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Heating, Ventilation, Air-Conditioning, and Refrigeration Technology
Mississippi Curriculum Framework

HVAC – Service and Installation (Program CIP: 47.0201 – HVAC & R Maintenance Technology/Technician)

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Contents

ADOPTION OF NATIONAL CERTIFICATION STANDARDS

The National Center for Construction Education and Research (NCCER) a not-for-profit 501(c)(3) education foundation created in 1996. It was developed with the support of more than 125 construction CEOs and various association and academic leaders who united to revolutionize training for the construction industry. Sharing the common goal of developing a safe and productive workforce, these companies created a standardized training and credentialing program for the industry. This progressive program has evolved into curricula for more than 70 craft areas and a complete series of more than 70 assessments offered in over 4,000 NCCER-accredited training and assessment locations across the United States.

NCCER develops standardized construction and maintenance curricula and assessments with portable credentials. These credentials are tracked through NCCER's National Registry which allows organizations and companies to track the qualifications of their craft professionals and/or check the qualifications of possible new hires. The National Registry also assists craft professionals by maintaining their records in a secure database.

NCCER's process of accreditation, instructor certification, standardized curriculum, national registry, assessment, and certification is a key component in the industry's workforce development efforts. NCCER also drives multiple initiatives to enhance career development and recruitment efforts for the industry. NCCER is headquartered in Alachua, Fla., and is affiliated with the University of Florida's M.E. Rinker, Sr. School of Building Construction.

As the accrediting body for the industry, NCCER establishes the benchmark for quality training and assessments. By partnering with industry and academia, NCCER has developed a system for program accreditation that is similar to those found in institutions of higher learning. This process fosters national unity among the construction industry while providing a defined career path with industry-recognized credentials.

NCCER's accreditation process assures that students and craft professionals receive quality training based on uniform standards and criteria. These standards are outlined in the NCCER Accreditation Guidelines and must be adhered to by all NCCER Accredited Training Sponsors and Accredited Assessment Centers.

For more information related to implementing NCCER at your local campus, please contact visit http://mcef.net/.

North American Technician Excellence
The HVAC Support Technician Certificate

This exam is designed to support technicians who have worked in the field for 6 to 12 months. Topics linked to the NATE professional level certifications are covered, but at a more fundamental level. Earning this certificate demonstrates increased knowledge and skills, and strengthens the foundation needed to pursue NATE's professional certifications.

The HVAC Support Technician Certificate is monitored or proctored. As such, technicians are required to take this exam at a Testing Organization. *Those who pass this exam earn a certificate, not a NATE certification.* Therefore, recertification (certification renewal) is not required.

NATE Certification

Technicians with two or more years of experience can earn installation, service or senior certification in one or more of the installation or service specialty areas shown in the exam listing. A technician must pass both the core and a specialty exam to be NATE-certified.

RETA certification requires meeting eligibility criteria and demonstrating knowledge of industrial refrigeration concepts, principles and practices. RETA certification exams and other requirements assess competencies in the realm of industrial refrigeration operation. RETA training materials provide the fundamental knowledge needed to understand these concepts and operating principles.

The exams were developed based on surveys of experienced industrial refrigeration operators, managers and consultants. They also are consistent with recommended training objectives established in the Ammonia Refrigeration Training Guideline (ARTG) document developed in 2005, an industry project sponsored by RETA, IIAR and IARW in which benchmarks were established with regard to industrial refrigeration operation.

ETA certification exams are accredited by ANSI (American National Standards Institute), which requires that they are continually scrutinized by an organization whose sole mission is to establish, maintain and assure that the highest industry standards are set and met in a continuous and ongoing basis. ANSI is certainly recognized and often highly regarded by regulatory agencies such as EPA and OSHA in the establishment and maintenance of the highest industrial and safety benchmarks.

RETA's ANSI accreditation assures to its members and industry that those who meet requirements to earn RETA credentials have met an established competence level to operate ammonia refrigeration systems in a safe and efficient manner.

RETA is fully committed to maintaining the fairness, impartiality, validity and integrity of all RETA certification programs. RETA policies and procedures are designed to assure that all decisions about certifying every candidate are based solely on the candidate's qualifications and performance on RETA examinations and other certification-related activities.

The National Coalition of Certification Center

With buildings responsible for almost half of the world's energy consumption and 40 percent of that attributed to heating, ventilation and air-conditioning systems, the HVAC industry has become a key focus area for businesses and organizations challenged to manage costs and preserve the environment. As a result, the industry is going through a transformation with more emphasis being placed on renewable energy sources, advanced technologies and energy saving strategies.

As this dynamic industry is changing, it's creating new, exciting opportunities for professionally trained and certified technicians … professionals who can help businesses run more efficiently, lower operational costs, be more productive and reduce their environmental impact.

NC3 and Trane help shape tomorrow's workforce through certification programs, industry supported curriculum and hands-on training. Students receive an industry-validated NC3 certificate as proof of skills achievement that can offer enhanced employment potential and higher productivity on the job

INDUSTRY JOB PROJECTION DATA

The HVAC-Service and Installation (CIP: 47.0201) require Long-Term on-the-job training. There is expected to be 9.24% increase at the state level. Median annual income for this occupation is $38,833.60 at the state level. A summary of occupational data from the State Workforce Investment Board Data Center is displayed below:

Table 1: Education Level

Program Occupations	Education Level
Heating, air conditioning, and refrigeration mechanics and installers	Long-Term on-the-job training

Table 2: Occupational Overview

	Region	State	United States
2018 Occupational Jobs	2,261	2,261	339,149
2028 Occupational Jobs	2,470	2,470	381,724
Total Change	209	209	42,575
Total % Change	9.24%	9.24%	12.55%
2018 Median Hourly Earnings	$18.67	$18.67	$22.89
2018 Median Annual Earnings	$38,833.60	$38,833.60	$47,611.20
Annual Openings	21	21	4,258

Table 3: Occupational Breakdown

Description	2010 Jobs	2020 Jobs	Annual Openings	2010 Hourly Earnings	2010 Annual Earnings 2,080 Work Hours
Heating, air conditioning, and refrigeration mechanics and installers	2,261	2,470	21	$18.67	$38,833.60

Table 4: Occupational Change

Description	Regional Change	Regional % Change	State % Change	National % Change
Heating, air conditioning, and refrigeration mechanics and installers	209	9.24%	9.24%	12.55%

ARTICULATION

Articulation credit from Secondary Career Pathway programs to Postsecondary Heating, Ventilation, and Air Conditioning is available. Secondary students who have completed the articulated the Secondary Career Pathway Courses listed below may be awarded articulated college credit according to Mississippi Community College Board (MCCB) guidelines (http://www.mccb.edu/pdfs/ct/StatewideArtManual201213.pdf).

Articulated Secondary Course	**Articulated Postsecondary Course**	**Aligned Industry Certification**
46.0000 Construction: Carpentry Concentration 46.0302 Electrical 46.0101 Masonry 47.0201 HVAC 47.0303 Industrial Maintenance 48.0503 Metal Fabrication 48.0508 Welding	ACT 1003 or CTE 1143	NCCER Core

TECHNICAL SKILLS ASSESSMENT

Colleges should report the following for students who complete the program with a career certificate, technical certificate, or an Associate of Applied Science Degrees for technical skills attainment:

NCCER Core Assessment ($45.00)
NCCER HVAC Level 1 and 2 Credential ($50.00 - $100.00)

OR

NCCER NCCT HVAC Level 1 ($45.00)

OR

NC3 Airflow Certification
NC3 Refrigeration Diagnostics Certification
NC3 Variable Speed Motors Certification
NC3 Air to Air Heat Pump Certification

Alternate Assessment Adoption Process:

- Only one assessment will be used the initial year with the colleges having the option to request the other assessment after that one-year period.
- The adopted alternate assessment should be administered, in lieu of the MS-CPAS, at any site of the college offering the program.
- Colleges that adopt an alternate assessment are required to test all students enrolled in that program with that alternate assessment per the noted level of academic attainment.
- Alternate assessments approved during the curriculum writing meetings can be adopted after the validation of the curriculum.
- Assessments adopted during curriculum writing meetings also require a minimum of one year before another assessment can be considered for adoption.
- If more than one assessment is adopted and mapped during the curriculum writing meeting, one assessment will be identified as the approved assessment and must be used for one year prior to any of the other adopted assessments can be used for that program.
- After the one-year adoption period, colleges may request to use any of the other assessments adopted during the curriculum writing meeting.
- If an additional assessment is identified after the one-year adoption period, a college may request to use that assessment but must provide the crosswalk with the alternate assessment request.

PROGRAM DESCRIPTION

Heating, Ventilation, Air-Conditioning, and Refrigeration Technology is a postsecondary instructional program that prepares individuals to work in engineering departments or private firms installing, maintaining, and operating small or medium air-conditioning, heating, and refrigeration systems. Instruction prepares individuals to work in a commercial and residential setting performing special tasks relating to designing ductwork, assembly, installation, servicing, operation, and maintenance of heating, cooling, and refrigeration systems according to the standards of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., Air-Conditioning Contractors of America (ACCA), Air-Conditioning Heating Refrigeration Institute (AHRI), and others. Included are air-conditioning, heating, and refrigeration devices; equipment, techniques, and systems; and maintenance and operation of these systems. HVAC offers an Accelerated Pathway Credential/15 hour certificate, Career certificate, Technical certificate and/or an Associate of Applied Science Degree.

