilities of system components
9. Heat rejection systems
   a. Condensers
   b. Exchangers
   c. Cooling towers
   d. Heat recovery
10. Plant operating engineer duties
    a. Frequencies of lubrications and equipment adjustment needs
    b. Recordkeeping
    c. Supervision
    d. Responsibilities

VALUE/ATTITUDE

CONCEPTS:

1. Appropriate math, graphs, and tables
2. Know proper temperature difference (pressure) settings to obtain optimum efficiency
3. Importance of basic principles in advanced systems
4. Need to reason out and calculate what happens to gas when pressure or temperature changes
5. Appropriate refrigerant
6. Efficiencies
7. Tables and computations
8. Reasoning behind codes
9. Know and understand the two cooling mediums (their ranges and quantities)
10. Need for routine maintenance

TASK AREA: Design

TASK # 10.7: Residential Air Conditioning Systems

COMPETENCY: Design a properly sized, balanced, and competively priced residential air conditioning system.

CRITERION: The system will be complete with equipment list, layout sketch for heating and cooling units, distribution and return duct system, appropriate control system.

SKILL/PROCESS:

1. Calculate heating and cooling needs.
2. Select proper equipment to meet estimated needs.
3. Choose operating and safety controls.
4. Prepare data for load calculations to be made by computer.
5. Calculate the humidity requirements for a residence.
6. Select humidifier and controls.
7. Analyze existing systems for alterations to conserve energy.

KNOWLEDGE/THEORY:

1. Heating and cooling needs
   a. Know insulation ("R" Factor)
   b. Understand importance of orientation, shading, landscaping
   c. Compute sq. and cu. ft.
   d. Determine effects of infiltration and exfiltration
   e. Understand importance of design temperature
   f. Understand air flow patterns and problems
   g. Comprehend ventilation requirements
2. Equipment selection
   a. Must incorporate needs into a specific group of equipment
   b. Be able to locate that equipment in manufacturer's or supplies catalogue
   c. In selecting the equipment design take into consideration size, cost, and availability
   d. Know safety and environmental requirements
3. Controls
   a. Have understanding of all types of control systems and be able to select most feasible and appropriate system
   b. Know and understand local codes and requirements
4. Load calculations
   a. Understand basic calculator operations and methods of data computations
   b. Load calculations
5. Humidity requirements
   a. Apply general knowledge of humidity, its control, and problems associated with selecting improper conditions
   b. Select proper size unit to achieve desired humidity levels
   c. Read and operate psychrometric test equipment
6. Humidifiers
   a. Determine suited humidifier and controls for given application
   b. Know the advantages and differences of the varied humidifiers and humidity controls

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7. Equipment alterations
    a. Be able to do 6a. and 6b.
    b. Relate existing equipment to newest available equipment for energy conservation

VALUE/ATTITUDE
CONCEPTS:

1. Energy conservation
    a. Proper insulation is a very good investment for energy savings
    b. There is much demand for personal skills to deal with energy consuming equipment
2. Code requirements
3. Computer programming
4. Psychrometric familiarity
5. Load requirements
6. Energy conservation
7. Safety

TASK AREA: Design

TASK # 10.8: Residential Air Distribution

COMPETENCY: Calculate, design, size, and price complete residential air distribution system.

CRITERION: From blueprint install and balance as required for air conditioning and heating.

Service air handling components (both electrical and mechanical).

SKILL/PROCESS:
1. Demonstrate an understanding of air movement in a distribution system.
2. Measure and calculate air volume.
3. Measure and calculate air velocities.
4. Estimate blower capacity and air quantities required.
5. Estimate and measure friction loss.
6. Correctly size and layout an air distribution system.
7. Balance an existing residential system.
8. Appraise a residential air distribution system and distinguish between good and bad.
9. Make recommendation as may be indicated for improving an unsatisfactory residential air distribution system.

KNOWLEDGE/THEORY:
1. Air properties and distribution systems
   a. CFM, blow, throw, turbulence, airflow restriction, turning vanes trunks, sweeps, takeoffs, grills, registers, dampers, etc.
   b. Must know how to calculate CFM to # per cu. ft.
   c. Must know and understand humidity requirements
2. Air volume
   a. Must be able to demonstrate the use of temperature change method of air volume calculations
   b. Measure air volume
3. Air velocities
   a. Must have ability to use velocity meter
   b. Must have ability to calculate pressure drop using standard water gauge.
4. Basics of heating vs. cooling distribution systems
   a. Must be able to calculate amount of air needed and must be able to size blower to handle amount of air
   b. Must take into consideration types of blower fans and pressures that they will operate
   c. Quantities of air needed for cooling vs. the amount needed for heating
   d. Outlets for cooling vs. outlets for heating
   e. Compromised systems
5. Friction loss
   a. Understand what causes friction loss
      1. Aspect ratio
      2. Duct length
      3. Internal surface texture
      4. Vains

   b. Understands the use of a water gauge to calculate friction loss
6. Size and lay out air distribution system
   a. Must understand and adhere to rules governing equal friction method of trunk, takeoff, and return air design
   b. Correct air distribution delivery and return
7. Balancing a system
   a. Must be able to adjust correct volume of treated air to any conditioned space
   b. Must understand function of dampers and registers to facilitate 7a above
8. Evaluation of systems
   a. Refer to 1, 2, 3, and 6 above
   b. Distinguish good from bad
9. Improving existing systems
   a. Must draw conclusions
   b. Decide problem areas
   c. Formulate corrective action

VALUE/ATTITUDE
CONCEPTS:
1. Obtaining full value of equipment
   a. Equipment will not perform satisfactorily with poor distribution system
   b. System will be expensive to operate
2. Properly tailored systems for each specific application gives best performance
3. Conform grills and registers to decor
4. Size air handling equipment to operate at a normal sound level
5. Know problems encountered without proper equipment
6. Size
7. Instrument readings
8. Correct evaluation
   a. Volume
   b. Velocity
   c. Heat gain/loss
   d. Sound
9. Recommendations as required

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TASK AREA: Design

TASK # 10.9: Commercial Air Conditioning Systems

COMPETENCY: Design a commercial air conditioning system that meets design criteria and budget.

CRITERION: Calculate heating and cooling loads.
Select equipment.
Design air and hydronic system components.

SKILL/PROCESS:
1. Calculate heating and/or cooling requirements of a commercial type structure.
2. Select the correct size and type of heating and/or cooling equipment to meet these requirements.
3. Interpret a psychrometric chart to measure the state of mixture of two (or more) air streams.
4. Use various engineering data in the form of charts, tables, and graphs to evaluate specific heat, humidification, and de-humidification.
5. Calculate humidity requirements and select humidifier with control system for type of heating system employed.
6. Evaluate a commercial air conditioning system for maximum energy utilization and conservation.
7. Determine air flow requirements.

KNOWLEDGE/THEORY:
1. Calculating heating and/or cooling requirements
2. Selecting the correct size and type commercial air conditioning system
3. Interpreting a psychrometric chart
4. Using various engineering data to evaluate
5. Calculating humidity requirements and selecting humidifier
6. Evaluating a commercial air conditioning system
7. Determining air flow requirements

VALUE/ATTITUDE
CONCEPTS:
1. Required math
2. Equipment sizing
3. Existing and anticipated conditions
4. Tables, references, and manufacturer's data
5. Humidity requirements
6. Power or energy conservation
7. Structure requirements (occupancy)

TASK AREA: Design

TASK # 10.10: Commercial Air Distribution Systems

COMPETENCY: Given a set of blueprints and specifications, compute heat gain and loss and select project equipment for commercial air distribution system.

CRITERION: When properly installed, system will provide comfort conditions within the comfort zone.

SKILL/PROCESS:

1. Calculate air flow requirements.
2. Demonstrate knowledge and understanding of air and its behavior in a commercial air distribution system.
3. Design a simple constant velocity system.
4. Design a simple velocity reduction system.
5. Design a simple equal friction system.
6. Design a simple static regain system.
7. Compare the four systems and evaluate each.
8. Select the best system for a specific application.
9. Calculate individual room air volume requirements.
10. Select proper diffusers, registers, and grills.
11. Design a complex equal friction system.
12. Calculate air requirements for each outlet.
13. Calculate air volume and velocity in each section of duct.
14. Calculate friction loss for each component and all duct work.
15. Determine blower capacity requirements.
16. Use instruments in testing, adjusting, and balancing various air distribution systems for commercial use.
17. Evaluate air motion within a conditioned commercial area using modern instrumentation.
18. Make recommendations as may be indicated for improving an unsatisfactory commercial air distribution system.

KNOWLEDGE/THEORY:

1. Calculating air flow requirements
   a. Cooling
   b. Heating
   c. Ventilation
2. Demonstrating knowledge and understanding of air (psychrometrics of air)
3. Designing a simple velocity system
4. Designing a simple velocity reduction system
5. Designing a simple equal friction system
6. Designing a simple static regain system
7. Comparing the four systems and evaluating each
8. Selecting the best system
9. Calculating individual room air volume requirements
10. Selecting proper diffusers, registers, and grills
11. Designing a complex equal friction system
12. Calculating air requirements
13. Calculating air volume and velocity

14. Calculating friction loss
15. Determining blower capacity requirements
16. Using instruments
17. Evaluating air motion
18. Making recommendations

VALUE/ATTITUDE

CONCEPTS:

1. Required conditions
2. Understand the basic information of psychrometrics
3. Appropriate tables and charts
4. Understand advantages and disadvantages
5. Evaluation of system installation (features and cost)
6. Recommendations suiting structure and its requirements
7. Applicable rules and appropriate demands
8. Suitable and appropriate in keeping with the decor
9. Hot and cold deck multiplex system and dampers
10. Face and velocity requirements
11. Room and occupancy requirements
12. Appropriate measurements
13. Manufacture charts and curves
14. Instruments and usage
15. Conditions (movement temperature and humidity)
16. Customer/owner instructions

TASK AREA: Design

TASK # 10.11: Electric Heat Systems

COMPETENCY: Given a set of blueprints and specifications, design an electric heat system to conform to design conditions according to ASHRAE guide.

