Ohio

Transportation Systems

CAREER FIELD TECHNICAL CONTENT STANDARDS

2013

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Ohio | Department of Education

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Foreword

The Career Field Technical Content Standards serve as the curricular framework for Ohio's career-technical education pathway programs as outlined in Ohio Administrative Code 3301-61-03 (Criteria for Secondary Workforce Development Programs).

Career Field Technical Content Standards outline the knowledge and skills needed for success in careers across multiple pathways. Validated by Ohio business and industry representatives in conjunction with Ohio educators, these standards form the basis for developing educational programming in Ohio secondary schools. The standards also serve as the framework for developing strong career pathways that connect secondary education with postsecondary education systems and the workplace.

This version of Career Field Technical Content Standards is intended to support the ongoing evolution of career technical education pathway programs. The standards tend to be somewhat broader than previous versions and are not repeated for individual pathways or occupational areas. The broader and non-duplicated statements are intended to capture the knowledge and skills that can be applied across any number of occupations in a pathway rather than focusing on the requirement of a single occupation. After all, the intent of a pathway program is to prepare a student for a range of educational and career opportunities following high school.

Pathway programs prepare students to combine broad knowledge, insight and understanding of business processes, academic attainment and workplace readiness with depth of knowledge and expertise in a technical area. Knowing that many careers will require some level of postsecondary education, the content standards also delineate the knowledge and skills necessary to seamlessly transition to postsecondary educational programs.

This document seeks to provide the basis for educational programming that will provide the employee with fundamental skill-sets that employers demand. This ensures that Ohio's workforce of tomorrow is competitive in a global environment. An environment that requires knowledge and skills can be applied in a broader context, aimed at innovation to support new products and services in an ever-changing economy.

In addition to the extensive engagement of secondary and postsecondary educators and business/industry professionals, development of these standards represents a collaborative effort of the following professional partners: the Ohio Department of Education's Office of Career-Technical Education; the Ohio Board of Regents Secondary Career-Technical Alignment Initiative; and CETE, known as the Center on Education and Training for Employment, at The Ohio State University.

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Acknowledgements

A number of individuals contributed their time and expertise to this development. Special thanks go to all the business representatives and educators named in this document.

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Those listed above provided vision and implementation support for the Transportation Systems Career Field Technical Content Standards and Ohio's Transportation Systems educational programs.

Philosophy and Principles for Implementation

Ohio Career Field Initiative

The overarching framework for Ohio career-technical education is outlined in the Ohio Revised Code and subsequent administrative rules, which specify career-technical programming based on 16 career fields. To view the full text of Administrative Rule 3301-61-03 (Criteria for Secondary Workforce Development Programs), go to: http://education.ohio.gov/Topics/Career-Tech/Career-Development-OCIS/CTE-Administrative-Rules-Update. These 16 fields provide the framework for an Ohio career field initiative that seeks to foster the educational shift necessary to respond to the needs of a rapidly changing global environment.

A career field is a "group of occupations and broad industries based on common characteristics" (see www.careertech.org). Career fields are the basis for developing both broad and specialized technical content standards that serve as a framework for curriculum, instruction, assessment and program design, addressing the needs of an entire industry and business sector. Ohio's 16 career fields align with national efforts to broaden career-technical education, integrate career-technical with academic study and reflect the workforce needs of today and tomorrow. For today's students to be adequately prepared for tomorrow's workforce, they must have an education that:

- **Incorporates a broad, long-term conception of work in combination with the depth of specialization skills;**
  Employees need a comprehensive understanding beyond a single occupational area. Career-technical programming needs to be provided in a larger context, so students can generalize learning, make connections between education and work and adapt to changes in their careers. Workplace knowledge and skills are needed to prepare employees for collaborating and problem solving while contributing to the broader business process.
- **Emphasizes the acquisition of strong academic knowledge and skills; and**
  Academic skills provide the foundation for career success. The integration of academic content standards with career field technical content standards helps to contextualize learning for students, making English language arts, mathematics, social studies and science relevant to students as a means to an important end—success at work and in life.
- **Facilitates high-school-to-postsecondary transitions.**
  A lifetime of change means a lifetime of learning, including postsecondary education. Students need knowledge and skills for success in a variety of postsecondary options, including apprenticeships, industry credentialing through adult education, two- and four-year college degree programs and graduate school.

Career Pathways

A key component of the Ohio Career Field Initiative is a career pathway, which is a coherent, articulated sequence of rigorous academic and career-technical coursework commencing in the ninth grade and leading to an associate degree, baccalaureate degree and beyond–an industry-recognized certificate and/or licensure. Pathways facilitate a seamless transition from high school to postsecondary education (including apprenticeships, adult education, two- and four-year colleges and graduate school) and from postsecondary education to the workplace. The career pathway is developed, implemented and maintained in partnership among secondary and postsecondary education, business and employers. Career pathways are available to all students, including adult learners and lead to rewarding careers.

To effectively facilitate the transition from secondary to postsecondary education and a career, high school career pathways should encompass:

1. Challenging technical coursework in a chosen career field based on career field technical content standards;
2. Rigorous academics that meet Ohio's academic content standards and grade-level expectations;
3. Electives that relate to career objectives;
4. Instructional enhancements such as experiential and authentic learning opportunities (e.g., work-based learning, mentorships, internships) and career-technical student organization participation;
5. Opportunities (when appropriate) for program and student certification and licensure;
6. Preparation for transition to further study that includes college readiness and opportunities to earn college credit while in high school;
7. Preparation for transition to employment with advancement opportunities;
8. Performance targets that include high school academic and technical testing/exit and postsecondary entry/placement requirements;
9. Various sector(s) within an industry or encompass a function that crosses industry sectors;
10. The scope of opportunities in the related industry and available college programs;
11. Opportunities to prepare for a range of careers, including
    a. multiple employment opportunities after high school and
    b. opportunities for students to enter and succeed in postsecondary and continuing education programs;
12. Transferable skills required for employment in the range of occupations aligned to the pathway; and
13. Opportunities to learn skills across the pathway as well as in specialized areas.

For additional information on the Career Field Initiative, including Ohio Career Field Technical Content Standards and Career Pathways, go to http://education.ohio.gov/Topics/Career-Tech/Career-Fields.

Structure and Format

The Career Field Technical Content Standards document is composed of a series of strands comprised of outcomes that each contain a set of competencies.

- A strand is a large content area under which multiple outcomes are organized, regardless of the pathway. It includes a title and a concise description with statements that capture multiple, broad areas of learner knowledge and skills expected across all outcomes in the strand. There are approximately six strands of content per career field. Strand 1, Business Operations/21st Century Skills (employability skills, leadership and communications, business ethics and law, knowledge management and information technology, global environment, business literacy, entrepreneurship/entrepreneurs, operations management, financial management, sales and marketing and principles of business economics), is the same for all career-technical education career fields.
- An outcome is an overarching statement that summarizes the knowledge and skills described in a set of individual competencies to be learned by the end of the 12th grade. There are usually 5–15 outcomes within a strand, depending on the breadth of content to be addressed.
- A competency is a specific statement of essential knowledge or skill to be learned in the pathway program. There are usually 5–12 competencies under an outcome.