SUGGESTED COURSE SEQUENCE

Accelerated Pathway Credential/15 hour certificate

			SCH Breakdown				Clock Hour Breakdown			Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Clinical/ Internship	Total Clock Hours	Lecture	Lab	Clinical/ Internship	Certification Name
ACT 1003	Introduction to Heating and Air Conditioning Technology	3	2	2		90				
ACT 1124	Basic Compression Refrigeration	4	2	4		150				
ACT 1313	Refrigeration System Components	3	2	2		90				
ACT 1713	Electricity for Heating, Ventilation, Air-Conditioning, and Refrigeration	3	2	2		90				
ACT 2433	Refrigerant, Retrofit, and Regulations	3	2	2		90				
	TOTAL	**16**	**10**	**12**		**510**				

Career Certificate Required Courses (Service and Installation Concentration)

			SCH Breakdown				Clock Hour Breakdown			Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Intern-ship	Total Clock Hours	Lecture	Lab	Intern-ship	Certification Name
ACT 1003	Introduction to Heating and Air Conditioning Technology	3	2	2		90				
ACT 1124	Basic Compression Refrigeration	4	2	4		150				
ACT 1133	Brazing and Piping	3	2	2		90				NCCER Core or Selected modules of NC3 certifications NATE Support Technician
ACT 1214	Controls	4	2	4		150				
ACT 1313	Refrigeration System Components	3	2	2		90				
ACT 1713	Electricity for Heating, Ventilation, Air-Conditioning, and Refrigeration	3	2	2		90				
ACT 2414	Heating, Ventilation, Air Conditioning, and Refrigeration I	4	2	4		150				NCCER Core Or Selected modules of NC3 certifications
ACT 2433	Refrigerant, Retrofit, and Regulations	3	2	2		90				
ACT 2513	Heating Systems	3	2	2		90				

										NCCER Level 1
TOTAL		**30**	**18**	**24**		**990**				

Technical Certificate Required Courses

			SCH Breakdown				Clock Hour Breakdown			Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Intern-ship	Total Clock Hours	Lecture	Lab	Intern-ship	Certification Name
ACT 2424	Heating, Ventilation, and Air Conditioning II	4	2	4		150				
ACT 2324	Commercial Refrigeration	4	2	4		150				
ACT 2624	Heat Load and Air Properties	4	2	4		150				NCCER Level 2
	Electives	3				0				
TOTAL		**15**				**450**				

General Education Core Courses

To receive the Associate of Applied Science degree, a student must complete all of the required coursework found in the Career Certificate option, Technical certificate option, and a minimum of 15 semester hours of General Education core. The courses in the General Education Core may be spaced out over the entire length of the program so that students complete some academic and Career Technical courses each semester or provided primarily within the last semester. Each community college will specify the actual courses that are required to meet the General Education Core Requirements for the Associate of Applied Science degree at their college. The Southern Association of Colleges and Schools Commission on Colleges (SACSCOC) Section 9 Standard 3 of the *Principles of Accreditation: Foundations for Quality Enhancement*[1] describes the general education core.

Section 9 Standard 3:

3. The institution requires the successful completion of a general education component at the undergraduate level that

   a) is based on a coherent rationale.

   b) is a substantial component of each undergraduate degree program. For degree completion in associate programs, the component constitutes a minimum of 15 semester hours of the equivalent; for baccalaureate programs, a minimum of 30 semester hours or the equivalent.

   c) ensures breadth of knowledge. These credit hours include at least one course from each of the following areas: humanities/fine arts, social/behavioral sciences, and natural science/mathematics. These courses do not narrowly focus on those skills, techniques, and procedures specific to a particular occupation or profession.

<<<Add any additional general education standards as required for programmatic accreditation here and footnote below.>>>

General Education Courses

			SCH Breakdown			Contact Hour Breakdown		Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Total Contact Hours	Lecture	Lab	Certification Name
	Humanities/Fine Arts	3						
	Social/Behavioral Sciences	3						
	Math/Science	3						
	Academic electives	6						
	TOTAL	**15**						

[1] Southern Association of Colleges and Schools Commission on Colleges. (2017). *The Principles of Accreditation: Foundations for Quality Enhancement*. Retrieved from http://www.sacscoc.org/2017ProposedPrinc/Proposed%20Principles%20Adopted%20by%20BOT.pdf

Standard 2.7.3 from the Principles of Accreditation: Foundations for Quality Enhancement1 describes the general education core.

> Section 2.7.3 In each undergraduate degree program, the institution requires the successful completion of a general education component at the collegiate level that (1) is substantial component of each undergraduate degree, (2) ensures breadth of knowledge, and (3) is based on a coherent rationale. For degree completion in associate programs, the component constitutes a minimum of 15 semester hours or the equivalent. These credit hours are to be drawn from and include at least one course from the following areas: humanities/fine arts, social/behavioral sciences, and natural science/mathematics. The courses do not narrowly focus on those skills, techniques, and procedures specific to a particular occupation or profession.

Technical Electives

			SCH Breakdown				Clock Hour Breakdown			Certification Information
Course Number	Course Name	Semester Credit Hours	Lecture	Lab	Intern-ship	Total Clock Hours	Lecture	Lab	Intern-ship	Certification Name
ACT 2713	HVAC Project Commissioning	1	1			15				
ACT 291(1-3)	Special Project in Heating, Ventilation, Air-Conditioning and Refrigeration Technology	1-3		2-6		60-180	0	60-180	0	
ACT 292(1-6)	Supervised Work Experience in Heating, Ventilation, Air-Conditioning, and Refrigeration Technology	1-6			3-18	135-810	0	0	135-810	
WBL 191(1-3) WBL 192(1-3) WBL 193(1-3) WBL 291(1-3) WBL 292(1-3) WBL 293(1-3)	Work-Based Learning	1-6			3-18	135-810			135-810	
Any Other Technical Course As Approved by the Instructor per local community college.										

[1] Southern Association of Colleges and Schools Commission on Colleges. (2012). *The principles of accreditation: Foundations for quality enhancement*. Retrieved from http://www.sacscoc.org/pdf/2012PrinciplesOfAcreditation.pdf

CAREER CERTIFICATE REQUIRED COURSES

Course Number and Name: ACT 1003 Introduction to Heating and Air Conditioning Technology

Description: This course is designed to introduce students to the fundamental skills associated with all HVAC courses. Safety, basic tools, special tools, and equipment, communication skills, employability skills, and materials handling topics are included.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

Module 00101--Basic Safety NATE –NATE 1.1.1

1. Explain the idea of a safety culture and its importance in the construction crafts. NATE 1.1.1 I
2. Identify causes of accidents and the impact of accident costs. NATE 2.1.2E &1.1.1 D, ESCO 4.66-4.67
3. Explain the role of OSHA in job-site safety. NATE 2.1.1 A B C, ESCO 4.61-4.62
4. Explain OSHA's General Duty Clause and 1926 CFR Subpart C. NATE 2.1.2 A, J, ESCO 4.61-4.62
5. Recognize hazard recognition and risk assessment techniques. NATE 2.1.2 A, J
6. Explain fall protection, ladder, stair, and scaffold procedures and requirements. NATE 1.1.1 B & 2.1.2 C, ESCO 4.61
7. Identify struck-by hazards and demonstrate safe working procedures and requirements. NATE 2.1.2 E
8. Identify caught-in-between hazards and demonstrate safe working procedures and requirements. NATE1 .1.1D
9. Define safe work procedures to use around electrical hazards. NATE 1.1.3 A, B, V & 2.1.4 A, B, C, ESCO 4.66-4.67
10. Demonstrate the use and care of appropriate personal protective equipment (PPE). NATE 1.1.1 E, F, G & NATE 2.1.2F, G, H
11. Explain the importance of hazard communications (HazCom) and material safety data sheets (SDSs). NATE 1.1.1J & 1.1.6 A, B, C, D; NATE 2.1.2 K, 2.1.7 A, B, C, D NATE 1.3.1
12. Identify other construction hazards on your job site, including hazardous material exposures, environmental elements, welding and cutting hazards, confined spaces, and fires. NATE 1.1.1 C, K; NATE 1.1.5, A; NATE 2.1.2 D, L,

Module 00102---Introduction to Construction Math NATE –NATE 1.3.2

1. Add, subtract, multiply, and divide whole numbers, with and without a calculator.
2. Use a standard ruler, a metric ruler, and a measuring tape to measure.
3. Add, subtract, multiply, and divide fractions.
4. Add, subtract, multiply, and divide decimals, with and without a calculator.
5. Convert decimals to percentages and percentages to decimals.
6. Convert fractions to decimals and decimals to fractions.
7. Explain what the metric system is and how it is important in the construction trade.
8. Recognize and use metric units of length, weight, volume, and temperature.
9. Recognize some of the basic shapes used in the construction industry and apply basic geometry to measure them.

Module 00103---Introduction to Hand Tools NATE 1.1.8 , NATE 1.1.9, NATE 2.2.1, NATE 2.2.1, NATE 2.2.2, NATE 2.2.3 NC3 Airflow Certification, NC3 Refrigeration Diagnostics Certification, NC3 Variable Speed Motors Certification, NC3 Air to Air Heat Pump Certification

1. Recognize and identify some of the basic hand tools and their proper uses in the construction trade.
2. Visually inspect hand tools to determine if they are safe to use.
3. Safely use hand tools.

Module 00104---Introduction to Power Tools NC3 NATE 1.1.8 , NATE 1.1.9, NATE 2.2.1, NATE 2.2.1, NATE 2.2.2, NATE 2.2.3, Airflow Certification, NC3 Refrigeration Diagnostics Certification, NC3 Variable Speed Motors Certification, NC3 Air to Air Heat Pump Certification

1. Identify power tools commonly used in the construction trades.
2. Use power tools safely.
3. Explain how to maintain power tools properly.

Module 00105---Introduction to Construction Drawings NATE 1.2, NATE 2.3

1. Recognize and identify basic construction drawing terms, components, and symbols.
2. Relate information on construction drawings to actual locations on the print.
3. Recognize different classifications of construction drawings.
4. Interpret and use drawing dimensions.

Module 00107---Basic Communication Skills

1. Interpret information and instructions presented in both verbal and written form.
2. Communicate effectively in on-the-job situations using verbal and written skills.
3. Communicate effectively on the job using electronic communication devices.

Module 00108---Basic Employability Skills

1. Explain your role as an employee in the construction industry.
2. Demonstrate critical thinking skills and the ability to solve problems using those skills.
3. Demonstrate knowledge of computer systems and explain common uses for computers in the construction industry.
4. Define effective relationship skills.
5. Recognize workplace issues such as sexual harassment, stress, and substance abuse.

Module 00109---Introduction to Materials Handling NATE 2.1.6

1. Define a load.
2. Establish a pre-task plan prior to moving a load.
3. Use proper materials-handling techniques.
4. Choose appropriate materials-handling equipment for the task.
5. Recognize hazards and follow safety procedures required for materials handling.