CRITERION: System will perform correctly for comfort heating and cooling when properly installed.

SKILL/PROCESS:

1. Calculate the heat loss in wattage on a room basis for a structure.
2. Select the most appropriate type of system for a particular application.
3. Choose the correct operating and safety controls for the system selected.
4. Design and lay out the complete system.
5. Demonstrate the ability to inspect and test systems and components for safe and proper operation.
6. Correct problems with electric heat system (design or any component).
7. Compare and evaluate various systems.
8. Estimate approximate annual operating cost.
9. Measure efficiency of any electric heat system.
10. Make recommendations as may be indicated for greated energy conservation and/or comfort.

KNOWLEDGE/THEORY:

1. Heat loss calculations
   a. Use of heat loss tables
   b. Use of BTU to watts conversion factors
2. Select system
   a. Requires knowledge of all types of systems, system limitations, and the requirements of particular applications
   b. Variety of applications
3. Controls
   a. Requires knowledge of controls needed to operate different systems safely
   b. Choose controls
4. Design and layout
   a. Must have knowledge of application limitations, advantages and disadvantages, application design requirements, code requirements, and operating cost
   b. Lay out system
5. Inspection and testing
   a. Must be able to simulate all conditions or functions necessary to operate safety controls
   b. Must know all required safety controls for all types of systems
6. Adjusting system
   a. Must understand system design, operating sequence, and controls
   b. Correct problems

7. Compare systems
   a. Must have knowledge of various systems
   b. Compare and evaluate
8. Operating costs
   a. Must have knowledge of heat loss or gain, system efficiency, degree days, and the organization of operation
   b. Estimate costs
9. Efficiency
   a. Knowledge of system and instrument to collect data
   b. Math to complete data collected
10. Energy conservation
   a. Knowledge of method to reduct heat loss
   b. Knowledge of methods to attain highest efficiency possible
   c. Knowledge of criteria necessary for comfort

VALUE/ATTITUDE
CONCEPTS:
1. Correctness
2. Results
3. Appearance
4. Speed
5. Accuracy
6. Basic applied electricity
7. Knowledge of the three basic types
8. Compute "U" factor and calculate BTU/watt demand
9. Energy consumption
10. Good customer relations

TASK AREA: Design

TASK # 10.12: Solar Heating and Cooling Systems

COMPETENCY: ~~Design and sketch~~ out all components and associated equipment for total solar heating and cooling system.

CRITERION: The system will be practical, feasible, and easily installed.

It will supply all needs for heating and cooling without sacrifice of comfort to the occupants.

SKILL/PROCESS:

1. Demonstrate an understanding of terminology associated with solar energy.
2. Determine promising applications of solar energy.
3. Evaluate the economics and performance of solar systems.
4. Estimate average energy availability at the earth's surface.
5. Differentiate between climate constants in different areas.
6. Select collectors.
7. Select storage medium.
8. Determine collector orientation.

KNOWLEDGE/THEORY:

1. Terminology associated with solar systems
   a. Collectors, transfer, storage radiation, orientation, latitude, longitude
   b. Function
2. Solar energy applications
   a. Understands the major types of systems
   b. Possible applications and emerging technology
   c. How heat is transferred, stored, collected, rejected in each of these types
3. Economics and performance of solar systems
   a. Initial cost
   b. Payback
4. Energy availability
   a. Cost of oil, coal, gas, solar equipment, and fuel for these
   b. Solar ins lation
5. Climatic constants
   a. Sun belt latitude/longitude
   b. Cloud cover restrictions
   c. Direct vs. diffuse radiation
6. Collectors
   a. Flat plate, coil, air concentrator evacuated tube, roof, wall pond, mirror mass wall, greenhouse
   b. Selection criteria
7. Storage medium
   a. Water, rock, salt solution, concrete, ground
   b. Active/passive
8. Collector orientation
   a. Structural, aesthetic, and geophysical considerations

b. Geographical and mounting considerations

VALUE/ATTITUDE
CONCEPTS:

1. Advantages of solar water heating
2. Economics of solar systems
3. Know when back up is needed
4. Factors involved in choosing best system for job
5. Cost of all forms of energy
6. How long will various forms of energy be available
7. Cost of maintenance on controls, collectors cleaning, leaks, and pumps
8. Collector concepts
9. Hold over storage
10. Appearance
11. Applicability
12. Water heating
13. Energy comparison
14. Energy conversion
15. Analyze various systems
16. Design problems

TASK AREA: Design

TASK # 10.13: Automotive Air Conditioning

COMPETENCY: Given an automobile with factory installation or add-on air conditioning, the student must from memory be able to approach service problem for a correct trouble diagnosis.

CRITERION: Name auto manufacture, year, component or system failure, then correct problem using manufacturer's specifications.

SKILL/PROCESS:

1. Install gauge manifold.
2. Interpret pressure readings.
3. Determine correct refrigerant and oil level.
4. Identify component failure.
5. Use sling psychrometer to obtain wet bulb temperature.
6. Know oil type and amount required for system lubrication.
7. Know how to replace components, evacuate, and recharge system.
8. Use electrical schematics.
9. Check fuses.
10. Check for open circuits.
11. Check for grounding (shorts).
12. Demonstrate air bypass and diversion from outside vents to bi-level, defrost, heating, and cooling.
13. Perform miscellaneous service, i.e., drains, belts, vibration, drives, bolts and nuts, and cleaning process.

KNOWLEDGE/THEORY:

1. Installing gauge manifold
   a. Identify refrigerant used
   b. Understand contaminants
2. Interpreting pressure readings
   a. Safety
   b. Operational
   c. Low/high side
3. Determining correct refrigerant level
   a. Sight glass method
   b. Weight method
4. Identifying component failure
   a. Valve breakage
   b. Clutch wear
   c. Bearing failure
   d. Electrical failure
   e. Noise level
5. Using sling psychrometer
   a. Apply readings obtained
   b. Understand psychrometrics in order to balance head
6. Knowing oil type and amount required
7. Knowing how to replace components, evacuate, and recharge system
8. Using electrical schematics

9. Checking fuses
    a. Method
    b. Types
10. Checking for open circuits
    a. Testing procedure
    b. Correction
11. Checking for grounding (shorts)
    a. Corrective measures
    b. Checking procedure
12. Demonstrating air bypass and diversion
    a. Leverage controls
    b. Servos
13. Performing miscellaneous service
    a. Leak testing
    b. Clutch slippage
    c. Noise and identify
    d. Belts and adjustments

VALUE/ATTITUDE
CONCEPTS:
1. Safety first
2. Identify refrigerants
    a. R-12
    b. R-12/31
    c. Others
3. Evacuation, recharging, and leak testing
4. Understand causes and correct failure while following instructions (written and oral)
5. Reason for obtaining data; corrective measures
6. Functions of oil
    a. Lubrication
    b. Heat dissipation
    c. Cleaning a system
7. Economy
8. Electrical diagnosis and remedy
9. Correct replacement ability to read service manuals and follow written instructions
10. Ohm meter or continuity testers
11. Know corrective approach i.e., new harness, wire replacement or repair
12. Know service and approach
13. Dash and control area for proper or correct service approach

TASK AREA: Drafting and Blueprint Reading

TASK # 11.1: Planning

COMPETENCY: Given a job order, develop preliminary sketches, evaluations, and measurements. From these, develop plans and working drawings to scale.

CRITERION: Plans and specifications to be accurate, to scale, dimensioned, clear and concise with necessary elevations, sections, and enlargements so as to give a true picture of job requirements.

SKILL/PROCESS:
1. Organize activities for efficiency.
2. Outline data for use.

KNOWLEDGE/THEORY
1. Have all drafting tools readily available to eliminate having to make unnecessary trips to the source of supply
2. Have preliminary sketches and field measurements ready for use
3. Be able to justify any recommendations

VALUE/ATTITUDE
CONCEPTS:
1. Organize for good work
2. Proper use of time
3. Unnecessary distractions
4. Systematic approach
5. Development of plan and ideas

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TASK AREA: Drafting and Blueprint Reading

TASK # 11.2: Sketching

COMPETENCY: Given a job order, develop sketches showing required elevations and preliminary plan.

CRITERION: Sketches of elevations and floor plan to be developed to scale showing required detail.

SKILL/PROCESS:
1. Sketch objects.
2. Sketch working drawings.

KNOWLEDGE/THEORY:
1. Objects
   a. Show plan view, front elevations, and side elevations
   b. A pictorial view may be helpful
2. Working Drawings
   a. Marking drawings to be drawn up only after all corrections and changes are made from preliminary plans
   b. Make plans to applicable scale

VALUE/ATTITUDE CONCEPTS:
1. Understanding requirements of project
2. Corrections if required
3. Ease of completion of plan
4. Sizing of equipment from space provided
5. Correctness of work
   a. Pride of completed job
   b. Understanding of work by others
   c. Proper scale for use by others
   d. Self-satisfaction

TASK AREA: Drafting and Blueprint Reading

TASK # 11.3: Technical Drawing

COMPETENCY: Lay out duct plans and drawings of various apparatus.

CRITERION: Neat plans provided with details, notes, etc., that skilled mechanic could understand and fabricate.

SKILL/PROCESS:
1. Use drafting equipment.
2. Draw objects so as to describe their shape through orthographic, pictorial, sectional and/or auxilliary view techniques.
3. Use scales to describe the size of an object.
4. Do lettering and dimensioning.