Each set of outcomes and competencies is included in one or more pathways in the career field. Outcomes and competencies form the basis for developing secondary courses, programs, instruction and assessment, facilitating transition from one educational level to the next and to the workplace. This supports career readiness and long-term career success by:

- Providing the basis for effective collaboration, teamwork and communication across pathways;
- Laying the groundwork for successful transfer of knowledge and skills across pathways, thereby facilitating horizontal and vertical career success and
- Equipping students and workers with the skills needed to transition to new and emerging careers throughout a working lifetime.

All outcomes and competencies in the Career Field Technical Content Standards have been verified as essential by business and labor representatives within the pathway or pathways specified.

These essential outcomes and competencies specify industry-based knowledge or hands-on skills that CTE students need by the end of the 12th grade to be successful in their selected career pathway and on-going learning (such as college, apprenticeships and military opportunities).

Development of Transportation Systems Career Field Technical Content Standards

The process for the development of the Transportation Systems Career Field Technical Content Standards began in February 2012 and culminated in June 2013. Over the course of 2012–2013, numerous business and industry representatives as well as secondary and postsecondary educators from across the state of Ohio took part in the formal development process. The following summarizes the various stages of the development process.

Research and Development

The involvement of subject matter experts, including educators, was critical to the completion of the draft revision of the document. Development was also informed by consulting the following sources of information:

- National Association of State Directors of Career Technical Education Consortium (NASDCTEc) Common Career Technical Core (CCTC) standards and Programs of Study;
- Industry-based certifications/standards;
    - Automotive Service Excellence (ASE) student certification test specifications and task lists, automobile;
    - 2008 National Automotive Technicians Education Foundation (NATEF) standards;
    - ASE student certification test specifications and task lists, collision repair and refinishing, medium/heavy truck;
    - Automobile series (2012 NATEF Standards), Maintenance and Light Repair;
    - ASE student certification – Engine Repair (Auto), Automatic Transmission/Transaxle (Auto), Manual Drive Train and Axles (Auto), Electronics (Auto), Electrical/ Electronic Systems (Truck), Brakes (Auto), Suspension and Steering (Auto), Heating and Air Conditioning (Auto), Brakes (Truck), Suspension and Steering (Truck), Engine Performance (Auto), Diesel Engines (Truck), Mechanical & Electrical Components (Collision), Structural Analysis & Damage Repair (Collision), Non-Structural Analysis & Damage Repair (Collision), Painting & Refinishing (Collision);
    - Federal Aviation Administration (FAA) Regulations Part 65 (FAR 65);
    - FAA Part 65—certification: airmen other than flight crewmembers Subpart D—mechanics;
    - Airframe Rating;
    - Powerplant Rating;
- SkillsUSA;
- Partnership for 21st Century Skills;
- Career-Technical Transfer Assurance Guides (CTAGs);
- University System of Ohio Academic Program Guide; and
- Ohio Industry Employment Projections Report, 2008-18.

Futuring Panel

On May 15, 2012, the Transportation Systems futuring panel brought together key business and industry representatives from across the state to advise the Ohio Department of Education on trends impacting the Transportation Systems career field. The participants were asked to share their perceptions on changes in the workplace, employment trends, changes in technical skill requirements, needed workplace readiness skills and available industry-recognized standards and credentials. This feedback was used to develop and streamline the standards document into what is most demanded by the labor market.

Validation Panel

On November 5 and December 18, 2012, and January 23, 2013, a diverse group of Ohio business and industry representatives participated in panels to authenticate and rate the importance of the work-related competencies in the draft standards document. Drawn from various sectors and regions of the state, the panels identified what employees should know and be able to do in the two Transportation Systems pathways. Secondary and postsecondary education representatives participated on the panels to gain an understanding of the standards development process as well as to provide their perspective to the business representatives, when needed.

Postsecondary Alignment

The goal of the Secondary Career-Technical Alignment Initiative (SCTAI) was to develop new statewide Career-Technical Assurance Guides (CTAGs) for secondary career-technical institutions using the combined process of the Ohio Board of Regents' CTAG development process with the Ohio Department of Education's Career Field Technical Content Standards development process. The result of this collaboration was a tighter alignment between secondary career-technical and postsecondary content and the development of pathways that encourage college-going and increase statewide postsecondary options for career technical students. For more information on CTAGs and opportunities for statewide postsecondary articulated transfer credit, visit https://student-transfer.ohiohighered.org.

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Career Pathways Definitions

The Transportation Systems Career Field prepares students for careers in in automotive, truck and aviation service and repair.

Air Transportation

Air Transportation program areas will provide students with the necessary technical and academic skills to assist with airframes and power-plants for the aviation industry.

Careers for which this pathway prepares students include:

Aircraft Mechanic
Aircraft Service Technician
Air Traffic Controllers
Avionics Technician
Ground Operations Specialists

Postsecondary majors for which this pathway prepares students include:

Aircraft Pilot (Private)
Aircraft Powerplant Technology/Technician
Airframe Mechanics and Aircraft Maintenance Technology/Technician
Airline/Commercial/Professional Pilot and Flight Crew
Aviation/Airway Management and Operations
Avionics Maintenance Technology/Technician

Ground Transportation

Ground Transportation program areas will provide students with the necessary technical and academic skills to diagnose, repair, service and maintain all types of vehicles and small engines.

Careers for which this pathway prepares students include:

Automotive Service Technician
Collision Repair Technician
Diesel/Truck Service Technicians
Estimator
Front End Technician
Insurance Adjuster
Maintenance and Light Repair(MLR)Technician
Mobile Heavy Equipment Mechanic
Motorcycle Technician
Painter Technician
Parts Manager
Power Sports Technician
Service Writer
Transmission Technician
Warranty Clerk

Postsecondary majors for which this pathway prepares students include:

Autobody/Collision and Repair Technology/Technician
Automobile/Automotive Mechanics Technology/Technician
Automotive Engineering Technology/Technician
Diesel Mechanics Technology/Technician
Heavy/Industrial Equipment Maintenance Technologies, Other
Mechanic and Repair Technologies/Technicians
Medium/Heavy Vehicle and Truck Technology/Technician

Strand/Outcome Pathway Chart

An "X" indicates that the pathway applies to the outcome.