Course Number and Name: ACT 1124 Basic Compression Refrigeration

Description: This course includes an introduction to the field of refrigeration and air-conditioning. Emphasis is placed on trade math, thermodynamics and heat transfer.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	150

Prerequisite: None

Student Learning Outcomes:

Level 1

Module 03101-Introduction to HVAC NATE 1.8.1 A

1. Explain the basic principles of heating, ventilation, air conditioning, and refrigeration. ESCO 3.0-3.6
    a. Explain the principles of heating.
    b. Explain the principles of ventilation.
    c. Explain the principles of air conditioning. ESCO 3.15-3.16
    d. Explain the principles of refrigeration.

2. Describe the principles that guide HVAC/R installation and service techniques. NATE 1.7 NC3 Refrigeration Diagnostics Certification, Variable Speed Motors Certification and Air-to-Air Heat Pump Certification
    a. Identify common safety principles and organizations. ESCO 6.11
    b. Describe the importance of LEED construction and energy management. ESCO 6.12-6.13-4
    c. Describe trade licensing and certification requirements. ESCO 6.11
    d. Identify important codes and permits.

3. Identify career paths available in the HVAC/R trade.
    a. Identify the responsibilities and characteristics needed to be a successful HVAC/R technician.
    b. Identify residential, commercial, and industrial career opportunities. ESCO 6.11
    c. Describe opportunities provided by equipment manufacturers. ESCO 5.46

Module 03102- – Trade Math NATE –

1. Convert units of measurement from the inch pound system to the metric system, and vice versa.
    a. Identify units of measure in the inch-pound and metric systems.
    b. Convert, length, area, and volume values. ESCO 6.1-6.9
    c. Convert weight values. ESCO 6.8-6.5, 3.14-1.14
    d. Convert pressure and temperature values.

2. Solve basic algebraic equations.
    a. Define algebraic terms. ESCO 6.2-6.31
    b. Demonstrate an understanding of the sequence of operations.
    c. Solve basic algebraic equations. ESCO 6.2

3. Identify and describe geometric figures. ESCO 6.25
    a. Describe the characteristics of a circle.
    b. Identify and describe types of angles. ESCO 6.25
    c. Identify and describe types of polygons.
    d. Calculate various values associated with triangles. ESCO 6.25

Module 03107- – Introduction to Cooling NATE 1.5.1, 1.5.2, 2.6.2, 2.6.3, 1.9.10.1 A&B

1. Explain the fundamental concepts of the refrigeration cycle. NC3 Refrigeration Diagnostics Certification ESCO 6.14, 6.18-19

a. Describe how heat affects the state of substances. ESCO 3.0-3.2
    b. Explain how heat is transferred from one substance to another.
    c. Describe pressure-temperature relationships. ESCO 3.3-3.4
    d. Describe the basic pattern of refrigerant flow and the changes of state that occur in the refrigeration cycle. ESCO 3.12, 3.15-16-3.20, 3.21
    e. Identify common instruments used to measure pressure and temperature.

2. Identify common refrigerants and their basic characteristics. NATE 2.4.1 & 2.4.9 NC3 Refrigeration Diagnostics Certification
    a. Identify fluorocarbon refrigerants. RETRO
    b. Describe the use of ammonia as a refrigerant. RETRO
    c. Identify various refrigerant containers and their safe handling requirements.

3. Identify the major components of cooling systems and how they function. NATE 1.9.2 NC3 Refrigeration Diagnostics Certification
    a. Identify basic compressors and their function in the system. ESCO 5.4, 3.52, 3.53
    b. Identify different condensers used to transfer heat. ESCO 3.30.c
    c. Identify different evaporators used to transfer heat. ESCO 3.30 f.
    d. Describe the devices used to meter refrigerant flow. NATE – Ready to Work NATE 1.92. ESCO 3.30.e
    e. Discuss basic refrigerant piping concepts. ESCO 3.7, 3.8
    f. Identify various accessories used in refrigeration circuits. ESCO 5.40-5.68

4. Identify the common controls used in cooling systems and how they function. NATE 1.9.3, 1.9.4 NC3 Refrigeration Diagnostics Certification
    a. Identify common primary controls. ESCO5.40-5.68

Course Number and Name: ACT 1133 Brazing and Piping

Description: This course includes various tools and pipe connecting techniques. This course includes specialized tools and test equipment required in heating, ventilation, air-conditioning, and refrigeration.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

Prerequisite: Instructor Approved

Student Learning Outcomes:

Level 1

Module 03103- – Basic Copper and Plastic Piping Practices NATE – Ready to Work 1.1.4, 1.1.9

1. Recognize and identify different types of copper tubing and their related fittings.
    a. Describe and identify copper tubing characteristics. ESCO 3.7
    b. Identify various copper fittings ESCO 3.8

2. Describe and demonstrate how to join copper tubing mechanically. ESCO 3.70B
    a. Measure, cut, and bend copper tubing to prepare it for joining. ESCO 3.41
    b. Describe and demonstrate the methods and tools used to join copper tubing. ESCO 3.41
    c. Describe common hangers and supports associated with copper tubing installations. ESCO 3.41

3. Recognize different types of plastic piping and show how it can be joined.
    a. Identify different types of plastic piping. ESCO 3.70b
    b. Identify the tools and products needed and demonstrate how to join plastic piping.

Module 03104- – Soldering and Brazing NATE – Ready to Work 2.1.5, 1.1.9, ESCO 3.70b

1. Describe and demonstrate the safe process of soldering copper tubing.
    a. Describe and demonstrate the use of the PPE, tools, and materials needed to solder copper tubing.
    b. Describe and demonstrate the preparation required for soldering.
    c. Describe and demonstrate the soldering process.

2. Describe and demonstrate the safe process of brazing copper tubing. ESCO 3.8
    a. Describe and demonstrate the use of the PPE, tools, and materials needed to braze copper tubing. ESCO 3.8, 3.70b
    b. Describe and demonstrate the preparation used for brazing. ESCO 3.8, 3.70b
    c. Describe and demonstrate the brazing process. ESCO 3.8, 3.70b
    d. Describe and demonstrate the process of brazing copper tubing to dissimilar metals. ESCO 3.8, 3.70b

Module 03105-13 – Basic Carbon Steel Piping Practices NATE – Ready to Work 2.3.2, ESCO 3.8-3.70b

1. Describe and identify the various types of steel pipe and fittings.
    a. Identify the characteristics and uses of steel pipe.
    b. Describe how pipe threads are classified and measured. ESCO 3.7
    c. Identify the various types of fittings used on steel pipe and describe how they are used.

d. Describe how to properly measure lengths of steel pipe.

2. Describe the tools and methods used to cut and thread steel pipe. ESCO 3.30.k
    a. Identify pipe cutting and reaming tools and describe how they are used.
    b. Identify threading tools and describe how they are used. ESCO 3.7

3. Explain and demonstrate the methods of installing and mechanically joining steel pipe. ESCO 3.7 & 3.8
    a. Explain and demonstrate the methods and use of the tools to connect threaded pipe.
    b. Explain and demonstrate an understanding of pipe grooving methods.
    c. Describe how to assemble flanged steel pipe.
    d. Describe how to correctly install steel pipe.

Course Number and Name: ACT 1214 Controls

Description: This course includes fundamentals of gas, fluid, electrical, and programmable controls.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	150

Prerequisite: Instructor Approved

Student Learning Outcomes:

Level 3

Module 03314– Control Circuit and Motor Troubleshooting NC3 Variable Speed Motors Certification, NC3 Refrigeration Diagnostics Certification, NATE 2.7.7, 2.7.8 ESCO 3.30 a-p

1. Identify and describe the operation of common HVAC control circuit devices. NATE 1.9.4
    a. Identify and describe the operation of relays, contactors, and motor starters.
    b. Identify and describe the operation of other common safety and control circuit devices.

2. Describe the operation, installation, and testing of various thermostats and temperature controls. NATE 2.4.8, NC3 Refrigeration Diagnostics Certification ESCO 5.34, 3.64-66
    a. Describe the operation of various thermostats and temperature controls. ESCO 5.34
    b. Identify and describe how to troubleshoot thermistors. NC3 Refrigeration Diagnostics Certification ESCO 4.54
    c. Explain how to install and wire thermostats. ESCO 4.54, 4.40, 2.22, 2.31
    d. Explain how to troubleshoot the functions of a thermostat. NC3 Refrigeration Diagnostics Certification ESCO 4.54, 4.40, 2.22, 2.31

3. Describe the sequence of operation for basic HVAC systems. NATE 1.7.3, 1.7.4 ESCO 3.19, 3.20
    a. Describe the sequence of operation of a basic cooling-only system. ESCO 3.20
    b. Describe the sequence of operation for a common heating and cooling system. ESCO 3.20, 3.30
    c. Describe the operation of basic pneumatic control systems. ESCO 2.46

4. Explain how to troubleshoot common control circuits and load components. NATE 2.4.6, NC3 Refrigeration Diagnostics Certification, ESCO 2.14, 2.18
    a. Identify basic safety practices related to troubleshooting HVAC power and control circuits.
    b. Explain how to approach HVAC-related problems and prepare for troubleshooting.
    c. Explain how to test high-voltage power sources. ESCO 4.10-4.12, 3.0, 2.69
    d. Explain how to troubleshoot control circuits and low-voltage power sources. ESCO 4.42-4.45
    Explain how to troubleshoot both resistive and Inductive loads, including motors and their related devices. NC3 Variable Speed Motors Certification, ESCO 4.33, 2.43, 2.44, 4.34
    e. Explain how to troubleshoot various hydronic control system components.

5. Describe the operation of variable frequency drives (VFD) and their selection considerations.
    a. Describe the operation of a VFD. ESCO 4.34
    b. Identify VFD parameters that can be programmed. ESCO 4.34
    c. Describe the important considerations for the selection of a VFD.
    d. Explain dynamic motor braking processes. NC3 Variable Speed Motors Certification

6. Identify and describe how to service electronically commutated motors (ECMs). NATE 2.4.5 NC3 Variable Speed Motors Certification
    a. Identify and describe the operation of ECMs. ESCO 4.34, 4.38
    b. Describe how to install and set up an ECM. ESCO 4.34, 4.38
    c. Describe how to troubleshoot an ECM. NC3 Refrigeration Diagnostics Certification

7 Discuss and service direct digital controls (DDC).
8. Explain computer energy management systems (EMS) controls.

Course Number and Name: ACT 2414 Heating, Ventilation, Air Conditioning, and Refrigeration I

Description: This course includes residential air-conditioning including indoor air quality. This course includes modules on basic maintenance, air quality equipment, troubleshooting cooling, and troubleshooting gas heating.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	150

Prerequisite: Instructor approved

Student Learning Outcomes:

Level 2

Module 03215- – Basic Maintenance NATE 1.8, ESCO 2.48

1. Identify and describe common gaskets, packing materials, seals, and bearings.
    a. Identify and describe common gasket and packing materials.
    b. Identify and describe common types of seals.
    c. Identify and describe common types of bearings.