KNOWLEDGE/THEORY:
1. Proper use of drafting tools
   a. Drafting equipment
   b. Practice
2. Visualize a finished product by shape and size using the three view method
   a. Drafting skills
   b. Isometrics and/or perspective
   c. Cross sections through difficult areas of equipment arrangements
3. Scales
   a. Know how to enlarge or reduce the size of an object on paper in order to bring out details of construction
   b. Use of scales
4. Lettering and dimensioning
   a. Know proper location for dimensions and standard method of lettering them using fractions or decimels
   b. Labeling of all items and ledgers of complete listing of equipment, sizes, and specifications

VALUE/ATTITUDE CONCEPTS:
1. Results
2. Speed
3. Clarity
4. Correctness
5. Ease of use
6. Appearance

TASK AREA: Drafting and Blueprint Reading

TASK # 11.4: Blueprint Reading

COMPETENCY: Given a job order with a blueprint, develop plan and specifications.

CRITERION: Draw plan to scale, develop elevations, and make required dimensions.

Develop charts and schedules of equipment and symbols used.

SKILL/PROCESS:
1. Visualize shapes of objects.
2. Determine dimensions.
3. Interpret specifications.
4. Know meanings of lines and symbols.

KNOWLEDGE/THEORY:
1. Visualizing shapes
   a. Concentration of various views
   b. Pictorial, plan, front elevation, side elevation
2. Determining dimensions and scales
   a. Make sure all dimensions correspond with notes of field measurements
   b. Verify heights and clearances
3. Interpreting specifications
   a. Technician must first thoroughly study all blueprints and the specifications which are also considered a part of the blueprints
   b. Note all unusual aspects
4. Lines and symbols
   a. All symbols and line density should be described separately on the blueprints
   b. Dimensions and symbols

VALUE/ATTITUDE
CONCEPTS:
1. Understanding job requirements
2. Correctness of plan
3. End results
4. Workmanship
5. Understand prints
6. Verification of requirements

TASK AREA: Drafting and Blueprint Reading

TASK # 11.5: Graphics

COMPETENCY: Develop graphs and fuel consumption for specific fuel using equipment.

CRITERION: Know and interpret energy use using known wattage/BTU for all fuels desired.

SKILL/PROCESS:
1. Prepare charts and graphs.
2. Develop diagrams.
3. Develop maps, pictures, and drawings.

KNOWLEDGE/THEORY:
1. Preparing charts
   a. Know the standard graphs for a fan curve or a flow chart
   b. Make proper interpretation
2. Developing diagrams
   a. Show a pictorial electrical wiring diagram
   b. Show a schematic electrical wiring diagram
3. Developing maps, pictures, and drawings (be able to read longitude, latitude, contours, etc., from any map)

VALUE/ATTITUDE
CONCEPTS:
1. Specification
2. Operation
3. Delivery requirements
4. Operation
5. Control
6. Comfort

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TASK AREA: Mathematics

TASK # 12.1: General Math

COMPETENCY: Solve problems in heat gain and loss, estimating, duct sizing, areas, volumes, and velocities.

CRITERION: Be able to arrive at correct heat loss and gain values from a blueprint.

Determine cost, overhead, selling price of job, and interest and percentages.

SKILL/PROCESS:
1. Perform basic operations.
2. Perform operations involving fractions, decimals, and percentages.

KNOWLEDGE/THEORY:
1. Basic operations
   a. Addition
   b. Subtraction
   c. Multiplication
   d. Division
   e. By long hand only
2. Fractions, decimals, and percentages
   a. Fractions
   b. Decimals
   c. Percentages
   d. Converting
   e. Operation, performance, and appreciation to trade problems

VALUE/ATTITUDE
CONCEPTS:
1. Pay check
2. Tax refund
3. Savings account
4. Debt
5. Credit
6. Interest
7. Sheetmetal work
8. Estimate and pricing work

TASK AREA: Mathematics

TASK # 12.2: Measurements

COMPETENCY: Lay out and size components in all systems by applying math involved in time, rate, distance as related to volume, weights, and energy demands.

CRITERION: From job specifications, be able to calculate size of equipment and system components for a given job.

SKILL/PROCESS:
1. Use English system.
2. Use metric system.

KNOWLEDGE/THEORY:
1. English system
   a. Dimensions
   b. Dimensional analysis
   c. Conversion systems
2. Metric system
   a. Meter, kilogram, liter, centigrade (Celsius)
   b. The floating decimal
   c. Scientific notation
   d. Absolute pressure
   e. Absolute temperature

VALUE/ATTITUDE CONCEPTS:
1. Fit
2. Quantity
3. Length
4. Width
5. Depth
6. Waste
7. Temperature
8. Imports
9. Time
10. Weight

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TASK AREA: Mathematics

TASK # 12.3: Algebra

COMPETENCY: Solve equations for unknowns with air movement problems such as duct size, velocity, volume mixtures desired.

CRITERION: Lay out duct systems using algebraic principles.

Solve for temperatures, pressures, and volumes as used in the refrigeration process.

SKILL/PROCESS:
1. Perform basic operations.
2. Perform advanced operations.

KNOWLEDGE/THEORY:
1. Basic operations
   a. Add, subtract, multiply, divide
   b. Symbols
   c. Rules, postulates, anxioms
2. Advanced operations
   a. Equations, linear, factoring, exponents, logarithms
   b. Basic operations
   c. Add, subtract, multiply, and divide
   d. Reciprocals

VALUE/ATTITUDE
CONCEPTS:
1. Money
2. Profit
3. Loss
4. Refund
5. Money cost
6. "Therms"
7. Unknown quantities

TASK AREA: Mathematics

TASK # 12.4: Geometry

COMPETENCY: Prepare good duct fitting layout.

Calculate compressor capacity.

CRITERION: Be proficient in sheetmetal layout.

Be able to do application engineering.

SKILL/PROCESS:
1. Use plain and solid figures.
2. Determine area and volume.

KNOWLEDGE/THEORY:
1. Plain and solid figures
   a. Point, line, angle, degree, straight, curve
   b. Plane
   c. Volumetric
   d. Cube
   e. Cylinder
   f. Cone
2. Area and volume
   a. Basic concepts of two and three dimensional figures
   b. The triangulation for area and the breaking of all figures into small cubes, cones, cylinders, and spheres

VALUE/ATTITUDE

CONCEPTS:
1. Flat sheets
2. Duct fittings
3. Valves
4. Cubic yds., ft., centimeter
5. Compressor speed
6. Displacement
7. Piston dimensions
8. Efficiency

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TASK AREA: Mathematics

TASK # 12.5: Trigonometry

COMPETENCY: Use trigonometry to solve problems related to duct fabrication and installation.

CRITERION: Solve right angle trigonometry problems for unknowns.

Uses trigonometry in laying out and joining ducts.

SKILL/PROCESS:
1. Perform basic operations.
2. Perform advanced operations.

KNOWLEDGE/THEORY:
1. Knowledge of sines, cosines, and tangents
    a. How to use tables to find the above
    b. Knowledge of "3,4,5" and "1,12,13" triangles
    c. The knowledge of angles with relationship of forces acting and reacting
    d. Trigonometry functions in relation to circles and triangles
2. Advanced trigonometry operations

VALUE/ATTITUDE
CONCEPTS:
1. In dealing with force and motion, trigonometry knowledge can be helpful
2. Relationship to geometry
3. Duct work with complex joints and runs
4. Duct fabrication

TASK AREA: Safety and First Aid

TASK # 13.1: Safety

COMPETENCY: Determine correct safety measures for various locations.

CRITERION: Know local, state, and federal laws pertaining to storage of compressed gases.

Use correct safety measures for protection to eyes.

Have proper ventilation for soldering and brazing.

Use OSHA approved equipment and tools.

SKILL/PROCESS:
1. Use safety equipment.
2. Know and abide by safety rules and regulations.
3. Locate and switch off the master power switch.
4. Perform safe evacuation from shop.
5. Protect equipment and personnel from unsafe conditions.

KNOWLEDGE/THEORY:
1. Using safety equipment
   a. Use correct fire extinguisher
   b. How to rig equipment to be lifted in place
   c. How to lift with legs without causing injury to back
   d. Keep loose clothing away from rotating machinery
   e. How to use a ladder
   f. How to use and maintain hand tools
2. Knowing and abiding by safety rules and regulations
   a. Safety with compressed gas cylinders
   b. Safety with compressed air
   c. Use of eye protection
   d. Soldering and brazing on refrigeration systems
   e. Venting refrigerant from a system with a burnout
   f. Safety on a ladder
   g. Safe use of power tools
3. Locating and turning off the master power switch
   a. Location of each master power switch
   b. Know what actions are required to turn the power off
4. Evacuating from shop
   a. Be familiar with building evacuation plans
   b. Know the most direct route to outside and safety
5. Protect equipment and personnel
   a. Safety instructions
   b. OSHA regulations

VALUE/ATTITUTDE
CONCEPTS:
1. Safety as a personal attitude
2. Taking chances
3. Need for first aid training

4. Importance of looking out for the safety of others
5. Reassessment of jobs completed
6. Being aware of safety attitudes of others
7. Correct storage
8. Controls and relief valves
9. Goggles or glasses
10. Ventilation
11. Correct disposal
12. Approved for job
13. Awareness of equipment utilities
14. Exit locations
15. Building equipment
16. Simple first aid

TASK AREA: Safety and First Aid

TASK # 13.2: First Aid

COMPETENCY: Administer first aid to accident victim using life saving techniques.

CRITERION: Be able to stop flow of blood, administer mouth to mouth resusitation, cpr, and prevent or treat for shock.

Be able to describe treatment to proper medical authorities.

SKILL/PROCESS:
1. Perform simple first aid procedures.
2. Know location to first aid kit.

KNOWLEDGE/THEORY:
1. Performing basic first aid
   a. Treating and dressing small open wounds
   b. Use and location of eye wash fixture
   c. Treatment for acid spill
   d. Treatment for electrical shock
   e. What constitutes first aid
2. First aid kits
   a. Location in shop
   b. Location on job
   c. Location on trucks

VALUE/ATTITUDE
CONCEPTS:
1. Who will benefit from first aid
2. Reason for first aid
3. Patient comfort
4. Avoiding shock
5. Preventing more serious reactions
6. Treatment of injury
7. Awareness of life saving techniques

TASK AREA: Welding

TASK # 14.1: Oxyacetylene

COMPETENCY: Select a soldering project, prepare the surface, select the flux, select filler material, and solder the project.