Strand/Outcome	Pathway	
	Air Transportation	Ground Transportation
Strand 1: Business Operations/21st Century Skills page 2		
Outcome 1.1: Employability Skills	X	X
Outcome 1.2: Leadership and Communications	X	X
Outcome 1.3: Business Ethics and Law	X	X
Outcome 1.4: Knowledge Management and Information Technology	X	X
Outcome 1.5: Global Environment	X	X
Outcome 1.6: Business Literacy	X	X
Outcome 1.7: Entrepreneurship/Entrepreneurs	X	X
Outcome 1.8: Operations Management	X	X
Outcome 1.9: Financial Management	X	X
Outcome 1.10: Sales and Marketing	X	X
Outcome 1.11: Principles of Business Economics	X	X
Strand 2: Safety, Tools and Maintenance page 12		
Outcome 2.1: Facility Safety	X	X
Outcome 2.2: Personal Safety	X	X
Outcome 2.3: Tool and Equipment Preventive Maintenance	X	X
Outcome 2.4: General Maintenance	X	X
Strand 3: Engine Adjustments and Repair page 15		
Outcome 3.1: Engine Cylinder Head and Block Assemblies		X
Outcome 3.2: Computerized Engine Controls		X
Outcome 3.3: Ignition System		X
Outcome 3.4: Fuel, Air induction and Exhaust System		X
Outcome 3.5: Lubrication and Cooling Systems		X
Strand 4: Systems Performance page 18		
Outcome 4.1: Hydraulic Brake Systems		X
Outcome 4.2: Drum and Disc		X
Outcome 4.3: Air Brake Systems		X
Outcome 4.4: Antilock Brakes		X
Outcome 4.5: Electrical and Electronic Systems		X

Strand/Outcome	Pathway	
	Air Transportation	Ground Transportation
Outcome 4.6: Batteries		X
Outcome 4.7: Starting and Charging Systems		X
Outcome 4.8: Lighting and Accessories		X
Outcome 4.9: Heating, Ventilation and Air Conditioning Systems		X
Strand 5: Drivetrain page 24		
Outcome 5.1: Automatic Transmission and Transaxle Performance		X
Outcome 5.2: Manual Transmission and Transaxle		X
Outcome 5.3: Clutches		X
Outcome 5.4: Drive Axle Universal and Differentials		X
Outcome 5.5: Steering		X
Outcome 5.6: Suspension		X
Outcome 5.7: Wheel Alignment		X
Outcome 5.8: Wheels and Tires		X
Strand 6: Body and Frames page 28		
Outcome 6.1: Structural		X
Outcome 6.2: Nonstructural		X
Outcome 6.3: Joining and Cutting Metals		X
Outcome 6.4: Plastics and Adhesives		X
Outcome 6.5: Surface Preparation		X
Outcome 6.6: Paint Preparation and Application		X
Strand 7: Aviation and Aeronautics page 33		
Outcome 7.1: Aviation	X	
Outcome 7.2: Basic Electricity Concepts	X	
Outcome 7.3: Drawings	X	
Outcome 7.4: Materials and Processes	X	
Outcome 7.5: Operations and Services	X	
Outcome 7.6: Mathematics and Physical Principles	X	
Outcome 7.7: Power Plant	X	
Outcome 7.8: Airport Environments	X	
Outcome 7.9: Air Traffic Control and Communication	X	
Outcome 7.10: Meteorology	X	
Outcome 7.11: Flight Environment	X	
Outcome 7.12: Aerodynamics	X	

Strand/Outcome	Pathway	
	Air Transportation	Ground Transportation
Outcome 7.13: Performance	X	
Outcome 7.14: Human Factors	X	
Strand 8: Aircraft Systems page 40		
Outcome 8.1: Mechanics	X	
Outcome 8.2: Airframe	X	
Outcome 8.3: Sheet Metal and Non-Metallic Structures	X	
Outcome 8.4: Metal Components	X	
Outcome 8.5: Assembly and Rigging Operations	X	
Outcome 8.6: Landing Gear Systems	X	
Outcome 8.7: Power Systems	X	
Outcome 8.8: Control Systems	X	
Outcome 8.9: Instrument, Communication and Navigation Systems	X	
Outcome 8.10: Fuel Systems	X	
Outcome 8.11: Electrical Systems	X	
Outcome 8.12: Position, Warning and Hazard Control Systems	X	
Outcome 8.13: Engines	X	
Outcome 8.14: Instrument Systems	X	
Outcome 8.15: Fire Protection Systems	X	
Outcome 8.16: Electrical, Ignition and Starting Systems	X	
Outcome 8.17: Lubrication and Cooling Systems	X	
Outcome 8.18: Fuel Systems	X	
Outcome 8.19: Induction and Exhaust System	X	
Outcome 8.20: Propellers	X	
Outcome 8.21: Unducted Fans and Auxiliary Power Units	X	
Total Outcomes by Pathway:	50	43
Total Outcomes:	78	

TRANSPORTATION SYSTEMS

CAREER FIELD
TECHNICAL CONTENT STANDARDS

STRANDS 1-8

Strand 1. Business Operations/21st Century Skills

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

Outcome 1.1. Employability Skills

Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.1.1. Identify the knowledge, skills and abilities necessary to succeed in careers.
1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure and experience.
1.1.3. Develop a career plan that reflects career interests, pathways and secondary and postsecondary options.
1.1.4. Describe the role and function of professional organizations, industry associations and organized labor and use networking techniques to develop and maintain professional relationships.
1.1.5. Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, resumé writing, interviewing skills, portfolio development).
1.1.6. Explain the importance of work ethic, accountability and responsibility and demonstrate associated behaviors in fulfilling personal, community and workplace roles.
1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.
1.1.8. Identify the correlation between emotions, behavior and appearance and manage those to establish and maintain professionalism.
1.1.9. Give and receive constructive feedback to improve work habits.
1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.
1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.
1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits and abusive behavior.

Outcome 1.2. Leadership and Communications

Process, maintain, evaluate and disseminate information in a business. Develop leadership and team building to promote collaboration.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.2.1. Extract relevant, valid information from materials and cite sources of information.
1.2.2. Deliver formal and informal presentations.
1.2.3. Identify and use verbal, nonverbal and active listening skills to communicate effectively.
1.2.4. Use negotiation and conflict-resolution skills to reach solutions.
1.2.5. Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose.
1.2.6. Use proper grammar and expression in all aspects of communication.
1.2.7. Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.
1.2.8. Identify the strengths, weaknesses and characteristics of leadership styles that influence internal and external workplace relationships.
1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g., common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).
1.2.10. Use interpersonal skills to provide group leadership, promote collaboration and work in a team.
1.2.11. Write professional correspondence, documents, job applications and resumés.
1.2.12. Use technical writing skills to complete forms and create reports.
1.2.13. Identify stakeholders and solicit their opinions.
1.2.14. Use motivational strategies to accomplish goals.

Outcome 1.3. Business Ethics and Law

Analyze how professional, ethical and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.3.1. Analyze how regulatory compliance affects business operations and organizational performance.