2. Describe the properties of common lubricants and how they are applied. ESCO 3.51, ESCO 3.50
    a. Describe the properties of commonly used lubricants. ESCO 3.51, 3.50
    b. Explain the importance of selecting the proper lubricants and how to apply them. ESCO 3.51, 3.50

3. Identify different types of drive belts and describe how they are installed and adjusted. ESCO 1.52, 3.67, 2.48
    a. Identify various types of drive belts.
    b. Explain how to install and adjust drive belts.

4. Describe the inspection and/or maintenance requirements for selected equipment.
    a. Identify common health hazards associated with HVAC maintenance activities.
    b. Describe the common inspection and maintenance procedures for gas heating equipment.
    c. Describe the common inspection and maintenance procedures for DX cooling and heat pump systems. NC3 Air to Air Heat Pump Certification ESCO 7.23, 7.24A
    d. Describe the common inspection and maintenance procedures for various system accessories.
    e. Describe how to properly complete common HVAC service reports. ESCO 3.34

Module 03204- – Air Quality Equipment NATE 1.4.3, 2.5.2, ESCO 6.31

1. Explain the importance of indoor air quality and the factors to be controlled. ESCO 3.29, 6.22
    a. Identify the factors related to the quality of indoor air. ESCO 6.31
    b. Describe the elements of human comfort and their relationship to air properties. NC3 Airflow Certification

2. Describe the processes and equipment used to control humidity levels. NATE 1.4.2, ESCO 3.29
    a. Explain the relationship between air and moisture content. NC3 Airflow Certification ESCO 3.29
    b. Describe the processes and equipment used to humidify and dehumidify air. ESCO 3.29

3. Describe the equipment and devices used to control air cleanliness. NATE 2.5.3, 1.4.3, ESCO 1.17
    a. Identify the various types of media-based air filters.
    b. Describe the operation of non-media based air filtration and purification equipment.

4. Identify the equipment used to provide and control the introduction of fresh air into buildings. NATE 2.5.3 A&C
    a. Explain how dampers and economizers are used to control the introduction of fresh air.
    b. Describe the function and operation of energy and heat recovery ventilation systems.

Level 3

Module 03210- – Troubleshooting Cooling

1. Describe the operation of the refrigeration cycle and identify problems that can occur. NATE 2.6.1 NC3 Refrigeration Diagnostics Certification ESCO 5.6-13
    a. Identify the primary components of the refrigeration cycle and explain their individual function.
    b. Describe the operation of a typical refrigeration cycle.
    c. Explain the steps to analyzing refrigeration circuit operating conditions.
    d. Describe possible causes for specific abnormal pressures and temperatures.
    e. Explain how condenser and evaporator airflow problems affect the refrigeration cycle.
    f. Identify and describe problems related to fixed metering devices.
    g. Identify and describe problems related to TXVs and distributors.
    h. Identify and describe other problems related to the refrigerant circuit.

2. Explain how to troubleshoot and replace a cooling system compressor. NC3 Refrigeration Diagnostics Certification, ESCO 3.30 a&b
    a. Identify common problems that can result in compressor failure.
    b. Explain how to troubleshoot compressor mechanical problems.
    c. Explain how to replace a hermetic compressor following a failure.
    d. Describe the additional steps that may be required to replace a compressor following an electrical failure.

Module 03209- – Troubleshooting Gas Heating NATE 1.7.7, 1.9.6, 1.9.7

1. Describe how to troubleshoot the components related to gas heating. NC3 Refrigeration Diagnostics Certification
    a. Describe the control circuits and typical sequence of operation of various gas heating units. ESCO 7.12
    b. Describe the operation and troubleshooting process for thermocouples. ESCO 7.13
    c. Describe the operation and troubleshooting process for ignition devices. ESCO 7.13
    d. Describe the operation and troubleshooting process for flame sensors. ESCO 7.20
    e. Identify common problems associated with system airflow. ESCO 7.21

2. Identify Infrared gas heaters and describe how they operate. ESCO 7.16, 7.21
    a. Identify various types of infrared gas heaters.
    b. Describe the operating characteristics of infrared gas heaters.

3. Explain how to conduct a combustion analysis on a gas furnace. ESCO 7.14
    a. Identify combustion analysis equipment and the combustion byproducts that are of importance to the analysis.
    b. Describe the combustion analysis process and how to interpret basic results.

Course Number and Name: ACT 1313 Refrigeration System Components

Description: This course includes an in-depth study of the components and accessories of a sealed system including metering devices, evaporators, compressors, and condensers.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

Prerequisite: Instructor approved

Student Learning Outcomes:

Level 2

Module 03302- – Compressors NATE –1.9, 2.B, 1.3.3, ESCO a& b

1. Identify and describe the operation of various compressor types.
    a. Identify and describe the operation of various hermetic and semi-hermetic compressors.
    b. Identify and describe the operation of reciprocating compressors.
    c. Identify and describe the operation of rotary compressors.
    d. Identify and describe the operation of scroll compressors.
    e. Identify and describe the operation of screw compressors.
    f. Identify and describe the operation of centrifugal compressors.

2. Identify and describe various approaches to compressor capacity control. ESCO 3.53
    a. Identify and describe capacity control methods for reciprocating and scroll compressors. ESCO 5.52
    b. Identify and describe capacity control methods for screw and centrifugal compressors. ESCO 5.52

3. Describe common causes of compressor failures. NC3 Refrigeration Diagnostics Certification, ESCO 5.57
    a. Describe compressor failures related to the refrigerant circuit.
    b. Describe compressor failures related to electrical issues.

4. Identify and explain the operation of various compressor protection devices. ESCO 5.50
    a. Identify and explain the operation of various overload devices.
    b. Identify and explain the operation of other compressor protection devices.

5. Explain how to analyze the operation of a hermetic compressor. ESCO 3.30 a & b
    a. Explain how to evaluate the mechanical operation of an operable compressor.
    b. Explain how to evaluate the electrical operation of an operable compressor.

Module 03303- – Metering Devices NATE –NATE 1.9.2 D, ESCO 3.30 e

1. Explain the function of refrigerant metering devices and their effect on refrigerants. NC3 Refrigeration Diagnostics Certification
    a. Explain the function of metering devices. ESCO 5.11-5.18
    b. Describe how refrigerants react as they pass through a metering device.
    c. Identify distributors and explain their relationship to metering device performance and operation.

2. Identify fixed metering devices and explain how they function.

a. Identify and explain how fixed-orifice metering devices function.
b. Identify and explain how capillary tubes function.
c. Describe common problems associated with fixed metering devices.

3. Identify types of expansion valves and explain how they operate. ESCO 5.11-5.18
    a. Identify and explain the operation of manual expansion valves.
    b. Identify and explain the operation of automatic expansion valves.
    c. Identify and explain the operation of thermal expansion valves.
    d. Identify and explain the operation of electric and electronically controlled expansion valves.
    e. Describe common problems associated with all types of expansion valves.

4. Explain how thermal expansion valves are selected and installed. ESCO 5.11-5.18
    a. Explain how thermal expansion valves are selected for a given application.
    b. Describe the installation practices and considerations related to thermal expansion valves.

Course Number and Name: ACT 1713 Electricity for Heating, Ventilation, Air-Conditioning, and Refrigeration I

Description: This course includes basic knowledge of electricity, power distribution, components, solid state devices, and electrical circuits.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

Prerequisite: None

Student Learning Outcomes:

Level 1

Module 03106- – Basic Electricity NATE –1.6, 2.1.4, 2.4.7, 2.4.5,m 2.7.9, 2.4.2, 2.4.3, 2.7.9, 2.7.1, 2.7.4 ESCO 4.0

1. Describe the fundamentals of electricity.
    a. State how electrical power is created and distributed. ESCO 4.4
    b. State the safety practices associated with electricity. ESCO 4.0
    c. Describe the difference between alternating current and direct current. ESCO 4.2-4.3

2. Explain basic electrical theory.
    a. Define *voltage, current, resistance,* and *power* and describe how they are related. ESCO 4.7
    b. Use Ohm's law to calculate the current, voltage, and resistance in a circuit. ESCO 4.7
    c. Use the power formula to calculate how much power is consumed by a circuit. ESCO 4.8
    d. Describe the differences between series and parallel circuits and calculate circuit loads for each type. ESCO 4.12

3. Identify the electrical measuring instruments used in HVAC/R work and describe their uses. 4.10-4.11
    a. Describe how voltage is measured.
    b. Describe how current is measured.
    c. Describe how resistance is measured.

4. Identify electrical components used in HVAC/R systems and describe their functions. ESCO 4.13-4.14
    a. Identify and describe various load devices and explain how they are represented on circuit diagrams. ESCO 4.13-4.14
    b. Identify and describe various control devices and explain how they are represented on circuit diagrams. ESCO 4.13-4.14, 4.37
    c. Identify and describe the types of electrical diagrams used in HVAC/R work. ESCO 4.13-4.14

Level 2

Module 03206- – Alternating Current NATE –2.4.6, 2.4.5, 2.4.3, 2.4.13, 2.4.14

1. Explain how AC power is generated and how it is used.
    a. Explain the basic concepts of power generation.
    b. Describe a sine wave and how it is created. ESCO 4.30
    c. Explain the concept of AC power frequency. ESCO 4.36
    d. Explain how single- and three-phase power is provided for practical use.
    e. Identify resistive and inductive circuits. ESCO 4.36

2. Explain how transformers operate and identify various types of transformers used in HVAC systems.
    a. Explain how transformers operate. ESCO 4.42, 4.43, 4.44, 4.45-4.46
    b. Identify various forms of single-phase and three-phase transformers.