Select a brazing project, prepare the surface, select the flux, select filler material, and braze the project.

Select a welding project, prepare the workpiece, select rod, and weld the project.

Cut object according to print specifications.

CRITERION: Inspect flow of filler material for adherence, excessive build-up, weak spots, and appearance.

The student will set up torch for cutting operation, cut, and prepare weld test plates.

Inspect weld test plates for correct angles, size, and finish.

Inspect tightness for fitting, setting of gauges, size of tip, and lighting the torch.

Take project apart and inspect for cleanliness of parts, pits in filler material, and amount of filler material used.

Inspect for flow of filler material, adherence of filler material to part, and test project for strength.

The student will select a project, prepare the material, select filler material, and weld the part.

SKILL/PROCESS:
1. Perform soldering operations.
2. Perform brazing operations.
3. Perform welding operation.
4. Perform cutting operations.

KNOWLEDGE/THEORY:
1. Perform soldering operations
   a. Assembly and set up
   b. Preparation of materials
   c. Fluxes
   d. Flame control
   e. Temperature controls

f. Safety precautions
g. Selection of filler materials
h. Torch positioning
i. Disassembly and storage
2. Perform brazing operations (A-D same as above)
3. Perform welding operations
a. Assembly and set up
b. Preparation of materials
c. Flame control
d. Temperature control
e. Selection of filler materials
f. Safety precautions
g. Fusion
h. Torch positioning
i. Disassembly and storage
4. Perform cutting operations
a. Assembly and set up
b. Preparation of materials
c. Flame control
d. Torch positioning
e. Safety precautions
f. Disassembly and storage

VALUE/ATTITUDE
CONCEPTS:
1. Oxyacetylene welding
2. Relation to major area of study
3. Safety
4. Housekeeping
5. Quality of work
6. Care of equipment
7. Storage of equipment

TASK AREA: Welding

TASK # 14.2: Arc Welding

COMPETENCY: Set the welding machine for correct current, ensure positive ground connection, wear proper clothing, take safety precautions, strike an arc, and weld a part.

The student will select the proper electrode by using a print with welding specifications as to size and grade.

CRITERION: Inspect electrode as to specifications, size, and grade.

The student will prepare material for weld test plate, weld plate, clean slag, remove backup strip, saw coupons, grind surfaces, and chamfer.

Inspect for pits, slag, and form coupons to specifications.

Inspect for cracks and penetration of filler material to parent metal.

SKILL/PROCESS:
1. Set up equipment
2. Select electrode
3. Perform welding operation

KNOWLEDGE/THEORY:
1. Setting up equipment
   a. Current setting
   b. Connection of ground cable
   c. Proper clothing and protective equipment
   d. Safety precautions
2. Selection of electrodes
   a. Materials to be welded
   b. Use of finished product
   c. Size and specification numbers
   d. Welding symbols
3. Perform welding operations
   a. Preparation of work pieces
   b. Striking of arc
   c. Position of work piece
   d. Position of electrode
   e. Arc control
   f. Direction of movement
   g. Flux removal and cleaning

VALUE/ATTITUDE CONCEPTS:
1. Relates to major area of study

2. Safety
3. Housekeeping
4. Quality of work

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AHR

TASK AREA: Science

TASK # 15.1: Units and Measurements

COMPETENCY: Be able to accurately measure and calculate from instruments, tables, and graphs.

CRITERION: Takes accurate measurements in English and metric units.

Computes conversions from English to metric.

SKILL/PROCESS:
1. Identify units of length, weight, and volume.
2. Estimating the length and weight of objects in metric (SI) units.
3. Convert from inches to mm or cm and from lb. to kg.
4. Convert from $in.^3$ to $cm.^3$.
5. Perform measurements using English or metric machinist rules.
6. Perform measurements using English or metric micrometer calipers.
7. Perform measurements using English or metric vernier calipers.
8. Use the correct number of significant figures.
9. Estimate error in measurements and calculations.

KNOWLEDGE/THEORY:
1. Identifying units of length, weight, and volume
   a. Linear measurement
   b. Mass measurement
   c. Area measurement
   d. Cubic measurement
2. Estimating length and weight in metric units
   a. Use of milimeter, centimeter, meter, kilometer
   b. Use of gram and kilogram
3. Conversion of inches to mm and cm and lb. to kg.
   a. Convert inches to milimeters
   b. Convert milimeters to inches
   c. Convert inches to centimeters
   d. Convert centimeters to inches
   e. Pounds to kilograms
   f. Kilograms to pounds
4. Conversion of cubic inches to cubic centimeters
   a. Convert cubic inches to cubic centimeters
   b. Convert cubic centimeters to cubic inches
5. Performing measurements using English and metric rules
   a. Use an English unit rule
   b. Use a metric unit rule
6. Performing operations using English or metric micrometer calipers
   a. Measure some parts and record results
   b. Measure to specified accuracy
7. Performing operations using English or metric vernier calipers
   a. Measure parts with a vernier caliper
   b. Inside and outside calipers
8. Significant figures
   a. Appropriate figures from decimal for accuracy
   b. In multiplication

9. Estimating error in measurements and calculations
    a. Make measurements and calculate error
    b. Accuracy

VALUE/ATTITUDE
CONCEPTS:
1. AHR units and measurements
    a. Feet, inches, mm., cm., etc.
    b. Sq. yd., cm., mm., sq. ft., sq. in.
    c. Cu. yds., ft., cm. meter
    d. Duct area
    e. Wall area
    f. Fluid volumes and weights
    g. Microns
    h. Sq. in.
    i. Imported equipment
    j. SAE and metric wrenches
    k. Pressure controls
    l. Temperature controls
    m. Volumetric displacement
    n. Compressor displacement
    o. Pumping efficiency
    p. Duct fittings
    q. Air volumes
    r. Gas volumes
    s. Compression ratio
    t. Velocities
    u. Resistance to flow
    v. Weight per linear foot of fluid in piping
2. Scales
3. Vernier scales (inches or centimeters)
4. Mathematics
5. Accuracy

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TASK AREA: Science

TASK # 15.2: Properties of Materials

COMPETENCY: Know properties of materials used in air conditioning, heating, and refrigeration field.

CRITERION: Measure density, melting point, tensile strength, and specific heat.

SKILL/PROCESS:

1. Use tables of density, specific gravity, and specific heat.
2. Read gauges and meters.
3. Make measurements to determine density or specific gravity.
4. Make measurements to determine tensile strength.
5. Apply terms relating to properties of materials.
6. Calculate density, specific gravity, and specific heat.
7. Calculate temperature, volume, and pressure changes in a gas.
8. Relate densities to buoyancy and flotation.
9. Follow directions, both oral and written, from lab experiences.
10. Graph and interpret graphs.

KNOWLEDGE/THEORY:

1. Using tables
2. Reading gauges and meters
3. Making hydrometer measurements
4. Tensile strength
    a. Testing
    b. Expansion
    c. Compression
5. Terms relating to properties of materials
6. Calculating density, specific gravity, and specific heat
7. Calculating changes in a gas
8. Relating densities to buoyancy and flotation
9. Following directions
10. Graphs

VALUE/ATTITUDE CONCEPTS:

1. Significance for design
2. Appropriate tables and texts

TASK AREA: Science

TASK # 15.3: Mechanics

COMPETENCY: Develop the ability to perform tests on machinery.

CRITERION: Field test and compare to manufacturer's specifications for accuracy.

SKILL/PROCESS:
1. Measure the power output of a rotating shaft.
2. Determine the efficiency of a machine
3. Determine the energy required to do a given job.
4. Calculate velocity, distance, or time.
5. Calculate acceleration, change in velocity, or time.
6. Identify all forces acting on a body.
7. Determine force required to start or stop a body.
8. Identify causes of inefficiency in a machine.

KNOWLEDGE/THEORY:
1. Power
   a. Use of poney brake
   b. Use of tachometer
   c. Use of dynomometer
2. Efficiency
   a. Be able to measure power input and output
   b. Understand efficiency formula
   c. Understand sources of energy losses
3. Energy
   a. Be able to measure and apply distance, time, weight, force, friction, and inertia to determine energy required
   b. Forms of energy
4. Velocity
   a. Be able to use and apply velocity formula and solve for any of the variables
   b. Speed
5. Acceleration
   a. Be able to use and apply the acceleration formula and solve for any of the variables
   b. Know the acceleration of gravity constant
6. Forces
   a. Understand forces of gravity, centrifugal, centripetal friction, air pressure, acceleration, action, and reaction
   b. Free body diagrams
7. Friction
   a. Understand friction and inertia
   b. Fluid friction
8. Inefficiency
   a. Friction
   b. Tolerances
   c. Lubrication
   d. Number of energy conversions

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VALUE/ATTITUDE
CONCEPTS:
1. Sizing motor drives
2. Evaluating systems for efficiency
3. Choosing energy source
4. Improving efficiency to make system practical
5. Appropriate physics

TASK AREA: Science

TASK # 15.4: Heat

COMPETENCY: Measure temperature of materials or objects and their surroundings.

Given a specific material and a means of adding heat to it, determine expansion and quantity of heat absorbed.

CRITERION: Proper record and calculation of heat measurements.

SKILL/PROCESS:
1. Select correct thermometric device.
2. Use a thermometric device to determine temperature.
3. Calibrate thermometer.
4. Calculate linear expansion and apply to job at hand.
5. Calculate volume expansion of materials and apply to job at hand.
6. Calculate or estimate heat absorbed and given up due to a temperature change.
7. Calculate or estimate heat produced in a mechanical operation.