1.3.2. Follow protocols and practices necessary to maintain a clean, safe and healthy work environment.

1.3.3. Use ethical character traits consistent with workplace standards (e.g., honesty, personal integrity, compassion, justice).

1.3.4. Identify how federal and state consumer protection laws affect products and services.

1.3.5. Access and implement safety compliance measures (e.g., quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], United States Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.

1.3.6. Identify deceptive practices (e.g., bait and switch, identity theft, unlawful door-to-door sales, deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance.

1.3.7. Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g., harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal Employment Opportunity Commission [EEOC]).

1.3.8. Verify compliance with computer and intellectual property laws and regulations.

1.3.9. Identify potential conflicts of interest (e.g., personal gain, project bidding) between personal, organizational and professional ethical standards.

Outcome 1.4. Knowledge Management and Information Technology

Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.4.1. Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems).
1.4.2. Select and use software applications to locate, record, analyze and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines).
1.4.3. Verify compliance with security rules, regulations and codes (e.g., property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to the industry pathway.
1.4.4. Use system hardware to support software applications.
1.4.5. Use information technology tools to maintain, secure and monitor business records.
1.4.6. Use an electronic database to access and create business and technical information.
1.4.7. Use personal information management and productivity applications to optimize assigned tasks (e.g., lists, calendars, address books).
1.4.8. Use electronic media to communicate and follow network etiquette guidelines.

Outcome 1.5. Global Environment

Evaluate how beliefs, values, attitudes and behaviors influence organizational strategies and goals.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.5.1. Describe how cultural understanding, cultural intelligence skills and continual awareness are interdependent.
1.5.2. Describe how cultural intelligence skills influence the overall success and survival of an organization.
1.5.3. Use cultural intelligence to interact with individuals from diverse cultural settings.
1.5.4. Recognize barriers in cross-cultural relationships and implement behavioral adjustments.
1.5.5. Recognize the ways in which bias and discrimination may influence productivity and profitability.
1.5.6. Analyze work tasks for understanding and interpretation from a different cultural perspective.
1.5.7. Use intercultural communication skills to exchange ideas and create meaning.
1.5.8. Identify how multicultural teaming and globalization can foster development of new and improved products and services and recognition of new opportunities.

Outcome 1.6. Business Literacy

Develop foundational skills and knowledge in entrepreneurship, financial literacy and business operations.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.6.1. Identify business opportunities.
1.6.2. Assess the reality of becoming an entrepreneur, including advantages and disadvantages (e.g., risk versus reward, reasons for success and failure).
1.6.3. Explain the importance of planning your business.
1.6.4. Identify types of businesses, ownership and entities (i.e., individual proprietorships, partnerships, corporations, cooperatives, public, private, profit, not-for-profit).
1.6.5. Describe organizational structure, chain of command, the roles and responsibilities of the organizational departments and interdepartmental interactions.
1.6.6. Identify the target market served by the organization, the niche that the organization fills and an outlook of the industry.
1.6.7. Identify the effect of supply and demand on products and services.
1.6.8. Identify the features and benefits that make an organization's product or service competitive.
1.6.9. Explain how the performance of an employee, a department and an organization is assessed.
1.6.10. Describe the impact of globalization on an enterprise or organization.
1.6.11. Describe how all business activities of an organization work within the parameters of a budget.
1.6.12. Describe classifications of employee benefits, rights, deductions and compensations.

Outcome 1.7. Entrepreneurship/Entrepreneurs

Analyze the environment in which a business operates and the economic factors and opportunities associated with self-employment.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.7.1. Compare and contrast the four types of business ownership (i.e., individual proprietorships, partnerships, corporations, cooperatives).
1.7.2. Explain the role of profit as the incentive to entrepreneurs in a market economy.
1.7.3. Identify the factors that contribute to the success and failure of entrepreneurial ventures.
1.7.4. Assess the roles of nonprofit and for-profit businesses.
1.7.5. Develop a business plan.
1.7.6. Describe life cycles of an entrepreneurial business and an entrepreneur.
1.7.7. Create a list of personal strengths, weaknesses, skills and abilities needed to be successful as an entrepreneur.
1.7.8. Explain pathways used to become an entrepreneur.
1.7.9. Conduct a self-assessment to determine entrepreneurial potential.
1.7.10. Describe techniques for obtaining experience (e.g., apprenticeship, co-operative [co-op] education, work placement, internship, job shadowing) related to an entrepreneurial objective.
1.7.11. Identify initial steps in establishing a business (e.g., limited liability company [LLC], tax ID, permits, insurance, licensing).
1.7.12. Identify resources available to entrepreneurs (e.g., Small Business Administration, mentors, information resources, educational opportunities).
1.7.13. Protect intellectual property and knowledge (e.g., copyright, patent, trademark, trade secrets, processes).

Outcome 1.8. Operations Management

Plan, organize and monitor an organization or department to maximize contribution to organizational goals and objectives.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.8.1. Forecast future resources and budgetary needs using financial documents (e.g., balance sheet, demand forecasting, financial ratios).
1.8.2. Select and organize resources to develop a product or a service.
1.8.3. Analyze the performance of organizational activities and reallocate resources to achieve established goals.
1.8.4. Identify alternative actions to take when goals are not met (e.g., changing goals, changing strategies, efficiencies).
1.8.5. Use inventory and control systems to purchase materials, supplies and equipment (e.g., Last In, First Out [LIFO]; First In, First Out [FIFO]; Just in Time [JIT]; LEAN).
1.8.6. Identify the advantages and disadvantages of carrying cost and Just-in-Time (JIT) production systems and the effects of maintaining inventory (e.g., perishable, shrinkage, insurance) on profitability.
1.8.7. Collect information and feedback to help assess the organization's strategic planning and policymaking processes.
1.8.8. Identify routine activities for maintaining business facilities and equipment.
1.8.9. Develop a budget that reflects the strategies and goals of the organization.
1.8.10. Analyze how business management and environmental management systems (e.g., health, safety) contribute to continuous improvement and sustainability.

Outcome 1.9. Financial Management

Use financial tools, strategies and systems to develop, monitor and control the use of financial resources to ensure personal and business financial well-being.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.9.1. Create, analyze and interpret financial documents (e.g., budgets, income statements).
1.9.2. Identify tax obligations.
1.9.3. Review and summarize savings, investment strategies and purchasing options (e.g., cash, lease, finance, stocks, bonds).
1.9.4. Identify credit types and their uses in order to establish credit.
1.9.5. Identify ways to avoid or correct debt problems.
1.9.6. Explain how credit ratings and the criteria lenders use to evaluate repayment capacity affect access to loans.
1.9.7. Review and summarize categories (types) of insurance and identify how insurances can reduce financial risk.
1.9.8. Identify income sources and expenditures.
1.9.9. Compare and contrast different banking services available through financial institutions.
1.9.10. Identify the role of depreciation in tax planning and liability.