3. Explain the various types of induction motors and explain how they operate. NC3 Variable Speed Motors Certification
    a. Explain how single-phase motors operate. ECSO 4.23
    b. Describe single-phase motor starting circuits. ESCO 4.28
    c. Identify the physical and operating characteristics of three-phase motors. ESCO 4.26

4. Explain how to safely test various AC-powered devices. ESCO 4.23
    a. Identify electrical test instruments and methods used to test motors.
    b. Explain how to use a capacitor tester. ESCO 4.21-4.22, 4.39
    c. Identify basic electrical safety rules and guidelines for safely testing AC components. ESCO 4.0

Course Number and Name: ACT 2433 Refrigerant, Retrofit, and Regulations

Description: This course includes regulations and standards for new retrofit and government regulations. This course includes EPA regulations, local, and state codes.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

Prerequisite: None

Student Learning Outcomes:

Level 2

Module 03301- – Refrigerants and Oils NATE 2.4.12, 2.4.11.D, 1.1.5. NC3 Refrigeration Diagnostics Certification or NATE ESCO 3.17 –

1. Define *refrigerants* and their desirable characteristics and identify the various applications that require specific refrigerant characteristics.
    a. Define *refrigerants* and identify desirable characteristics.
    b. Identify the various applications that require specific refrigerant characteristics.

2. Identify various refrigerant classifications and describe their environmental impact. ESCO 3.23
    a. Identify the primary chemical classifications of common characteristics.
    b. Describe the environmental concerns associated with refrigerants.
    c. Identify and describe compounded and blended azeotropic, near-azeotropic, and zeotropic refrigerants. ESCO 3.24
    d. Identify the safety classifications of refrigerants. ESCO 3.23

3. Explain how to use pressure-temperature (P-T) charts to calculate superheat and subcooling.
    a. Explain how to use P-T charts for compound, azeotropic, and near-azeotropic refrigerants to calculate superheat and subcooling. ESCO 5.49-5.51, 3.44-3.45
    b. Explain how to use P-T charts for zeotropic refrigerants to calculate superheat and subcooling. ESCO 3.23

4. Describe the important issues related to the function of lubricating oils in the refrigerant circuit.
    a. Identify the important characteristics of refrigerant oils. ESCO 1.52
    b. Identify mineral-based and synthetic oils. ESCO 1.52
    c. Describe issues related to the movement of oil through the refrigerant circuit. ESCO 3.23
    d. Describe the various types and sources of oil contamination. ESCO 3.52
    e. Describe common practices associated with handling, charging, and removing oils. ESCO 3.52

5. Explain the considerations related to various refrigerant conversion processes. ESCO 1.52
    a. Identify issues of concern for all refrigerant conversions. ESCO 3.52
    b. Describe common practices related to popular refrigerant conversions. ESCO 3.23

Module 03205- – Leak Detection, Evacuation, Recovery, and Charging NATE 1.7.5 & 1.7.63NC3 Refrigeration Diagnostics Certification or NATE –
Describe the equipment and approaches used to leak test refrigerant circuits. ESCO 3.10, 3.9, 3.10

a. Describe the various devices used to detect refrigerant leaks. ESCO 3.9
b. Describe how leak detection is approached based on the current refrigerant charge in the system. ESCO 1.44 & 1.45

2. Describe refrigerant containment and management requirements and the equipment used to recover refrigerants. ESCO 3.10
    a. Identify the basic refrigerant containment requirements of Section 608 of the Clean Air Act. ESCO 3.10-1.42
    b. Identify and explain how to operate refrigerant recovery and recycling equipment.

3. Explain the related principles and identify the equipment used to evacuate refrigerant circuits. ESCO 5.43 -5.44
    a. Explain the basic principles of refrigerant circuit evacuation.
    b. Identify and explain how to operate the equipment used to evacuate refrigerant circuits.

4. Describe the procedures for charging refrigerant circuits. ESCO 3.6
    a. Identify and describe the equipment and components related to refrigerant charging. ESCO 3.6
    b. Explain how to properly charge various types of refrigerants using different methods. ESCO 5.53, 5.54

5. Describe and perform basic elements of refrigerant recovery and recycling. NC3 Refrigeration Diagnostics Certification or NATE –ESCO 3.10

    a. Define terms associated with refrigerant recovery.
    b. Describe and apply the safety procedures needed.
    c. Describe environmental issues regarding refrigerant, including legislation, protocol, laws, and regulations.
    d. Perform refrigerant recovery and recycling.

6. Identify/explain the functions and types of lubricants, and perform basic service activities. ESCO 1.52, 5.50
    a. Demonstrate handling of polyolester (POE).
    b. Demonstrate how to draw an oil sample from the system.
    c. Use an acid test kit for mineral oil and AB.

Course Number and Course Name: ACT 2513 Heating Systems

Description: This course includes various types of residential and commercial heating systems. This course includes gas, oil, electric, compression, and hydronic heating systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	90

Prerequisite: None

Student Learning Outcomes:

Level 1

Module 03108- – Introduction to Heating NATE –.4.1, 2.5.1, 1.7.7, 1.9.6, 1.9.7,ESCO 7.16, 7.17

1. Explain the fundamental concepts of heating and combustion.
    a. Describe the heat transfer process.
    b. Identify gas fuels and their combustion characteristics.

2. Describe the role of forced-air gas furnaces in residential heating. ESCO 7.12, 7.13
    a. Describe the types of gas furnaces and how they operate.
    b. Identify and describe the equipment and controls used in gas furnaces.
    c. Describe the basic installation and maintenance requirements for gas furnaces.

3. Describe hydronic and electric heating systems. ESCO 2.17-2.19
    a. Describe the operation of hydronic heating systems.
    b. Describe the operation of electric heating equipment. ESCO 2.2-2.6

Module 03109- – Air Distribution Systems NATE 1.9.1, 1.10.2, 1.9.5, 1.4.4, 1.9.10.D, NC3 Airflow Certification

1. Describe the factors related to air movement and its measurement in air distribution systems.
    a. Describe how pressure, velocity, and volume are interrelated in air flow.
    b. Describe air distribution in a typical residential system.
    c. Identify common air measurement instruments.

2. Describe the mechanical equipment and materials used to create air distribution systems. ESCO 3.66
    a. Describe various blower styles and applications.
    b. Describe various fan designs and applications.
    c. Demonstrate an understanding of the Fan Laws.
    d. Describe common duct materials and fittings.
    e. Identify the characteristics of common grilles, registers, and dampers.

3. Identify the different approaches to air distribution system design and energy conservation.
    a. Identify air system design strategies for cold climates.
    b. Identify air system design strategies for warm climates.
    c. Explain the importance of maximizing energy efficiency through the proper insulation, sealing, and testing of air distribution systems.

Level 2

Module 03211- – Heat Pumps NATE 1.8.1.E NC3 Air to Air Heat Pump Certification

1. Explain heat pump operating principles and their related performance ratings. ESCO 5.11-5.14
    a. Explain how heat pumps can extract heat from air and water. ESCO 5.2
    b. Describe the Coefficient of Performance (COP) and how it is determined. ESCO 5.2
    c. Describe the Heating Seasonal Performance Factor (HSPF) and how it is determined. ESCO 5.2
    d. Describe the Seasonal Energy Efficiency Ratio (SEER) and how it is determined. ESCO 5.2

2. Describe the operation of heat pump systems. ESCO 5.6 & 5.7
    a. Describe the refrigeration cycle of heat pumps. ESCO 5.11-5.14
    b. Identify the various types of heat pump systems. ESCO 5.11-5.14
    c. Describe the basic control strategies for heat pumps and defrost cycles. ESCO 5.11-5.14
    d. Identify unit components that are important to heat pump operation. ESCO 5.11-5.14
    e. Describe sources of supplemental and/or emergency heat used in heat pumps. ESCO 5.11-5.14

3. Identify common installation practices associated with heat pumps. ESCO 3.30A-P
    a. Identify installation practices associated with split systems.
    b. Identify installation practices associated with packaged systems. ESCO 5.1

4. Describe the operation of electric heating equipment used with heat pumps. ESCO 5.32
    a. Explain how electric heating equipment operates. ESCO 5.25 & 5.35
    b. Identify the major components of an electric heater.

Module 03202- – Chimneys, Vents, and Flues NATE 1.9.6.C, 1.9.7.C

1. Describe the principles of combustion. ESCO 7.14, 7.16,7.17
    a. Describe the requirements for combustion and flame characteristics.
    b. Distinguish between complete and incomplete combustion.
    c. Describe the contents of flue gases and related concerns.

2. Identify the basic requirements and components of a furnace venting system. ESCO 7.14, 7.16,7.17
    a. Explain the basic principles of combustion and ventilation.
    b. Identify vented appliance categories.
    c. Describe the construction of various venting systems.

3. Describe the basic venting considerations for various gas-fired heating units. ESCO 7.14, 7.16,7.17
    a. Describe the venting considerations for natural-draft furnaces.
    b. Describe the venting considerations for induced-draft furnaces.
    c. Describe the venting considerations for condensing furnaces.

TECHNICAL CERTIFICATE REQUIRED COURSES

Course Number and Name: ACT 2424 Heating, Ventilation, and Air Conditioning II

Description: This course includes a continuation of Heating, Ventilation, and Air Conditioning I with modules related to introduction to hydronic systems, troubleshooting heat pumps, and troubleshooting accessories.

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Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	150

Prerequisite: Instructor approved

Student Learning Outcomes:

Level 2

Module 03203- – Introduction to Hydronic Systems

1. Describe hydronic systems and the principles of closed-system water flow.
    a. Describe the basic properties of water and the significance of its contents.
    b. Describe the relationship between water flow and system pressures.

2. Describe the primary types of hot-water heating systems and their components.
    a. Identify gravity and forced hydronic systems.
    b. Describe the different types of boilers used.
    c. Identify primary boiler components.
    d. Identify common components related to air and pressure control.
    e. Identify common components related to water level and flow control.

3. Identify various hot-water heating piping systems and the various terminal devices used.
    a. Describe the characteristics of one- and two pipe systems.
    b. Describe the function of hot-water zoning systems.
    c. Identify various hot-water heating system terminal devices.

4. Describe the methods and devices used to select pumps and balance water flow in hydronic systems.
    a. Identify the devices used to measure and control water flow in hydronic systems.
    b. Describe how circulating pumps are selected based on required flow rates.
    c. Explain how to measure pump pressures and system flow rates in an operating system.

Level 3

Module 03311- – Troubleshooting Heat Pump NATE 1.8.1. E NC3 Air to Air Heat Pump Certification , ESCO 5.21-5.26

1. Compare heat pumps to standard cooling systems and describe their operating cycles.
    a. Compare heat pump systems to standard cooling systems and identify the different types.
    b. Describe the three operating cycles of common heat pumps.