KNOWLEDGE/THEORY:
1. Thermometric devices
   a. Thermometers, pyrometers, thermistors, thermocouples and thermopile
   b. Advantages
2. Temperature
   a. Be able to use all instruments in No. 1 above
   b. Read English of metric scale
3. Calibrating thermometers
   a. Compare reading when in distilled ice water
   b. Adjustment techniques
4. Linear Expansion
   a. Use coefficient of expansion and temperature difference for prediction
   b. Selection of materials for application
5. Volume expansion
   a. Calculate
   b. Measure
   c. Apply
6. Heat absorption
   a. Understand sensible heat and latent heat
   b. Understand specific heat
   c. Know how to use basic formula (Q-WCST)
7. Heat production
   a. Use friction formula
   b. Conversion of energy losses converted to BTU

VALUE/ATTITUDE
CONCEPTS:
1. Comfort and control
2. Calculating load

3. Determining accuracy of instruments
4. Determining expansion of joints
5. Determining expansion of liquids
6. Determining load material handling
7. Estimating sensible load
8. Output divided by input

TASK AREA: Science

TASK # 15.5: Light and Sound

COMPETENCY: Interpret effect of sound as related to physical comfort.

Recommend construction practices that use sunlight to an advantage in heating and cooling a structure.

CRITERION: Be able to make accurate sound measurements.

Describe how sunlight affects heating/cooling needs of a structure.

SKILL/PROCESS:
1. Determine the efficiency of a light fixture.
2. Layout a simple lighting system.
3. Predict the results of additive color mixing.
4. Predict the results of subtractive color mixing.
5. Determine the reverberation time of a room.
6. Analyze the performance of a loud speaker.
7. Measure and evaluate noise level.
8. Calculate BTU gain or loss from a structure.

KNOWLEDGE/THEORY:
1. Lighting efficiencies
2. Lighting system requirements
   a. Electrical demand
   b. Lighting demand
3. Color wheel
4. Subtractive color mixing
5. Resonance
6. Speaker performance (output divided by energy input)
7. Noise
   a. Sources of noise
   b. Damping noise
   c. Acceptable noise levels
8. Sunlight
   a. Structure orientation and construction
      1. Eaves
      2. Orientation
      3. Windows
      4. Shade
   b. Heat gain/loss of structure
      1. Degree day calculations
      2. Structure weatherization characteristics
      3. BTU calculations
      4. Solar characteristics

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VALUE/ATTITUDE
CONCEPTS:
1. Use decible meter
2. Determine sun's effect as related to the heating/cooling need of a structure
3.
4. Light meter and design
5. Appropriate physics

TASK AREA: Science

TASK # 15.6: Electricity and Magnetism

COMPETENCY: Given electrical measurement instruments, demonstrate proper use to isolate and correct electrical problems.

CRITERION: Proper meter (instrument) selected and connected to circuit properly.

Power "on" or "off" as appropriate for proper measurement and to prevent damage to instrument.

Isolate troubles in transformers and controls (magnetic) to low voltage or operating voltage problem.

Determine if a motor is working within its capabilities.

Use National Electric Code (NEC) to determine conductor size, fuse, or circuit breaker size.

SKILL/PROCESS:

1. Install meters and take readings.
2. Set up simple circuits.
3. Test with an ohmmeter.
4. Convert joules to ft.-pounds.
5. Convert joules to calories
6. Convert watts to hp.
7. Determine cost of electrical energy used.
8. Replace blown fuses.
9. Determine wire size.
10. Use an electromagnet.
11. Use an induction coil.
12. Charge a lead storage battery.
13. Use a transformer.
14. Build an induction heater.
15. Rectify alternating current
16. Use a capacitor to product phase shift.
17. Use a variable resistor to control current.
18. Use an oscilloscope.
19. Determine charge of lead battery with hydrometer.
20. Use Ohm's law to find resistance.
21. Use relays, generators, and electric motors.
22. Use a generator.
23. Use an electric motor.
24. Build a copper wire cell.
25. Ground an electrical device.
26. Determine the impedance of a coil.
27. Show lines of force of a magnet.
28. Determine compound resistance.
29. Determine how voltages combine.

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30. Determine how currents combine.
31. Determine that like charges repel, etc.
32. Determine the power used by a lamp, etc.
33. Find the resistivity of a metal.
34. Determine the electrical equivalent of heat.
35. Find the horsepower of a motor.
36. Use the laws of transformers.
37. Explain the operation of a voltmeter and ammeter.
38. Find the field lines around a current-carrying wire.
39. Use the National Electrical Code Handbook*

KNOWLEDGE/THEORY:

1. Meters
   a. Understands operational methods and procedures of voltmeters, ammeters, and ohmmeters
   b. Use these to determine correct valves
2. Circuits
   a. Equipment to show circuits including power source, conductor, loads, and switches
   b. Make up circuits
3. Ohmmeter
   a. Understands correct sequence and rules pertaining to checking for continuity with an ohmmeter
   b. Precautions
4. Joules to ft.-pounds
5. Joules to calories
   a. Relationship
   b. Formula for con ersion
6. Watts to hp
   a. Understand relationship and reason for converting from watts to hp and back
   b. Formula for conversion
7. Cost of electrical energy
   a. Calculating energy cost
   b. Calculating energy usage
8. Fuses
   a. Is able to recognize a blown fuse
   b. Replacing blown fuses
9. Wire sizes
   a. Read charts pertaining to amperage and conductor size
   b. Understand relationship and code requirements
10. Electromagnetism
    a. Electromagnets
    b. Solenoids
11. Induction coil
    a. Principle
    b. Uses
12. Lead storage battery
    a. Connect proper terminals and set amperage and time controls to completely charge battery
    b. Test charge
13. Transformers
    a. Understand principle
    b. Uses of transformer for voltage changes and isolation

14. Electric furnaces
    a. Types
    b. Applications
15. Rectifying alternating current
    a. Understand and apply knowledge of motor
    b. Monitor rectified current
16. Capacitors
    a. Phase shift to accomplish motor starting and greater efficiency
    b. Types
17. Variable resistors
    a. Demonstrate ability to raise or lower current by use of a variable resistor
    b. Applications
18. Oscilloscopes
19. Determining charge of batteries
    a. Understands specific gravity and its relationship to electrical conductivity and particle contest
    b. Using hydrometer to determine charge
20. Ohm's Law
    a. Can define and manipulate the formula from the triangle
    b. Measure resistance
21. Relays
    a. Understand electromechanical principle and how it can be applied and converted from one form of energy to another
    b. Using relays
22. Generators
    a. Principles
    b. Use
23. Electric Motors
    a. Principles
    b. Use
24. Copper wire cells
    a. Construct a simple voltaic cell to understand different potential of dissimilar metals
    b. Applications
25. Grounding electrical devices
    a. Understands necessity of a ground and its purpose as far as safety is concerned
    b. Grounding electrical devices
26. Impedance
    a. Uses meters to find impedance of different coils
    b. Applications
27. Lines of force
    a. Uses iron fillings to prove the existance of lines of force
    b. Applications
28. Compound resistance
    a. Identify run, common, and start leads of a motor
    b. Calculate in simple circuits
29. Combining voltages
    a. Uses volt meter to find the potential between two phases of electricity
    b. Calculate in simple circuits

30. Combining current
    a. Uses an ammeter to find each current and total current in a unit
    b. Calculate in simple circuits
31. Charge
    a. Uses magnets to prove the repulsion attraction theory
    b. Applications
32. Power
    a. Uses and understands the function of a wattmeter to measure total power consumption
    b. Calculations
33. Resistance
    a. Uses and understands principles behind an ohmmeter
    b. Other applications
34. Electrical equivalent of heat
    a. Conversion
    b. Calculation
35. Horsepower
    a. Understands the meaning of horsepower and its computation
    b. Read labels
36. Transformers
    a. Explains and connects transformer to produce specific voltages and currents
    b. Application
37. Voltmeters and ammeters
    a. Understands D'arsonal movement and factors that influence it
    b. Uses meters
38. Field of force uses meters to prove the existance of lines of force
39. National Electrical Code Handbook
    a. Be familiar with conductor sizes, disconnects, fuse and circuit breaker sizes, use of book to look up answers to questions on grounding of motors and equipment

VALUE/ATTITUDE

CONCEPTS:

1. Use of proper instrument saves troubleshooting time
2. Can explain cost of equipment use to customer
3. Test a fuse using ohmmeter or voltmeter
4. Use of dual element fuses on motor circuits
5. Use of National Electric Code for safe wiring of circuits and fire prevention safety
6. Applied mathematics
7. Identify types and usage
8. Proper selection of replacement motors for condensers and air handlers
9. Low voltage source for control circuits
10. Use of snap-around ammeter possible because of this

* National Electrical Code has been adopted as Volume IV to the North Carolina Building Code.

TASK AREA: Science

TASK # 15.7: Auxiliary

COMPETENCY: Develop the ability to graphically illustrate functions or data.

CRITERION: Can perform simple data analysis techniques.

Does work accurately.

SKILL/PROCESS:
1. Plot a graph.
2. Read a graph.
3. Read diagrams and charts.
4. Perform the four basic arithmetic functions.
5. Extract a square root.
6. Add inverses.

KNOWLEDGE/THEORY:
1. Plotting graph
   a. Explain value of a position through the use of dots or lines on graph paper
   b. Applications
2. Reading graphs
   a. Comprehend information passed through the use of a graph
   b. Reading various graphs
3. Diagrams and charts
   a. Interpret information on lines or graph paper
   b. Pie charts
   c. Histograms, etc.
4. Basic arithmetic functions
   a. Use basic mathematics to solve problems involving figures
   b. Word problems
5. Square roots
6. Inverses

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TASK AREA: Communications

TASK # 16.1: Reading

COMPETENCY: Read chapter of textbook giving time required and how much was retained.

CRITERION: Understands what is read.

SKILL/PROCESS:
1. Read manuals, workbooks, work orders, and memos.
2. Read books in the field.
3. Read the bulletin board and company publications.
4. Look up words in the dictionary.
5. Read articles in trade journals.
6. Read and interpret written instructions.