Outcome 1.10. Sales and Marketing

Manage pricing, place, promotion, packaging, positioning and public relations to improve quality customer service.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.10.1. Identify how the roles of sales, advertising and public relations contribute to a company's brand.
1.10.2. Determine the customer's needs and identify solutions.
1.10.3. Communicate features, benefits and warranties of a product or service to the customer.
1.10.4. Identify the company policies and procedures for initiating product and service improvements.
1.10.5. Monitor customer expectations and determine product/services satisfaction by using measurement tools.
1.10.6. Discuss the importance of correct pricing to support a product's or service's positioning in the marketing mix.
1.10.7. Describe the importance and diversity of distribution channels (i.e., direct, indirect) to sell a product.
1.10.8. Use promotional techniques to maximize sales revenues (e.g., advertising, sales promotions, publicity, public relations).
1.10.9. Describe how product mix (e.g., product line, product items) maximize sales revenues, market, share and profit margin.
1.10.10. Demonstrate sales techniques.

Outcome 1.11. Principles of Business Economics

Examine and employ economic principles, concepts and policies to accomplish organizational goals and objectives.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

1.11.1. Identify the economic principles that guide geographic location of an industry's facilities (e.g., relative scarcity, price, quantity of products and services).

1.11.2. Identify the difference between monetary and nonmonetary incentives and explain how changes in incentives cause changes in behavior.

1.11.3. Use economic indicators to identify economic trends and conditions (e.g., inflation, interest rate fluctuations, unemployment rates).

1.11.4. Determine how the quality, quantity and pricing of goods and services are affected by domestic and international competition in a market economy.

1.11.5. Analyze factors that affect currency and exchange rates.

1.11.6. Explain how financial markets and government policies influence interest rates (credit ratings/debt ceiling), trade deficits and unemployment.

1.11.7. Describe how economic performance and culture are interdependent.

1.11.8. Identify the relationships between economy, society and environment that lead to sustainability.

1.11.9. Describe how laws and regulations influence domestic and international trade.

Strand 2. Safety, Tools and Maintenance

Learners apply principles of safety and use of tools to maintain equipment and the environment to prevent accidents and mitigate hazards.

Outcome 2.1. Facility Safety

Handle materials, prevent accidents and mitigate hazards.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

2.1.1. Use Occupational Safety and Health Administration (OSHA)-defined procedures for identifying employer and employee responsibilities, situations that require working in confined spaces and safety labeling.
2.1.2. Identify and communicate hazards associated with slippery surfaces and lighting.
2.1.3. Apply inspection, rejection criteria and load-handling practices used with slings and spreaders.
2.1.4. Use American National Standards Institute (ANSI) hand signals and symbols.
2.1.5. Identify the reason to use ground fault interrupter circuits (GFCIs), sources of electrical hazards and established shutdown and lock-out/tag-out procedures.
2.1.6. Identify and eliminate workplace clutter and maintain clearance and boundaries.
2.1.7. Identify symptoms of exposure to health-threatening environments (e.g., temperature; chemical; biological; noise, vibrations, harshness [NVH] hazards).
2.1.8. Identify procedures for handling, storage and disposal of hazardous materials.
2.1.9. Identify the locations of emergency flush showers, eyewash fountains, Material Safety Data Sheets (MSDSs), fire alarms and exits.
2.1.10. Describe the interactions of incompatible substances in measuring and mixing chemicals.
2.1.11. Select and operate fire extinguishers based on the class of fire.
2.1.12. Conduct safety inspection of a workspace.
2.1.13. Identify the types of ergonomic workflow and the need for them.
2.1.14. Inspect air and exhaust systems, intake filters, fans and other mechanical components.

Outcome 2.2. Personal Safety

Practice personal safety.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

2.2.1. Interpret personal safety rights according to the employee Right-to-Know plan.

2.2.2. Describe the risk factors associated with working under the influence of drugs and alcohol and how it increases the risk of accident, lowers productivity, raises insurance costs and reduces profits.

2.2.3. Select, use, maintain and dispose of Personal Protective Equipment (PPE) appropriate to job tasks, conditions and materials.

2.2.4. Identify workplace risk factors associated with repetitive motion and lifting, operating and moving heavy objects.

2.2.5. Demonstrate appropriate body mechanics in lifting and moving heavy objects.

2.2.6. Identify the steps in providing first aid and cardiopulmonary resuscitation (CPR).

Outcome 2.3. Tool and Equipment Preventive Maintenance

Identify, use, clean, maintain and perform planned preventive maintenance on tools and equipment.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

2.3.1. Identify the types of hand tools, power tools and stationary equipment and describe their function.

2.3.2. Identify potential hazards and limitations related to the use of hand tools, power tools and stationary equipment.

2.3.3. Operate power tools and stationary equipment in accordance with established procedures and safety standards.

2.3.4. Ensure the presence and functionality of safety systems and hardware.

2.3.5. Clean, lubricate and adjust power tools and stationary equipment.

2.3.6. Identify, select and maintain fluids and filters.

2.3.7. Inspect and maintain fluid conveyance and storage components (e.g., hoses and lines, valves, nozzles).

2.3.8. Identify the requirements for calibrating metering, monitoring and sensing equipment.

Outcome 2.4. General Maintenance

Provide general maintenance to mechanical systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	X

Competencies

2.4.1. Inspect for leakage at seals, gaskets and bushings.
2.4.2. Inspect fluid levels and fluid conditions on all mechanical systems.
2.4.3. Select engine, powertrain, power steering and brake system fluids based on characteristics and applications.
2.4.4. Describe characteristics of engine fuels and fuel additives.
2.4.5. Perform engine oil and filter change.
2.4.6. Replace fuel filters.
2.4.7. Flush and fill the engine cooling system.
2.4.8. Inspect, service, or replace air filters, filter housings and intake ductwork.
2.4.9. Drain and replace drivetrain fluids and filters.
2.4.10. Flush, fill and bleed the power steering system and replace filters.
2.4.11. Flush, fill and bleed the brake system.
2.4.12. Store mechanical systems fluids and waste products.
2.4.13. Inspect and replace drive belts.
2.4.14. Identify the sources of air conditioner (A/C) system odors.
2.4.15. Inspect and service the battery and battery cables, connectors, clamps and hold downs.
2.4.16. Inspect interior and exterior lamps and sockets.
2.4.17. Verify operation of instrument panel gauges and warning/indicator lights and reset maintenance indicators.
2.4.18. Verify windshield wiper and washer operations, replace wiper blades and refill the washer reservoir (where applicable).
2.4.19. Inspect, repair to industry standards and rotate tires and reset the tire pressure monitor system (TPMS).
2.4.20. Lubricate all suspension and chassis grease fittings and body lubrication points.
2.4.21. Test, inspect and service fifth wheel mounting bolts, air lines and locks.