2. Describe the sequence of operation for the common operating modes. ESCO 5.21-5.26
    a. Describe the sequence of operation for the cooling mode.
    b. Describe the sequence of operation for the three heating modes.
    c. Describe the sequence of operation for the defrost mode.

d. Describe the sequence of operation of dual fuel systems.
e. Describe the use of microprocessor controls in heat pump systems.

3. Explain how to check and/or troubleshoot various functions and components of heat pump systems. NC3 Refrigeration Diagnostics Certification, NC3 Air to Air Heat Pump Certification, ESCO 5.21-5.26
    a. Explain how to check field and factory wiring.
    b. Explain how to check and troubleshoot heat pump thermostats.
    c. Explain how to test thermistors.
    d. Explain how to check the various types of valves found in heat pumps.
    e. Explain how to check defrost control circuits.

Module 03312- – Troubleshooting Accessories **NATE 1.10.1.C, 2.7.2, 2.7.3.**NC3 Refrigeration Diagnostics Certification ESCO 7.8-7.8, 1.17

1. Describe how to troubleshoot various HVAC system accessories.
    a. Describe how to approach the troubleshooting process.
    b. Describe how to troubleshoot humidifiers.
    c. Describe how to troubleshoot electronic air cleaners.
    d. Describe how to troubleshoot UV lighting devices.

2. Describe how to troubleshoot accessories related to the introduction of outside air.
    a. Describe how to troubleshoot economizers.
    b. Describe how to troubleshoot recovery ventilators.

Course Number and Name: ACT 2324 Commercial Refrigeration

Description: This course includes a study of various commercial refrigeration systems. This course also includes installation, servicing, and maintaining systems.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	150

Prerequisite: Instructor approved

Student Learning Outcomes:

1. Define and perform checks of multiplexed evaporator systems. ESCO 3.30A-B
    a. Explain the application of multiplexed systems. ESCO 1.25
    b. Describe the physical construction of a common rack system.
    c. Check and adjust evaporator pressure regulating (EPR) valves.
    d. Identify capacity of compressors according to manufacturer's specifications. ESCO 3.68

2. Explain and perform routine maintenance and repairs of refrigerated storage.
    a. Explain the difference among medium, low, and ultralow temperature storage systems.
    b. Explain the operation of various types of freezers and coolers.
    c. Explain the different methods of defrost.

3. Explain and perform routine maintenance and repair of ice makers. ESCO 1.0
    a. Explain the operation of various types of ice makers.
    b. Explain the different methods of harvest.

4. Identify and discuss operations check of packaged liquid chillers.
    a. Discuss the applications of liquid chillers.
    b. Explain the operation of liquid chillers.

5. Explain and perform maintenance of other system applications.

Course Number and Name: ACT 2624 Heat Load and Air Properties

Description: This course includes introduction to heat load calculations for residential and light commercial heating, ventilation, air-conditioning, and refrigeration systems. This course includes air distribution, duct sizing, selection of grills and registers, types of fans, air velocity, and fan performance. This course introduces air testing instruments and computer usage.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
4	2	4	150

Prerequisite: None

Student Learning Outcomes:

Level 2

Module 03213- – Sheet Metal Duct Systems NATE 1.7.2.A, 2.5.4 ESCO 6.30

1. Identify and describe common types of sheet metal.
    a. Identify various types of steel sheet metals.
    b. Identify various types of alloy sheet metals.

2. Identify various methods of joining sheet metal. ESCO 6.30
    a. Identify various types of duct seams.
    b. Identify various methods of duct component connection.

3. Describe the methods used to suspend and support sheet metal duct. NC3 Airflow Certification, ESCO 6.30
    a. Describe methods used to suspend sheet metal duct.
    b. Describe methods used to support sheet metal duct.

4. Describe methods used to insulate and attenuate sheet metal duct. NC3 Airflow Certification, ESCO 6.30
    a. Describe the selection and installation of duct lining products.
    b. Describe the selection and installation of external duct wraps.

5. Identify various sheet metal duct accessories and describe their installation. NC3 Airflow Certification, ESCO 6.30
    a. Identify and describe the installation of various types of dampers.
    b. Identify and describe the installation of duct takeoffs and access doors.

6. Identify different types of flexible duct and explain how it is installed. NC3 Airflow Certification, ESCO 6.30
    a. Identify different types of flexible duct.
    b. Explain how flexible duct is connected and supported.

Module 03214- Fiber Class and Fabric Duct Systems NATE 1.7.2.B, 1.7.2.C. 2.5.4, ESCO 6.30

1. Describe the standard and application considerations related to fiberglass duct. .
    a. Identify the standards related to fiberglass duct.
    b. Identify application considerations related to fiberglass duct.

2. Describe the methods used to fabricate and repair fiberglass duct. NC3 Airflow Certification
    a. Describe how to close and join fiberglass duct using various methods.
    b. Describe how to repair both minor and major fiberglass duct damage.

3. Describe the methods used to suspend and support fiberglass duct systems. NC3 Airflow Certification
    a. Describe methods used to suspend and support fiberglass duct.
    b. Describe methods used to suspend and support fiberglass duct fittings and risers.

4. Describe fabric-based air distribution products and their installation methods. NC3 Airflow Certification
    a. Identify various types and designs of fabric based air distribution products.
    b. Describe the various methods of installing and suspending fabric-based air distribution products.

Module 03201– Commercial Airside Systems NATE 1.7.2.D, ESCO 6.26

1. Describe basic commercial airside systems and their operating characteristics.
    a. Describe the typical operating characteristics of a commercial airside system.
    b. Describe the purpose and function of ventilation and exhaust systems.

2. Describe various approaches used in commercial air distribution design.
    a. Describe single-zone constant volume system operation.
    b. Describe multi-zone constant volume system operation.
    c. Describe variable volume, variable temperature (VVT) system operation.
    d. Describe variable air volume (VAV) system operation.

3. Describe common air terminal operation and related air delivery devices.
    a. Explain the basic operation of VVT and single duct VAV terminal devices.
    b. Explain the basic operation of fan-powered VAV terminals.
    c. Identify various styles of commercial grilles and registers.

4. Identify the characteristics and components of various airflow sources.
    a. Describe the various forms and components of packaged systems.
    b. Describe the various forms and components of air handling units.
    c. Describe the purpose and function of economizers.
    d. Describe common accessories used with commercial airside systems

TECHNICAL ELECTIVE COURSES

Course Number and Name: ACT 1823 Ammonia Refrigeration I

Description: This course is designed to prepare the student for entry level employment in the field of industrial ammonia refrigeration. In this course students will explore the necessary tools, safety, and operating procedures essential when working with refrigeration equipment and OSHA standards.

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Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: None

Student Learning Outcomes:

1. ***Chapter 1 – Fundamental Items*** RETA
   a. Evolution of Refrigeration
   b. Definition of Refrigeration
   c. Refrigeration
   d. The Purpose of a Refrigerant System
   e. Operating Personnel and Refrigeration Systems
   f. Numbers and Mathematics
   g. Basic Units of Measurement
   h. Length
   i. Area
   j. Volume
   k. Rate
   l. Weight and Mass
   m. Introduction to Pressure
   n. Pressure in General
   o. An Introduction to Air (Gas) Pressure
   p. Introduction to Heat
   q. Heat Quantity
   r. Heat is Defined by Its Effect on an Object
   s. Heat Movement
   t. An introduction to the Change of State
   u. Understanding of the Principles Used in Refrigeration
   v. Specific Heat
   w. Introduction to the Pressure/Temperature Relationship
   x. Properties of Refrigerants
   y. Ways that Heat Energy Flows
   z. Rate of Heat Flow
   aa. Combination Equations
   bb. Heat Energy Profile of Water
   cc. Combination Heat Calculations
   dd. Figuring Out the Tonnage

2. ***Chapter 2 – The Refrigeration Cycle*** RETA
    a. An Introduction to the Mechanical Refrigeration Cycle
    b. The Cycle Presented Graphically
    c. Moving Heat with the Refrigeration Cycle
    d. Introduction to System Factors
    e. System Review
    f. Saturation
    g. Subcooling
    h. Superheat
    i. Heat of Compression
    j. Compression Ratio
    k. Specific Volume
    l. Non-Condensable Gases
    m. Pressure Drops

3. ***Chapter 3 – Properties of Refrigerants*** RETA
    a. Background History of Some Refrigerants
    b. Carbon Dioxide
    c. Refrigerant Selection Factors
    d. Saturated Operating Pressures
    e. Refrigerant Operating Characteristics Comparison
    f. Discharge Temperature
    g. Discharge Temperature of Reciprocating Compressors
    h. Discharge Temperature of Screw Compressors
    i. Equipment Selection
    j. Refrigerant Cost and Availability
    k. Safety
    l. Exposure Hazards
    m. Self-Alerting Characteristics
    n. Flammability
    o. Reactivity
    p. First Aid
    q. Handling Refrigerants
    r. Hydrostatic Expansion
    s. BLEVE
    t. Refrigerant 717 (Ammonia)
    u. Advantages
    v. Disadvantages
    w. Determining the Point of an Ammonia Leak
    x. First Aid for Exposure
    y. Halocarbon Refrigerants
    z. Advantages
    aa. Disadvantages
    bb. Determining the Point of the Halocarbon Leak
    cc. Environmental Concerns and Regulations

4. ***Chapter 4 – Saturated Refrigerant Tables*** RETA
    a. Saturated Refrigerant Table Introduction
    b. Saturated Refrigerant Table Information

5. ***Chapter 5 – Refrigeration Compressor Types*** RETA

a. Refrigerant Vapor Compressors
b. Compressor Functions
c. Compressor Categories
d. Introduction to Positive Displacement Compressors
e. Open Drive Compressors
f. Types of Positive Displacement Compressors
g. Reciprocating Compressor
h. HDA – Horizontal, Double Acting Compressors
i. VSA – Vertical Single Acting Compressors and "V" – "W" High Speed Compressors
j. Hermetic Compressors
k. Semi-Hermetic Compressors
l. Rotary Vane Compressors
m. Rotary Screw Compressors
n. Oil and the Screw Compressor
o. Capacity Control for Positive Displacement Compressors
p. Single Crew Compressors
q. Introduction to Two Stage Compression, and Booster Compressors