KNOWLEDGE/THEORY:
1. Reading manuals, etc.
   a. Every employee should read
   b. Employee should understand technical information for the job level
2. Reading books in field
   a. Requirement for technician or foreman
   b. Highly technical material aids job-related decisions
3. Reading bulletin boards and company publications
   a. Enables employees to stay informed
   b. Reading these should become habit
4. Using dictionary
   a. Knowing word meaning is necessary while reading
   b. Dictionary is vital tool in reading comprehension
5. Reading trade journals
   a. Presents latest trade developments
   b. Information on latest equipment changes
6. Reading written instructions

VALUE/ATTITUDE CONCEPTS:
1. Basic tool for all education
2. Need to keep up with ones in field
3. Importance of being an informed and well-rounded person
4. Being able to understand what others are saying
5. The need to have libraries for personal use
6. Being able to keep in touch with times

TASK AREA: Communications

TASK # 16.2: Writing

COMPETENCY: Given a trade journal, outline a topic

CRITERION: Outline should be legible.

SKILL/PROCESS:
1. Write reports, work orders, memos, and instructions.
2. Make written application for employment, including resume.
3. Fill out a job application form.
4. Write a business letter.
5. Spell major terms related to job.
6. Write legibly.
7. Complete requisitions and purchase orders.
8. Make out a bill for goods sold.

KNOWLEDGE/THEORY:
1. Writing reports, work orders, memos, and instructions
2. Making written application for employment, including resume
3. Filling out a job application form
4. Writing a business letter
5. Spelling major terms related to job
6. Writing legibly
7. Completing requisitions and purchase orders
8. Making out a bill for goods sold

VALUE/ATTITUDE CONCEPTS:
1. Basic tool for all education
2. Writing out instructions for others
3. Important to be a well-rounded person
4. Pride in all forms of communication

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TASK AREA: Communication

TASK # 16.3: Talking

COMPETENCY: Given a product from major areas, give a talk explaining the different parts, how they function, and what purpose each plays with the total project.

CRITERION: Understood by others.

SKILL/PROCESS:
1. Give oral directions.
2. Speak to a small group.
3. Solve problems by asking questions.
4. Make suggestions to superiors constructively.
5. Talk on the telephone in a job setting.
6. Participate in discussions.
7. Report orally on work.
8. Show conversational courtesy to others.

KNOWLEDGE/THEORY:
1. Giving oral directions
2. Speaking to groups
3. Solving problems by asking questions
4. Making constructive suggestions
5. Talking on the business phone
6. Participating in discussions
7. Reporting orally on work
8. Showing conversational courtesy to others

VALUE/ATTITUDE CONCEPTS:
1. Basic tool for all education
2. Giving others oral directions

TASK AREA: Communications

TASK # 16.4: Listening

COMPETENCY: Given verbal instructions or information, understands what is said.

CRITERION: Makes appropriate response to instructions or information.

SKILL/PROCESS:
1. Listen for correct meaning.
2. Listen for information and directions.
3. Listen to understand a person.
4. Listen to share feelings.

KNOWLEDGE/THEORY:
1. Listening for correct meaning.
2. Listening for information and directions.
3. Listening to understand a person.
4. Listening to share feelings.

VALUE/ATTITUDE CONCEPTS:
1. Understanding what is heard
2. Basic tool to education
3. Putting what is heard to work
4. Being able to listen to customer to find out what he needs
5. Asks questions to be sure you understand what your customer needs

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TASK AREA: Communications

TASK # 16.5: Visual Interpretation

COMPETENCY: Showing a film, individual should summarize what was viewed.

CRITERION: Understands what was seen.

SKILL/PROCESS:

1. Be aware of surroundings.
2. Recognize problems and dangers.
3. Interpret signs, symbols, posters, and other visuals.
4. Interpret freehand sketches and diagrams.
5. Interpret graphs and maps.

KNOWLEDGE/THEORY:

1. Be alert
2. Know the different signs related to the industry
3. Ability to read
4. Know your OSHA safety rules
5. Graphs and maps

VALUE/ATTITUDE CONCEPTS:

1. Developing a mental picture
2. Interpretation of signs
3. Using signs as a directive
4. Aware of safety rules and regulations

TASK AREA: Professional Practice

TASK # 17.1: Business Management

COMPETENCY: Manage a business.

CRITERION: Continue as a profitable business.

SKILL/PROCESS:
1. Maintains good human relations with other employees.
2. Keeps records of customer on file.
3. Maintains good public relations.
4. Can compute overhead cost of each job.
5. Knows local, state, and federal regulations pertaining to equipment to be used.

KNOWLEDGE/THEORY:
1. Employee relations
   a. Knows the employee
   b. Knows how he will react to different situations
2. Customer records
   a. Knows a system so that a customer's equipment can be found quickly (and what was done on equipment)
   b. Knows age of equipment and case history
3. Public relations
   a. Sets up a system which will bring the business to the attention of the general public in an acceptable manner
   b. Satisfies customers
4. Computing overhead costs (material, labor, hidden cost, tax, etc.)
5. Regulations
   a. Has regulations on hand
   b. Familiar with laws that affect AHR field.

VALUE/ATTITUDE

CONCEPTS:
1. Importance of employee loyalty
2. Personalize customers to maintain good relations
3. Importance of public awareness to business
4. Management must be responsible for doing a good job and for making a profit
5. Maintain good relations with inspectors

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TASK AREA: Professional Practice

TASK # 17.2: Ethics

COMPETENCY: Gain respect of others.

CRITERION: Has respect of competitors, public, employer, and other employees.

SKILL/PROCESS:

1. Respects competitors in same field.
2. Feels obligation to public to do a good job.
3. Has obligation to employer to give fair treatment.
4. Knows the value of work competently done.
5. Respects laws, rules, and regulations which must be observed.

KNOWLEDGE/THEORY:

1. Respects competitors
   a. Knows how other businesses do their job
   b. Friend instead of critic
   c. Respects competitor's work
2. Quality work
   a. Performs satisfactory work
   b. Charge reasonable fee
3. Employee relations
   a. Compensations for good work
   b. Compensations for proper attitude toward company
4. Praise
   a. Appreciates and comments on excellence of work done by other employees
   b. Knows standards for evaluating work
5. Standards
   a. Performs to standards even when able to get by with less

VALUE/ATTITUDE
CONCEPTS:

1. Display professional attitude
2. Be proud of every job completed or attempted
3. Maintain good employee morale so that employee will stay with company
4. Have neat appearance
5. Be trustworthy

TASK AREA: Professional Practice

TASK # 17.3: Standards

COMPETENCY: Interpret manufacturer's bulletins and disseminate information of changes involving operation, costs, efficiencies, and codes.

CRITERION: Maintain and be able to give information as to operational characteristics, performance, mortality, and past records.

SKILL/PROCESS:

1. Keeps up-to-date records of changes.
2. Keeps in touch with manufacturer's recommendations.
3. Knows laws pertaining to equipment.
4. Keeps informed.
5. Does quality work.

KNOWLEDGE/THEORY:

1. Evaluating literature
   a. Reads current information pertaining to equipment
   b. Records changes where necessary
2. Manufacturer's data
   a. Reads latest brochures, magazines, journals, etc.
   b. Files specifications
3. Codes
   a. Reads and understands building, fire, and electrical codes
   b. Be familiar with regulations
4. Keeping informed
   a. Follows safety requirements
   b. Reads current literature in the field
5. Quality work to standard
   a. Recognizes craftmanship
   b. Follows accepted procedures

VALUE/ATTITUDE CONCEPTS:

1. Knows types, installation date, and other pertinent data concerning unit
2. Knows latest ideas, equipment and theories
3. Adheres to codes
4. Doesn't flaunt knowledge
5. Cleans up premises

TASK AREA: Professional Practice.

TASK # 17.4: Marketing

COMPETENCY: Calculate job overhead, labor, material, tax, etc., including miscellaneous costs such as using sub-contractors.

CRITERION: Ability to bid a job and answer pertinent customer questions.

SKILL/PROCESS:
1. Aware of total cost of equipment.
2. Knows overhead cost to deliver and/or install material.
3. Maintains list of available supplies to choose from.
4. Aware of alternate systems to be used.
5. Can explain health benefits to customer.
6. Analyzes what can be done to decrease cost of installation and operation without sacrificing quality.
7. Can compute initial cost of job relative to operational cost.

KNOWLEDGE/THEORY:
1. Investments
   a. Takes care of equipment
   b. Gets maximum use out of equipment
2. Overhead
   a. Purpose
   b. Minimizing
3. Inventory
   a. Sources
   b. Items
4. Alternate systems and components
   a. Be aware of all types of systems
   b. Know applications and methods
   c. Sub-contractors
5. Effectiveness of system
   a. Have working/practical knowledge of health benefits
   b. Explain pleasure-giving aspects of system
6. Energy and cost conservation
   a. Have thorough knowledge of installation techniques
   b. Know energy conservation methods
   c. Know cost-cutting (approved) techniques
7. Cost efficiency
   a. Investment cost
   b. Maintenance cost
   c. Rate of return

VALUE/ATTITUDE CONCEPTS:
1. What owner or boss expects of service man

TASK AREA: Cultural Attributes

TASK # 18.1: Values

COMPETENCY: Exhibits commitment toward self and field of employment.

CRITERION: Performs expected duties willingly and competently.

Demonstrates good work habits.

SKILL/PROCESS:

1. Interested in being informed.
2. Interested in becoming a better employee.
3. Interested in concerns of employer.
4. Careful use of salary.
5. Committed to personal and professional goals.
6. Concern for standard of living.
7. Has desire to learn.