Strand 3. Engine Adjustments and Repair

Learners apply principles of computerized engine controls, two- and four-stroke cycle combustion, emission controls, cooling systems, cylinder head and block assemblies and lubrication systems to diagnose and repair malfunctions in recreational vehicles, automobiles and medium and heavy equipment.

Outcome 3.1. Engine Cylinder Head and Block Assemblies

Remove, disassemble and repair components in engine cylinder head and block assemblies.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

3.1.1. Describe the physical and mechanical principles of engine operation (i.e., motion, friction, thermodynamics).
3.1.2. Calculate displacement and compare and contrast displacement, horsepower and torque.
3.1.3. Compare and contrast two-cycle and four-cycle engines and their operating principles.
3.1.4. Describe the features, benefits and application of engine types.
3.1.5. Inspect an engine assembly for fuel, oil, coolant and other leaks and determine potential causes.
3.1.6. Diagnose engine noises and vibrations.
3.1.7. Verify the engine operating temperature.
3.1.8. Diagnose causes of excessive oil consumption and unusual exhaust color and sound.
3.1.9. Perform engine tests for vacuum, power balance, compression and leakage.

Outcome 3.2. Computerized Engine Controls

Perform diagnosis and repair of computerized engine controls.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

3.2.1. Retrieve and record stored on-board diagnostics (OBD) trouble codes and clear codes where applicable.

3.2.2. Follow published diagnostic procedures and steps to identify the causes of emissions or drivability concerns resulting from malfunctions in the computerized engine control system with stored diagnostic trouble codes.

3.2.3. Check for module communication errors (e.g., controller area network [CAN], BUS systems).

3.2.4. Inspect and test computerized engine control system sensors, powertrain control modules (PCMs), actuators and circuits.

3.2.5. Diagnose drivability and emissions problems resulting from malfunctions of interrelated systems (e.g., cruise control, security alarms, suspension controls, traction controls, air conditioning, automatic transmissions, non-original equipment manufacturer [OEM]-installed accessories).

Outcome 3.3. Ignition System

Perform ignition system diagnosis and repair.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

3.3.1. Explain basic ignition system theory.

3.3.2. Diagnose and repair ignition system problems (i.e., no starting, hard starting, engine misfire, poor drivability, spark knock, power loss, poor mileage, power loss, emissions concerns) on vehicles with electronic and distributor ignition systems.

3.3.3. Identify causes of cranks but fails to start, hard starting and starts but does not continue to run problems.

3.3.4. Identify causes of surging, rough operation, misfiring, low power, slow deceleration, slow acceleration and shutdown problems.

3.3.5. Inspect and test ignition primary and secondary circuit wiring and solid state components.

3.3.6. Check and adjust ignition system timing and timing advance and retard.

3.3.7. Inspect and test ignition system pickup sensor or triggering devices.

Outcome 3.4. Fuel, Air Induction and Exhaust System

Perform fuel, air induction and exhaust system diagnosis and repair.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

3.4.1. Explain principles of exhaust, intake and turbocharger design and operations.
3.4.2. Identify conditions of hot or cold no starting, hard starting, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling and emissions problems.
3.4.3. Check fuel for contaminants and quality.
3.4.4. Inspect and test fuel pumps and pump control systems for pressure, regulation and volume.
3.4.5. Inspect and test the cold enrichment system and components.
3.4.6. Inspect the throttle body, air induction system, intake manifold and gaskets for vacuum leaks and/or unmetered air.
3.4.7. Inspect and service governor systems.
3.4.8. Explain fuel injection theory.
3.4.9. Inspect and test fuel injectors.
3.4.10. Inspect the integrity of the exhaust manifold, exhaust pipes, mufflers, catalytic converters, resonators, tail pipes and heat shields.
3.4.11. Perform an exhaust system backpressure test.
3.4.12. Evaluate and repair exhaust gas recirculation and exhaust gas treatment systems.
3.4.13. Identify positive crankcase ventilation systems.
3.4.14. Identify the parts and functions of evaporative emissions controls systems.
3.4.15. Check and refill the diesel exhaust fluid (DEF) and service diesel particulate filter (DPF).

Outcome 3.5. Lubrication and Cooling Systems

Inspect lubrication and cooling systems operation.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

3.5.1. Explain principles of engine lubrication and cooling.
3.5.2. Perform lubrication, cooling system and pressure and sensor tests.
3.5.3. Inspect the oil pump gears or rotors, housing, pressure relief devices and pump drive.
3.5.4. Inspect, test and replace the radiator, pressure cap, coolant recovery tank and hoses.
3.5.5. Inspect and replace engine cooling and heater system hoses.
3.5.6. Inspect, test and replace the thermostat and gasket.
3.5.7. Test, drain, flush and refill coolant and bleed the cooling system.
3.5.8. Inspect, remove and replace the water pump.
3.5.9. Inspect and test mechanical and electrical fans, fan clutches, fan shrouds and air dams.

Strand 4. Systems Performance

Learners apply principles of brake systems, electrical and electronic systems and heating, ventilation and air conditioning (HVAC) systems to diagnose and repair malfunctions in on-road recreational vehicles, automobiles and medium and heavy trucks.

Outcome 4.1. Hydraulic Brake Systems

Identify, inspect and replace hydraulic components of brake systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

4.1.1. Identify pressure concerns in the brake system using hydraulic principles (Pascal's Law).
4.1.2. Identify poor stopping, pulling, or dragging concerns caused by malfunctions in the hydraulic system.
4.1.3. Measure brake pedal height and test pedal free play.
4.1.4. Check the master cylinder for internal and external leaks and proper operations.
4.1.5. Remove, bench bleed and reinstall the master cylinder.
4.1.6. Inspect brake lines for damage and wear.
4.1.7. Fabricate and install rigid and flexible fluid lines and fittings.
4.1.8. Identify brake pressure valves.
4.1.9. Check power assist operations (e.g., manifold or auxiliary pump vacuum supply to a vacuum-type power booster).

Outcome 4.2. Drum and Disc

Identify, inspect and replace mechanical components of drum and disc brake systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

4.2.1. Identify poor stopping, noise, vibration, premature wear, pulling, grabbing, dragging, or pedal pulsation concerns.
4.2.2. Remove the caliper assembly; clean; inspect for leaks, pad condition and damage; and replace.
4.2.3. Remove, clean, inspect and measure drums and rotors.
4.2.4. Refinish drums and rotors.
4.2.5. Remove, inspect and replace wheel cylinders.
4.2.6. Remove, clean, inspect and lubricate brake shoes, retaining hardware and adjustment hardware.
4.2.7. Pre-adjust brake shoes, seat the pads and adjust the parking brake system.
4.2.8. Lubricate drum and disc brake assembly components, reinstall and inspect for leaks.
4.2.9. Check the condition and operation of the parking brake and clean, lubricate, or replace as needed.
4.2.10. Check the operation of parking brake indicator light and brake stop light systems.
4.2.11. Inspect and adjust the caliper piston on an integral parking brake system.