6. ***Chapter 6 – Operation and Maintenance of Refrigeration Systems*** RETA
   a. The Role of the Operator
   b. Possible Responsibilities of the Refrigeration Operator
   c. System Surveillance
   d. Staring Work in a New Plant
   e. Coming On and Going Off Duty
   f. Staring Reciprocating Compressors, General
   g. Why the Oil Must be Warm
   h. Starting Rotary Vane Booster Compressors
   i. Staring Rotary Screw Compressors
   j. Staring Centrifugal Compressors
   k. A Dangerous Condition to Watch for When Starting a Compressor
   l. Recovering from a Slug
   m. More About Slugging
   n. Normal Shutdown of Compressors
   o. Log Sheets
   p. Preventive Maintenance & Operation of an Ammonia Refrigeration System

7. ***Chapter 7 – Lubrication*** RETA
   a. Introduction to Lubrication
   b. Functions of Lubricating Oil
   c. Refrigerant Oil
   d. Oil Quality
   e. Types of Lubrication Systems in Reciprocating Compressors
   f. The Splash System
   g. The Internal Force-Feed and Splash System
   h. The Full Internal Force-Feed System
   i. Oil in Ammonia Refrigeration Systems
   j. Draining Oil from Ammonia Refrigeration Systems
   k. Oil Stills
   l. Oil in Halocarbon Refrigeration Systems
   m. Records
   n. Screw Compressor Oil Management

o. Oil Cooling
p. Indirect Oil Cooling
q. Direct Oil Cooling
r. Lubrication of Other Equipment
s. Lubricants: Now and in The Future

8. ***Chapter 8 – Evaporators-Cooling Units*** RETA
   a. Expansion Devices
   b. Air Cooling
   c. Forced Convection Air Movement
   d. Product Coolers and Freezers
   e. Coil Defrost
   f. Liquid Cooling
   g. Secondary Coolant
   h. Plate and Frame
   i. Welded Plate
   j. Plate and Shell
   k. Falling Film
   l. Ice Makers
   m. Ice Builders
   n. Direct Contact Freezing
   o. Scraped Surface Heat Exchangers
   p. Process Tanks
   q. Methods of Supplying Refrigerant to Evaporators
   r. Installation
   s. Service and Maintenance

9. ***Chapter 9 – Condensers and High Pressure Receivers*** RETA
   a. The Condensing Process
   b. Types of Condensers
   c. Water-cooled Condensers
   d. Shell and Tube Condensers (Ammonia)
   e. Shell and Tube Condensers (Halocarbons)
   f. Installation of Shell and Tube Condensers
   g. Operation and Maintenance of Shell and Tube Condensers
   h. Plate Type Condensers
   i. Evaporative Condensers
   j. Introduction to Wet Bulb
   k. Water and Evaporative Condensers
   l. Evaporative Condenser Construction Description
   m. Evaporative Condenser Design
   n. Operation and Maintenance of Evaporative Condensers
   o. Air-Cooled Condensers
   p. Head Pressure Control of Air-Cooled Condensers
   q. Fan Cycling
   r. Two-Speed Fan Operation (Two-Speed Motors)
   s. Variable Frequency Drives
   t. Modulating Dampers
   u. Condenser Coil Flooding
   v. High Pressure Receivers
   w. Overpressure Protection

x. High Pressure Receiver Types
y. High Pressure Receive Considerations
z. Construction

10. ***Chapter 10 – Purging*** RETA
    a. Purging Problems
    b. Sources of Non-Condensable Gases
    c. Air Leaks
    d. Other Gases
    e. Manual Purging of Ammonia Systems
    f. Purging with System Not Operating (Off Line)
    g. Refrigerated Purgers
    h. Automatic Refrigerated Purgers

Course Number and Name: ACT 2823 Ammonia Refrigeration II

Description: This course is designed to prepare the student in a more in-depth and fundamental approach to industrial ammonia refrigeration. In this course students will explore the different types of ammonia refrigeration systems, devices and theories, including proper operation procedures and important refrigerant safety practices.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
3	2	2	60

Prerequisite: None

Student Learning Outcomes:

STUDENT LEARNING OUTCOME:

Chapter 1 - Heat Flow in Refrigeration Systems RETA

a. Heat Transfer
b. It is all about "U"
c. Effective air flow in a cold storage space
d. Conditions which increase cooling effect of Evaporators
e. Conditions which effect decreased cooling effect of Evaporators
f. Forced convection air movement
g. Heat Rejection
h. Insulation
i. Insulation can be ruined when you:

Chapter 2 – Enthalpy RETA

a. Terminology
b. Mollier (PH) Diagram Description
c. A Basic Single Stage Direct Expansion Plot
d. Plot of a Two Stage System
e. Plot of a Subcooling Coil Type Intercooler
f. The Gravity Flooded Evaporator And The Enthalpy Diagram
g. Pumped Recirculated Liquid Feed
h. Plotting Complex Sytems

Chapter 3 - Introduction to the Air/ Water Relationship – The Psychrometric Chart RETA

a. Relative And Absolute Humidity
b. Back To Basics: Psychrometrics And The Psychrometric Chart
c. Effect on Condensers
d. Infiltration Into A Freezer
e. Humidity Effect On A 34 Degree Fahrenheit Cooler

Chapter 4 – Low Side Liquid Feed Valves and Controls RETA

a. Hand Expansion Valves
b. Automatic Liquid Feed Controls
c. Valves That Supply Liquid Into Direct Expansion Evaporators
d. The Purpose Of A Low side Vessel In Refrigeration System
e. Automatic Liquid Feed Control Devises

Chapter 5 – Direct Expansion Systems RETA

a. Direct Expansion Evaporators
b. Liquid Feed To DX Evaporators
c. Controlling The Evaporating Temperature
d. Protecting The Compressor – The Suction Line Accumulator
e. The Effect Of Superheat On Theoretical Discharge Temperatures

Chapter 6 – Liquid Overfeed Systems RETA

a. Recirculation Ratio
b. Gas Pump Systems
c. The Double Pumper Drum System
d. Constant Pressure Recirculation System
e. Transfer To High Pressure Receiver
f. Top Feed And Bottom Feed Evaporators
g. Pump Sizing
h. Line Sizing
i. Pressure Vessel Sizing and Configuration
j. Controls
k. Setting Evaporator Feed
l. Refrigerant Charge
m. Initial Start Up And Operation
n. Oil Removal
o. Advantages and Disadvantages Of Pumped Liquid Recirculation Systems

Chapter 7 – Gravity Flooded Systems RETA

a. Gravity Flooded System Designs
b. Oil Control In Gravity Flooded Systems
c. Operating Problems
d. Consequences Of Carry Over

Chapter 8 – Secondary Coolant Circulation Systems RETA

a. Secondary Coolant Systems
b. Secondary Coolant Defrost Systems
c. Emerging Technologies – Ammonia In Commercial Applications

Chapter 9 – Two Stage Systems RETA

a. Operating Condition With Low Evaporator Temperatures
b. Introduction to “Two Stage” Compression, And Booster Compressors
c. Two-Stage System Theory Of Operation
d. Two-Stage Compression Systems
e. Two-Stage Systems and Non-Condensable
f. Cascade Systems
g. Vacuum Cooling

Chapter 10 – Evaporator Defrost RETA

a. Air Defrost
b. Electric Defrost
c. Water Defrost
d. Continuous Defrost
e. Hot Gas Defrost
f. General Items

Course Number and Name: ACT 291 (1-3) Special Project in Heating, Ventilation, Air-Conditioning, and Refrigeration Technology

Classification: Technical Certificate Elective

Description: This course includes is designed to provide the student with practical application of skills and knowledge gained in technical courses. The instructor works closely with the students to ensure that the selection of a project will enhance the student's learning experience.

Hour Breakdown:

Scheduled Hours	Lecture	Lab	Clock Hours
1		2	60
2		4	120
3		6	180

National Assessment:

Prerequisite: Instructor approved

Student Learning Outcomes:

1. Develop a written plan that details the activities and projects to be completed.
    a. Utilize a written plan that details the activities and projects to be done.
    b. Perform written occupational objectives.

2. Assess accomplishment of objectives.
    a. Prepare daily written assessment of accomplishment of objectives.
    b. Present weekly written report on activities done to instructor.

3. Utilize a set of written guidelines for the special project.
    a. Develop and follow a set of written guidelines.

Course Number and Name: ACT 292(1 – 6) Supervised Work Experience in Heating, Ventilation, Air-Conditioning, and Refrigeration Technology

Classification: Technical Certificate Elective

Description: This course is a cooperative program between industry and education and is designed to integrate the student's technical studies with industrial experience. Variable credit is awarded on the basis of one semester hour per 45 industrial contact hours.

Hour Breakdown:

Scheduled Hours	Lecture	Externship	Clock Hours
1		3	135
2		6	270
3		9	405
4		12	540
5		15	675
6		18	810

National Assessment:

Prerequisite: Completion of at least one semester of advanced coursework in Heating, Ventilation, Air-conditioning, and Refrigeration Technology

Student Learning Outcomes:

1. Apply technical skills needed to be a viable member of the workforce.
    a. Prepare a description of technical skills to be developed in the supervised work experience.
    b. Develop technical skills needed to be a viable member of the workforce.

2. Apply skills developed in other program area courses.
    a. Perform skills developed in other program area courses.

3. Apply human relationship skills.
    a. Use proactive human relationship skills in the supervised work experience.

4. Apply and practice positive work habits and responsibilities.
    a. Perform assignments to develop work habits and responsibilities.

5. Work with instructor and employer to develop written occupational objectives to be accomplished.
    a. Perform written occupational objectives in the supervised work experience.

6. Assess accomplishment of objectives.
    a. Prepare daily written assessment of accomplishment of objectives.
    b. Present weekly written reports of activities performed and objectives accomplished to instructor.

7. Utilize a set of written guidelines for the supervised work experience.
    a. Develop and follow a set of written guidelines for the supervised work experience.

Appendix A: CURRICULUM DEFINITIONS AND TERMS

- Course Name – A common name that will be used by all community colleges in reporting students

- Course Abbreviation – A common abbreviation that will be used by all community and junior colleges in reporting students

- Classification – Courses may be classified as the following:
    - Career Certificate Required Course – A required course for all students completing a career certificate.
    - Technical Certificate Required Course – A required course for all students completing a technical certificate.
    - Technical Elective – Elective courses that are available for colleges to offer to students.