KNOWLEDGE/THEORY:

1. Informed
   a. Keeps up with changes and improvements in equipment
   b. Aware of latest business developments
2. Motivated
   a. Does neat work
   b. Shows personal involvement in what is being done
   c. Improves technical skills
3. Concerns of employer
   a. Quality work
   b. Dependable help
   c. Efficient use of time
   d. Profit
4. Wise use of resources (budgets personal finances)
5. Committed to goals
   a. Knows that professional manners with a personal touch impress the public
   b. Disciplined
6. Standard of living (socio-economic factors related to job)
7. Self-improvement
   a. Knows that an employer will react favorably to the person who is willing to learn
   b. Personal satisfaction
   c. Professional advancement

VALUE/ATTITUDE CONCEPTS:

1. Value customer's expectations
2. Understanding of what employer expects
3. Quality work builds the reputation of the service technician
4. Knows that this is the key to being liked as well as to being successful

TASK AREA: Cultural Attributes

TASK # 18.2: Attitudes

COMPETENCY: Adapts and responds to concerns of others.

CRITERION: Has a good attitude.

Satisfies customers.

Pleases employer.

SKILL/PROCESS:

1. Has desire to please.
2. Understands others' problems.
3. Is willing to work hard to improve.
4. Wants to fit into scheme of things.

KNOWLEDGE/THEORY:

1. Desire to please
   a. Knows a pleased customer is a good customer
   b. Knows skills
2. Listens to customers/employer
   a. Determines source of problem
   b. Explains reason for having problems in system
3. Work ethic
   a. Practice improves both quality and proficiency
   b. Work smarter not harder
4. Adapts
   a. Identifying others with similar ideals and objectives
   b. Adjusting to situations one can't change

TASK AREA: Cultural Attributes

TASK # 18.3: Philosophy

COMPETENCY: Function consistently in everyday situations.

CRITERION: Shows promptness, cheerfulness, interest in goals of the company, and respect for his industry.

SKILL/PROCESS:

1. Interested in all persons benefitting from improved working conditions by performing quality work efficiently.
2. Consistent attitude toward all phases of work and private life.
3. Has a definite purpose to work.

KNOWLEDGE/THEORY:

1. Goals
   a. Satisfaction on the job
   b. Value on pride of work well done.
2. Objectives
   a. Attitude toward customers, fellow employees, and management
   b. A process which requires practice
3. Purpose
   a. Understanding one's responsibilities
   b. Appropriate authority
   c. Economics

TASK AREA: Cultural Attributes

TASK # 18.4: Humanistic and Social Skills

COMPETENCY: Pleasant associations within the company.

CRITERION: Character reflects the attitude and respect an individual has for himself, his fellow employees, and management.

SKILL/PROCESS:
1. Is dependable.
2. Understands all people.
3. Has aggressiveness to get the job done.
4. Is thorough in work habits.
5. Is thoughtful of others' problems.

KNOWLEDGE/THEORY:
1. Dependable
   a. Be on time
   b. Respond to requests promptly
   c. Utilize time for profit
2. Understanding
   a. Respect for viewpoints of others is necessary
   b. Tolerance
3. Aggressive
   a. Directing aggressiveness for the benefit of a group
   b. Outlets for aggressiveness
4. Thorough work habits
   a. This can be accomplished through practice
   b. Planning
   c. Example
5. Thoughtful of others' problems

TASK AREA: Interpersonal-Interactive Skills

TASK # 19.1 Leadership

COMPETENCY: Able to motivate people.

CRITERION: Gets desired results.

SKILL/PROCESS:

1. Is able to coordinate different phases of jobs.
2. Is able to take as well as give clear concise instructions in a businesslike manner.
3. Completes job in professional manner so company is well represented.
4. Motivates co-workers and helpers to accomplish objectives in least amount of time with quality retained.
5. Insures company equipment and supplies are not misused.

KNOWLEDGE/THEORY:

1. Coordinating work
   a. Coordinates tools, equipment, supplies, and personnel
   b. Effects smooth and orderly operation
2. Orders
   a. Gives comprehensible orders in manner acceptable to others
   b. Understands orders given to him.
   c. Never petty or unfair
   d. Encourage questions if orders are not clearly understood
3. Knowledge of fellow employees
   a. Encouragement
   b. Constructive criticism
   c. Strengths and weaknesses of employees
4. Motivation
   a. Quality workmanship
   b. Time conserved
   c. Profit for the company
5. Respects property of others
   a. Knowledge and use of proper tool for the proper job
   b. Knowledgeable and respectful use of company equipment

VALUE/ATTITUDE CONCEPTS:

1. Responsibility for completion and neatness of total job
2. Good employee moral resulting from clear instructions and strong leadership
3. More profitable work
4. Better quality of work
5. Enhanced possibility to receive greater renumeration

TASK AREA: Interpersonal-Interactive Skills

TASK # 19.2: Teamsmanship

COMPETENCY: Works well with others to get a job done.

CRITERION: Problems originating from one source is an indication of incompatibility.

Good team groups accomplish their goals with little help from management.

SKILL/PROCESS:
1. Works well with other employees.
2. Respects views and opinions of others.
3. Does not openly discriminate.
4. Is concerned with total company objectives.

KNOWLEDGE/THEORY:
1. Compatibility
   a. Compatibility increases work output
   b. Communication
2. Respect of varying viewpoints
   a. Understands and appreciates views of others
   b. Verbalizes disagreements
3. Non-discrimination
   a. Race
   b. Sex
   c. Mental/physical
   d. Beliefs
4. Goals

VALUE/ATTITUDE
CONCEPTS:
1. Is an indication of management ability
2. A management trait
3. Loss of respect from other persons
4. Attained goals increase morale and confidence

TASK # 15.3: Personnel Management

COMPETENCY: Good employee management relationships.

CRITERION: Employees willingly bring problems for assistance.

Employees confident in management.

Employees express their views.

SKILL/PROCESS:

1. Understands and appreciates need for rules and regulations that are a function of good management practices.
2. Understands and follows chain of command.
3. Decides who is to be assigned to job and how to best effect completion.

KNOWLEDGE/THEORY:

1. Management planning
   a. Cooperation
   b. Organization
   c. Communication
2. Protocol
   a. Knows immediate superior
   b. Follows instructions
3. Work assignments
   a. Recognizes the talent of individuals
   b. Assigns work

VALUE/ATTITUDE CONCEPTS:

1. Job security, chance for advancement
2. Satisfaction and contentment with work
3. More work accomplished with improved spirit

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TASK AREA: Interpersonal-Interactive Skills

TASK # 19.4: Group Interaction

COMPETENCY: Interacts within group to get job done.

CRITERION: Advancement in leadership and/or responsibility.

SKILL/PROCESS:
1. Enjoys participation in group activities.
2. Has something to contribute to group.
3. Understands that the good of the group should come first.
4. Aware of responsibilities of relating to individuals who are not as involved as they might be.

KNOWLEDGE/THEORY:
1. Group participation
   a. Is knowledgeable and in general keeps up with timely information
   b. Has an interest in other people
2. Contribution to group
3. Democratic process
   a. Knows how to be flexible
   b. Embraces concept of majority rule
4. Personal differences
   a. Knows or understands personal circumstances in various situations
   b. Motivation
   c. Cooperation
   d. Communication

VALUE/ATTITUDE
CONCEPTS:
1. Be friendly
2. Be an expert in some field
3. Have unselfish attitudes
4. Express personal reactions

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TASK AREA: Interpersonal-Interactive Skills

TASK # 19.5: Salesmanship

COMPETENCY: Makes sales.

CRITERION: Has satisfied customers.

SKILL/PROCESS:

1. Understands and has knowledge of product and services to be sold.
2. Attentive to customer's "signals," moods, etc., and analyzing these; adjusts sales pitch to benefit sale.
3. Attempts to get best reasonable price for company.
4. Makes a profit for the company.

KNOWLEDGE/THEORY:

1. Products and services
   a. Know what the product can do to meet the needs of the user
   b. Knows service requirements
2. Customer relations
   a. Develop and maintain interest in the discussion of the product
   b. Selling techniques
3. Profit
   a. Know the quality of other like (brands) products and their prices
   b. Costs and overhead factors
4. Overhead and growth
   a. Has the knowledge that a person's financial condition can never be better than the company that person works for
   b. Cost effectiveness
   c. Time utilization

VALUE/ATTITUDE

CONCEPTS:

1. Demonstrate, test, or prove its value
2. Customer realizes need for the product
3. Meets competition
4. Understands and appreciates fact that the better financial condition the company is in, the better position the salesman is in

TASK AREA: Information Retrieval

TASK # 20.1: Recall

COMPETENCY: Able to use knowledge of previous job.

CRITERION: Be able to use previous problems to solve new ones.

SKILL/PROCESS:
1. The recall of basic ideas by memory games, word/object associations, and other techniques
2. Takes notes to help recall technical facts.
3. Keeps log book for all jobs or installations that are not of the ordinary design.

KNOWLEDGE/THEORY:
1. Memory
   a. Make use of old ideas to develop new ideas
   b. Techniques for remembering
2. Review
   a. Know how to use technical facts to solve new problems
   b. Taking note
3. Record
   a. Know when to recognize a job that is not of ordinary design
   b. Record jobs that are out of the ordinary

VALUE/ATTITUDE
CONCEPTS:
1. Know value of association of ideas
2. Value of technical knowledge
3. Log book value

TASK AREA: Information Retrieval

TASK # 20.2: Data Collecting

COMPETENCY: Will have the various business technical information and knowledge to meet job needs.

CRITERION: Demonstrate ability to cope with many varied problems.

Apply the latest trade methods to work.

SKILL/PROCESS:
1. Reads technical manuals and trade journals, then files according to predetermined system.
2. Keeps personal technical library.
3. Collects manufacturer's releases and files in library.
4. Requests engineering data from related manufacturers and files for future use.
5. Removes installer's information sheets from new equipment and files under area and customer.