Outcome 4.3. Air Brake Systems

Identify, inspect and replace air brake systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

4.3.1. Identify poor stopping, air leaks, premature wear, pulling, grabbing, or dragging problems caused by supply and service system malfunctions.
4.3.2. Inspect and test a tractor protection valve.
4.3.3. Inspect and test emergency (spring) brake control and modulator valves, low pressure warning devices, wiring and connectors.
4.3.4. Inspect and test air pressure gauges, lines and fittings and replace as needed.
4.3.5. Check the air system buildup time.
4.3.6. Drain air reservoir tanks and check for oil, water and foreign material.
4.3.7. Inspect, adjust and align compressor drive belts, pulleys and tensioners.
4.3.8. Inspect, repair, or replace the compressor, air cleaner and air supply, oil supply and coolant lines, fittings and mounting brackets.
4.3.9. Inspect and test system pressure controls (i.e., governor, unloader assembly valves, intake screens, filters, lines, hoses, fittings).
4.3.10. Inspect air system lines, hoses, fittings and couplings.
4.3.11. Inspect and test air tank relief (safety) valves, one-way (single) check valves, two-way (double) check valves and manual and automatic drain valves.
4.3.12. Inspect and clean air drier systems, filters, valves, heaters, wiring and connectors.
4.3.13. Inspect and test air pressure gauges, lines and fittings.
4.3.14. Repair mechanical and foundation brakes.

Outcome 4.4. Antilock Brakes

Identify, inspect and replace antilock brake systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

4.4.1. Identify and inspect antilock brake system (ABS) components.
4.4.2. Identify poor stopping, wheel lock-up, abnormal pedal feel or pulsation and noise concerns caused by the ABS.
4.4.3. Identify ABS braking concerns caused by vehicle modifications (e.g., tire size, curb height, final drive ratio).
4.4.4. Identify ABS electronic controls and components.
4.4.5. Depressurize high-pressure components and bleed front and rear hydraulic circuits.
4.4.6. Re-adjust the caliper piston on an integral parking brake system.
4.4.7. Remove and install ABS electrical and/or electronic and hydraulic components.
4.4.8. Interpret the output signal, resistance charts to voltage/ground and frequency data.
4.4.9. Identify traction control and/or vehicle stability control system components.

Outcome 4.5. Electrical and Electronic Systems

Diagnose the electrical and electronic integrity of series, parallel and series-parallel circuits using principles of electricity (e.g., Ohm's Law, Watt's Law).

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

4.5.1. Interpret wiring diagrams of electrical circuits.
4.5.2. Measure the source voltage and perform voltage drop and current draw tests in electrical and electronic circuits.
4.5.3. Measure current, continuity and resistance.
4.5.4. Identify capacitance and inductance.
4.5.5. Inspect and test switches, connectors, relays, solenoid, solid state devices and wires of electrical and electronic circuits.
4.5.6. Remove and repair or replace terminal connectors.
4.5.7. Perform solder repair of electrical wiring.
4.5.8. Locate shorts, grounds, opens and resistance problems in electrical and electronic circuits.
4.5.9. Measure and diagnose the causes of excessive key-off battery drain (parasitic draw).
4.5.10. Inspect, test and replace or reset fusible links, circuit breakers and fuses.

Outcome 4.6. Batteries

Diagnose and service batteries.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

4.6.1. Identify battery construction and principles of operation.
4.6.2. Test battery performance using state-of-charge and conductance tests and record test results.
4.6.3. Confirm proper battery capacity for vehicle application and perform a battery capacity test.
4.6.4. Maintain or restore electronic memory functions.
4.6.5. Perform a battery charge.
4.6.6. Start a vehicle using jumper cables and a battery or auxiliary power supply using manufacturer's jumping techniques and precautions.
4.6.7. Remove and replace a battery.

Outcome 4.7. Starting and Charging Systems

Identify, inspect and replace starting and charging system components.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

4.7.1. Differentiate between electrical and engine mechanical problems that cause a slow crank or no crank condition.
4.7.2. Inspect, test and replace low and high current side components.
4.7.3. Perform charging system output tests to identify causes of undercharge, no charge and overcharge conditions.
4.7.4. Inspect and adjust or replace alternator drive belts, pulleys and tensioners and check pulley and belt alignment.
4.7.5. Remove, inspect and install an alternator and starter.
4.7.6. Identify the high voltage circuit of electric or hybrid electric vehicles and related safety precautions.

Outcome 4.8. Lighting and Accessories

Identify, inspect and replace electrical and electronic components of lighting systems and accessories.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

4.8.1. Identify the cause of brighter than normal, intermittent, dim, or no light operation.
4.8.2. Inspect, replace and aim headlights and bulbs.
4.8.3. Identify and inspect incorrect turn signal or hazard light operation.
4.8.4. Identify and inspect brake light circuit switches, wiring and connectors.
4.8.5. Identify system voltage and safety precautions associated with high-intensity discharge headlights.
4.8.6. Inspect and test gauges and gauge sending units for causes of abnormal gauge readings.
4.8.7. Identify incorrect horn operation.
4.8.8. Identify incorrect wiper and washer operation and replace.
4.8.9. Identify incorrect operation of motor-driven accessories.
4.8.10. Identify incorrect heated glass, mirror, or seat operation and repair.
4.8.11. Identify incorrect electric lock operation and repair.
4.8.12. Identify airbag supplemental restraint system (SRS) concerns.
4.8.13. Identify safety concerns for disarming and enabling the airbag system for vehicle service.

Outcome 4.9. Heating, Ventilation and Air Conditioning Systems

Diagnose and repair heating, ventilation and air conditioning (HVAC) system components and controls.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

4.9.1. Identify the major components of the HVAC system, their functions and the overall operation of the system.
4.9.2. Perform pressure and leak testing.
4.9.3. Identify air conditioning (A/C) system mufflers, hoses, lines, fittings, O-rings, seals, condenser and service valves.
4.9.4. Handle, identify, recover and store recycled refrigerant.
4.9.5. Evacuate and charge the A/C system.

Strand 5. Drivetrain

Learners apply principles of transmissions and transaxles, manual drivetrains and axles, steering and suspension, drive shafts and wheels to diagnose and repair malfunctions in recreational vehicles, automobiles and medium and heavy equipment to manufacturer's specifications.