- Description – A short narrative that includes the major purpose(s) of the course

- Prerequisites – A listing of any courses that must be taken prior to or on enrollment in the course

- Corequisites – A listing of courses that may be taken while enrolled in the course

- Student Learning Outcomes – A listing of the student outcomes (major concepts and performances) that will enable students to demonstrate mastery of these competencies

The following guidelines were used in developing the program(s) in this document and should be considered in compiling and revising course syllabi and daily lesson plans at the local level:

- The content of the courses in this document reflects approximately 75% of the time allocated to each course. The remaining 25% of each course should be developed at the local district level and may reflect the following:
    - Additional competencies and objectives within the course related to topics not found in the state framework, including activities related to specific needs of industries in the community college district
    - Activities that develop a higher level of mastery on the existing competencies and suggested objectives
    - Activities and instruction related to new technologies and concepts that were not prevalent at the time the current framework was developed or revised
    - Activities that include integration of academic and career–technical skills and course work, school-to-work transition activities, and articulation of secondary and postsecondary career–technical programs
    - Individualized learning activities, including work-site learning activities, to better prepare individuals in the courses for their chosen occupational areas

- Sequencing of the course within a program is left to the discretion of the local college. Naturally, foundation courses related to topics such as safety, tool and equipment usage, and other fundamental skills should be taught first. Other courses related to specific skill areas and related academics, however, may be sequenced to take advantage of seasonal and climatic conditions, resources located outside of the school, and other factors. Programs that offer an Associate of Applied Science Degree must include all of the required Career Certificate courses, Technical Certificate courses **AND** a minimum of 15 semester hours of General Education Core Courses. The courses in the General Education Core may be spaced out over the entire length of the program so that students complete some academic and Career Technical courses each semester. Each community college specifies the actual courses that are required to meet the General Education Core Requirements for the Associate of Applied Science Degree at their college.

- In order to provide flexibility within the districts, individual courses within a framework may be customized by doing the following:

    - Adding new student learning outcomes to complement the existing competencies and suggested objectives in the program framework.
    - Revising or extending the student learning outcomes
    - Adjusting the semester credit hours of a course to be up 1 hour or down 1 hour (after informing the Mississippi Community College Board [MCCB] of the change)

APPENDIX B: Recommended Tools and Equipment

CAPITALIZED ITEMS

1. Oxy-acetylene outfit (8)
2. Computers (1 per student)
3. Printers (1 per computer or networked lab)
4. Mobile laptop cart (1)

NONCAPITALIZED TOOLS

1. Bench/metal or wood tops with vises (10)
2. C clamps, assorted sets – 6-in., 8-in., 10-in. (3)
3. 3/8-in. and 1/2-in. corded and cordless drill motors (2 each)
4. Gear puller set (1)
5. 7-in. pedestal grinder, commercial (1)
6. 220-V kit quick start (1)
7. 110-V kit quick start (1)
8. Electronic leak detectors corded and cordless (2 each)
9. Ultrasonic and ultraviolet leak detectors (2 each)
10. Pop rivet gun set (1)
11. Service valve kits (2)
12. Snips: straight, left, right (3)
13. Soldering gun (2)
14. Combination squares (2)
15. Tap and die sets (1 metric and 1 SAE) (2)
16. 25-ft tape measures (2)
17. 3-ft metal rules (2)
18. Universal appliance truck (2)
19. Vacuum (wet or dry) (1)
20. Wheel puller set (1)
21. Pipe wrench set (1)
22. Chisel sets (2)
23. Combination wrench sets (1 metric and 1 SAE) (2)
24. Diagonal cutters (4)
25. Reciprocating saw (1)
26. Grinders, side (1-4 in. and 1-7 in.) (2)
27. File set (1)
28. Flare/swage sets (10)
29. Nitrogen tank and recycling regulator and relief valve (2)
30. First aid kit (1)
31. Schrader valve core removal tools (2)
32. Industrial flashlights (3)
33. Fuse pullers (2)
34. Hack saws/extra blades (2)
35. Ball-peen hammer sets (2)
36. Set, refrigeration flare nut wrenches (7/16 in. – 1 in.) (1)
37. Nut driver sets (4)
38. Pinch off tool (4)
39. Pliers (slip joint/needle nose/linesman locking) (3)
40. Scratch awls (2)
41. Screwdriver sets (2 straight and 2 Philips) (4)
42. Sockets and ratchet sets – 1/2-in., 3/8-in., 1/4-in. drive (1 metric and 1 SAE) (2 each)

43. Tubing bender set (1)
44. Tubing cutter kits (5)
45. Wire strippers (5)
46. Allen wrench sets (2)
47. Wire end crimpers (2)
48. 8-ft fiberglass ladders (3)
49. Four-wheel cart (1)
50. Appliance lift (1)
51. Circular saw (1)
52. Hand trucks for cylinders (4)
53. 12-ft fiberglass ladder (1)

CAPITALIZED EQUIPMENT

1. A/C split (gas and electric) (4)
2. A/C window unit (4)
3. Residential package heating (dual purpose, for heating and cooling instruction) (2)
4. Air-to-air heat pump (with electrical backup heat) (2)
5. Residential refrigerator (1)
6. Commercial ice maker (trainer) (1)
7. Vacuum pumps, two-stage (4)
8. Refrigerant identifier (1)
9. Recovery/recycling equipment (4)
10. Combustion test kit (1)
11. Basic electrical trainers (4)
12. Air-conditioning trainer (1)
13. Refrigeration trainer (1)
14. Heat pump trainer (1)
15. Solid state electronic trainer (1)
16. Electric heat trainer (1)
17. Gas heat trainer (1)
18. Compressor trainer (1)
19. Mini split (1)

NONCAPITALIZED EQUIPMENT

1. Clamp-on ammeters (4)
2. Hermetic analyzer (2)
3. Capacitor analyzer (2)
4. Set of recording ammeter and voltmeter (1)
5. Electronic thermometer (8)
6. Electronic charging scale (2)
7. Micron vacuum gauge (4)
8. Manifold gauge sets with low loss fittings (6)
9. Bimetal (digital) thermometers (6)
10. Temperature recorder (2)
11. Psychrometer (dry and wet bulbs) (2)
12. Storage tanks (6)
13. Hand oil pump (1)
14. U-tube manometer (4)
15. Carbon monoxide tester (1)
16. Velometers (dual purpose, for heating and cooling instruction) (2)

RECOMMENDED INSTRUCTIONAL AIDS

It is recommended that instructors have access to the following items:

1. Scientific calculator (1)
2. Cart, AV (for overhead projector)
3. Computer with operating software with multimedia kit (1)
4. Wireless Projector
5. DVD player (1)
6. Data projector (1)
7. Smart TV

Appendix: C COURSE CROSSWALK

Course Crosswalk

Heating, Ventilation, Air-Conditioning, and Refrigeration Technology

HVAC – Service and Installation (Program CIP: 47.0201 – HVAC & R Maintenance Technology/Technician)HVAC – Selling and Business (Program CIP: 52.1804 – Selling Skills and Sales Operations)

Note: Courses that have been added or changed in the 2019 curriculum are highlighted.

Existing			Revised		
2014 MS Curriculum Framework			2020 MS Curriculum Framework		
Course Number	**Course Title**	**Hours**	**Course Number**	**Course Title**	**Hours**
ACT 1003	Introduction to Heating and Air Conditioning Technology	3	ACT 1003	Introduction to Heating and Air Conditioning Technology	3
ACT 1124	Basic Compression Refrigeration	4	ACT 1124	Basic Compression Refrigeration	4
ACT 1133	Brazing and Piping	3	ACT 1133	Brazing and Piping	3
ACT 1214	Controls	4	ACT 1214	Controls	4
ACT 1313	Refrigeration System Components	3	ACT 1313	Refrigeration System Components	3
ACT 1713	Electricity for Heating, Ventilation, Air-Conditioning, and Refrigeration	3	ACT 1713	Electricity for Heating, Ventilation, Air- Conditioning, and Refrigeration	3
ACT 2414	Heating, Ventilation, Air Conditioning, and Refrigeration I	4	ACT 2414	Heating, Ventilation, Air Conditioning, and Refrigeration I	4
ACT 2433	Refrigerant, Retrofit, and Regulations	3	ACT 2433	Refrigerant, Retrofit, and Regulations	3
ACT 2513	Heating Systems	3	ACT 2513	Heating Systems	3
ACT 2424	Heating, Ventilation, and Air Conditioning II	4	ACT 2424	Heating, Ventilation, and Air Conditioning II	4
ACT 2324	Commercial Refrigeration	4	ACT 2324	Commercial Refrigeration	4
ACT 2624	Heat Load and Air Properties	4	ACT 2624	Heat Load and Air Properties	4
			ACT 1823	Ammonia Refrigeration I	3
			ACT 2823	Ammonia Refrigeration II	3

Appendix D: Recommended Textbook List

Recommended Heating, Ventilation, Air-Conditioning, and Refrigeration Technology

HVAC – Service and Installation (Program CIP: 47.0201 – HVAC & R Maintenance Technology/Technician)

Book Title	Author (s)	ISBN
Refrigeration and Air Conditioning Technology	John Tomczyk (Author), Eugene Silberstein (Author), Bill Whitman (Author), Bill Johnson (Author)	ISBN-13: 978-1305578296 ISBN-10: 1305578295
Lab Manual for Tomczyk/Silberstein/ Whitman/Johnson's Refrigeration and Air Conditioning Technology, 8th	John Tomczyk, Eugene Silberstein, et al.	ISBN9781305578708

Understanding Superscripts: Superscripts were created for assessment crosswalk purposes. The assessments were assigned numbers to help guide the crosswalk process.

The NATE assessment standards were assigned number as shown in the following example:

Topic: HVAC support Technician 1.1.1 a-l

Personal Safety Around Moving Machinery 1.1.2

Subtopic Electrical 3

Subtopic letters Safety Brazing and Soldering Practices 4 a-e

The ESCO assessment standards were assigned number as shown in the following example:

Commercial Refrigeration 1.0

Electric Heat 2.0

Residential Air Conditioning 3.0

Mathematics for HVAR and HVACR General Studies 6.0

Electrical 4.0

Heat Pump 5.0

Gas Heat 7.0

NC3 was assigned by topics.