KNOWLEDGE/THEORY:
1. Filing
   a. Locating the necessary information is a personal responsibility
   b. Systems of filing
2. Library
   a. Setting up personal library
   b. Benefits
3. Trade information
   a. Pertinent information
   b. Selective information for anticipated needs
4. Data acquisition and research
5. Information gathering and storage system

VALUE/ATTITUDE CONCEPTS:
1. Realizes that recall cannot be depended upon
2. Realizes that refresher study may be necessary after long periods of inactivity on a subject

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TASK AREA: Information Retrieval

TASK # 20.3: Self Instruction

COMPETENCY: Increases technical knowledge through self-study.

CRITERION: Individual job advancement.

SKILL/PROCESS:
1. Obtains subscriptions to trade journals.
2. Collects and files trade releases for new products for study and evaluation.
3. Attends service schools sponsored by both industry and educational institutions.
4. Checks flyers and releases sent by manufacturing companies for new or improved products, designs, or performance changes.

KNOWLEDGE/THEORY:
1. Trade journals
   a. Provides up-to-date knowledge of new equipment and processes used in the trade
   b. Sources of publications
2. New product literature
   a. New ideas are available in a fast changing market
   b. Related fields of interest (energy, conservation, etc.)
3. Service schools
   a. New service techniques
   b. Meeting and exchanging ideas
4. Screening information sources
   a. Checking "junk mail" gives access to placement on pertinent mailing lists
   b. Provides the newest information on competitive products

VALUE/ATTITUDE CONCEPTS:
1. Will help in instructional material
2. Eliminates outdated equipment and ideas
3. Techniques that cannot be found in textbooks
4. Salesman's followup call may prove productive

TASK AREA: Personal Skills and Traits.

TASK # 21.1: Reliability

COMPETENCY: Acts in reliable manner.

CRITERION: Arrives at job on time.

Keeps promises.

Follows instructions.

SKILL/PROCESS:
1. Arrives on time.
2. Keeps promises.
3. Follows instructions intelligently.

KNOWLEDGE/THEORY:
1. Punctuality
   a. Knows what is expected and lives up to it
   b. Breaks, holidays, etc.
2. Dependability
   a. Makes employer aware of things which might interfere with performance
   b. Notifies employer of schedule
3. Responsible
   a. Understands the place orders have in effective communication
   b. Asks for clarification if necessary

VALUE/ATTITUDE
CONCEPTS:
1. Understands need for punctuality
2. Understands what obligations and promises entail
3. Willing to listen carefully to orders

TASK AREA: Personal Skills and Traits

TASK # 21.2: Completes Job.

COMPETENCY: Is thorough and persistent.

CRITERION: Successful use of labor-saving information and tools.

Completes job.

SKILL/PROCESS:
1. Willing to finish job.
2. Listens carefully for complete instructions.
3. Uses best information and tools available for job.

KNOWLEDGE/THEORY:
1. Understands job needs
2. Understands need for accuracy
3. Labor-saving tool knowledge useful

VALUE/ATTITUDE CONCEPTS:
1. Is persistent to see end results
2. Not satisfied without accurate results

TASK AREA: Personal Skills and Traits

TASK # 21.3: Neatness

COMPETENCY: Sees job site neatness as a desirable goal.

CRITERION: Job area is free from clutter and clean.

Appearance is neat and appropriate for the job.

SKILL/PROCESS:
1. Always cleans up after job is done.
2. Keeps tools in proper shape.
3. Dresses appropriately for the job.
4. Keeps hair well groomed and uniform clean.

KNOWLEDGE/THEORY:
1. Clean work area
   a. Makes a good impression on a customer
   b. Increases company good will
2. Tool care
   a. Understands correct care for safety of tools
   b. Correct use of tools
3. Dress
   a. Knows safe and unsafe clothing characteristics
   b. Wears proper clothing
4. Grooming
   a. Hair styles
   b. Safety
   c. Cleanliness

VALUE/ATTITUDE
CONCEPTS:
1. Rejects unclean, unsafe work areas
2. Safety conscious
3. May save an injury or possible dismemberment
4. Consumer group is more accepting of well-groomed hair

TASK AREA: Personal Skills and Traits

TASK # 21.4: Efficiency

COMPETENCY: Works in an efficient manner.

CRITERION: Minimum time on job.

SKILL/PROCESS:
1. Looks for ways to save time and labor.
2. Completes tasks in appropriate period of time.
3. Looks for ways to save materials, use less expensive materials, and not waste materials.
4. Looks for ways to decrease non-productive work.

KNOWLEDGE/THEORY:
1. Knowledge of time and labor-saving devices and information
2. Completing tasks efficiently
   a. Standard
   b. Practice and familiarization
   c. Resources
   d. Work habits and techniques
   e. Maintenance of tools
3. Evaluates different concepts and methods
4. Analyzes comparative methods
   a. Evaluates all tasks toward job completion
   b. Eliminates unnecessary tasks

VALUE/ATTITUDE CONCEPTS:
1. Wants to accomplish job in shortest time consistent with good practice
2. Willing to try different methods of doing job
3. Suggests improvements
4. Listens to suggestions and studies best ones
5. Solicits suggestions

TASK AREA: Personal Skills and Traits

TASK # 21.5: Integrity

COMPETENCY: Answers truthfully and accurately at all times.

CRITERION: Statements are truthful and accurate at all times.

SKILL/PROCESS:
1. Can be trusted at all times.
2. Provides accurate information about the job.

KNOWLEDGE/THEORY:
1. Must report accurate conditions
2. Understands truthfulness

VALUE/ATTITUDE
CONCEPTS:
1. Will answer truthfully at all times
2. Will be an asset to the company

TASK AREA: Personal Skills and Traits

TASK # 21.6: Honesty

COMPETENCY: Accounts for monies and time.

CRITERION: Makes change carefully and keeps time records accurately.

SKILL/PROCESS:
1. Can handle money safely.
2. Is careful and honest with time allotted.

KNOWLEDGE/THEORY:
1. Knows value of money
2. Understands value of time and materials

VALUE/ATTITUDE
CONCEPTS:
1. Knows company must have all money collected if it is to prosper
2. Unwilling to waste time, parts, and materials

TASK AREA: Personal Skills and Traits

TASK # 21.7: Receptivity

COMPETENCY: Accepts various job assignments from those in authority.

CRITERION: Does not complain at changes in job assignments.

SKILL/PROCESS:
1. Accepts authority easily.
2. Accepts job assignments willingly.
3. Understands reason for job.
4. Takes time to get proper instructions and asks when there is doubt.

KNOWLEDGE/THEORY:
1. Understands need for authority
2. Understands need for varied job assignments
3. Initiative
   a. Job assignments
   b. Job responsibility
   c. Technical ability
4. Efficient and effective communications
   a. Questions save time and resources
   b. There are no dumb questions and no dumb answers

VALUE/ATTITUDE CONCEPTS:
1. Is not offended by others in authority
2. Is willing to learn all types of work conditions
3. Ask questions related to work
4. Learns from associates

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TASK AREA: Personal Skills and Traits

TASK # 21.8: Sensitivity

COMPETENCY: Treats others as he wants to be treated.

CRITERION: Gentle with others.

SKILL/PROCESS:
1. Has a feel for human relations.
2. Responds to others' feelings constructively.
3. Explains that overall needs must be met despite some difference of opinion.

KNOWLEDGE/THEORY
1. Feelings
   a. Understands basic psychology
   b. Relates to others well
2. Emphathy
   a. Application of "Golden Rule" principle
   b. Relating as equals
3. Resolution of differences
   a. Areas of agreement must be found rather than stressing disagreements
   b. Relief must be provided where there is serious agitation

VALUE/ATTITUDE
CONCEPTS:
1. Realizes that people always have different opinions but seeks to find accommodations
2. Makes effort to understand the "real" basis for feelings of others

TASK AREA: Personal Skills and Traits

TASK # 21.9: Practicability

COMPETENCY: Maintains good job relations.

CRITERION: Exhibits job stability.

Makes effective decisions.

SKILL/PROCESS:
1. Has ability to keep proper perspective of job relations.
2. Uses good judgment in work decisions.

KNOWLEDGE/THEORY:
1. Perspective
   a. Knows what the job consists of
   b. Knows the order of progression
2. Judgment
   a. Knows what is expected and/or required
   b. Have knowledge of good safety practices

VALUE/ATTITUDE
CONCEPTS:
1. Satisfaction, joy, peace of mind, and free from mental strain
2. A job the person will enjoy and one in which all parties involved will benefit

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TASK AREA: Personal Skills and Traits

TASK # 21.10: Friendliness

COMPETENCY: Understands basic psychology in the art of getting along with others and in following desires and wishes of employers.

CRITERION: Follow and be able to discuss personal skills, traits, and mental attitudes that are harmonious.

SKILL/PROCESS:
1. Willing to accept others' viewpoints.
2. Meets new people easily.
3. Help new personnel to become productive.

KNOWLEDGE/THEORY:
1. Openness
   a. Open minded
   b. Knowledgeable and diplomatic in following others' instructions
   c. Gives information to go-workers
2. Outgoing
   a. Attentive
   b. Recognizes personal faults and handles them in a way that makes co-workers feel at ease
3. Helpful

VALUE/ATTITUDE
CONCEPTS:
1. Do not assume when giving directions
2. Have and display empathy for others
3. "Keep your cool"

TASK AREA: Personal Skills and Traits

TASK # 21.11: Altruism

COMPETENCY: Devoted to interests of Air Conditioning, Heating, and Refrigeration field.

CRITERION: Attentive, positive, and knowledgeable as to aims and emphases of the AHR field task with alternatives.

SKILL/PROCESS:
1. Can place oneself in another's circumstances.
2. Interested in professional matters.

KNOWLEDGE/THEORY
1. Interested in the good of others and the job field
   a. Supports the operation and function of business and the profession
   b. Membership in the trade associations
2. Professional
   a. Honest and renders a fair day's work for an honest day's pay
   b. Promotes the AHR field
   c. Represents the business to the fullest

VALUE/ATTITUDE
CONCEPTS:
1. Familiar with societies and organizations
2. Handle all work assignments as the business demands
3. Appearance should be representative of the business

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