Outcome 5.1. Automatic Transmission and Transaxle Performance

Identify, inspect, adjust and replace automatic transmissions and transaxles.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

5.1.1. Research applicable vehicle and service information (e.g., transmission and transaxle system operation, fluid type, vehicle service history, service precautions, technical service bulletins).
5.1.2. Locate and interpret vehicle and major component identification numbers (i.e., vehicle identification number [VIN], vehicle certification labels, calibration decals).
5.1.3. Investigate fluid loss and condition concerns.
5.1.4. Inspect powertrain mounts.
5.1.5. Remove and reinstall the transmission, transaxle and torque converter.
5.1.6. Inspect for leaks on cooler lines and fittings.

Outcome 5.2. Manual Transmission and Transaxle

Diagnose and repair manual transmissions and transaxles.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

5.2.1. Identify the major components of manual transmissions, their function and the overall operation of manual transmissions.
5.2.2. Inspect, test and replace transmission and transaxle sensors and switches.

Outcome 5.3. Clutches

Identify and inspect clutches.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

5.3.1. Identify clutch noise, binding, slippage, pulsation and chatter.
5.3.2. Inspect the clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots and springs.
5.3.3. Inspect the hydraulic clutch slave and master cylinders, lines and hoses.
5.3.4. Inspect and replace the clutch pressure plate assembly and clutch disc.
5.3.5. Bleed the clutch hydraulic system.
5.3.6. Inspect and measure the flywheel runout, crankshaft endplay and ring gear for wear and cracks.
5.3.7. Check and adjust the clutch master cylinder levels and check for leaks.

Outcome 5.4. Drive Axle Universal and Differentials

Identify, inspect and replace drive axle and differential components.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

5.4.1. Identify and inspect drive axle and differential assemblies for noise, vibration and fluid leakage concerns.
5.4.2. Service and replace the shaft, yokes, boots and joints.
5.4.3. Replace drive axle seals, bearings and retainers.
5.4.4. Inspect, adjust and replace drive belts and chains.
5.4.5. Inspect and replace drive axle housing cover plates, gaskets, sealants, vents, plugs and seals.

Outcome 5.5. Steering

Identify steering system components.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

5.5.1. Disable and enable the supplemental restraint system (SRS).
5.5.2. Remove and replace the steering wheel and center and time the SRS coil (clock spring).
5.5.3. Inspect steering shaft universal joints and flexible couplings.
5.5.4. Remove, inspect, replace and adjust the power steering pump belt, power steering pump, power steering pump pulley, hoses and fittings and check pulley and belt alignment.
5.5.5. Inspect and replace the pitman arm, relay rod (centerlink/intermediate), idler arm and mountings and steering linkage damper.
5.5.6. Inspect, replace and adjust tie rod ends (sockets), tie rod sleeves and clamps.

Outcome 5.6. Suspension

Remove, inspect and install front and rear suspension.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

5.6.1. Identify short arm and long arm suspension system components.
5.6.2. Identify strut suspension system components.
5.6.3. Remove, inspect and install upper and lower control arms, bushings, shafts, upper and lower ball joints and rebound bumpers.
5.6.4. Remove, inspect and install strut rods (compression and tension) and bushings.
5.6.5. Remove, inspect and install steering knuckle assemblies.
5.6.6. Remove, inspect and install short arm and long arm suspension system coil springs and spring insulators.
5.6.7. Remove, inspect, install and adjust suspension system torsion bars and stabilizer bar bushings, brackets and links and inspect mounts.
5.6.8. Remove, inspect and install a strut cartridge or assembly, strut coil spring, insulators (silencers) and upper strut bearing mount.
5.6.9. Remove, inspect and install transverse links, control arms, bushings and mounts.
5.6.10. Remove, inspect and install leaf springs, leaf spring insulators (silencers), shackles, brackets, bushings and mounts.
5.6.11. Inspect, remove and replace shock absorbers.

Outcome 5.7. Wheel Alignment

Inspect and adjust wheel alignment.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

5.7.1. Inspect, remove and replace shock absorbers and inspect mounts and bushings.
5.7.2. Replace front and rear wheel bearings.
5.7.3. Identify vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, ride height and steering return concerns.
5.7.4. Check and adjust wheel caster, camber and toe and center the steering wheel.

Outcome 5.8. Wheels and Tires

Identify, inspect and replace wheel and tire components and assemblies.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

5.8.1. Identify tire wear patterns and tire construction.
5.8.2. Identify bearing noises and wheel vibration, shimmy and noise.
5.8.3. Measure wheel, tire, axle and hub runout.
5.8.4. Balance wheel and tire assembly.
5.8.5. Remove, inspect and reinstall the tire and wheel assembly and calibrate the tire pressure monitoring system.
5.8.6. Inspect and replace wheel studs.

Strand 6. Body and Frames

Learners apply principles of vehicle structural and nonstructural components, materials joining and cutting, surface reconstruction and cleaning and preparation and application of coatings and paints.

Outcome 6.1. Structural

Inspect and repair full frame and unibody structural damage.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

6.1.1. Measure the extent of direct and indirect structural damage and the direction of impact.
6.1.2. Identify sideway, twist and diamond frame damage.
6.1.3. Remove and replace damaged structural components.
6.1.4. Identify and analyze misaligned steering, suspension and powertrain components that can cause vibration, steering and wheel alignment problems.
6.1.5. Straighten and align the cowl assembly, roof rails and headers and hinge and lock pillars.
6.1.6. Straighten and align vehicle openings, floor pans and rocker panels.
6.1.7. Straighten and align quarter panels, wheelhouse assemblies and rear body sections.
6.1.8. Straighten and align front end sections.

Outcome 6.2. Nonstructural

Analyze and repair damage to nonstructural components.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

6.2.1. Determine the extent of the direct and indirect damage and the direction of impact.
6.2.2. Inspect, remove, label, store and replace exterior and interior trim, moldings, nonstructural body panels, door panels and components.
6.2.3. Inspect, remove, store and replace damaged vehicle mechanical and electrical components.
6.2.4. Protect panels, glass and parts adjacent to the repair area.
6.2.5. Remove corrosion protection, undercoatings, sealers and other protective coatings necessary to perform repairs.
6.2.6. Inspect, adjust and repair or replace window regulators, run channels, glass, power mechanisms and related controls.
6.2.7. Remove and reinstall or replace fixed glass (heated and non-heated) and modular glass.
6.2.8. Inspect and repair water leaks, dust leaks and wind noises and inspect, repair and replace weather stripping.
6.2.9. Inspect, adjust and repair or replace removable, manual or power-operated roof panel and hinges, latches, guides, handles and sunroof retainer and controls.
6.2.10. Inspect, remove, reinstall and align convertible top and related mechanisms.

Outcome 6.3. Joining and Cutting Metals

Join and cut aluminum, high-strength steel and other steels.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

6.3.1. Determine the correct welder type and wire diameter and gas to be used in a specific welding situation.
6.3.2. Set up and adjust the welder required for the material being welded.
6.3.3. Store, handle and install high pressure gas cylinders.
6.3.4. Protect panels, glass and vehicle interior adjacent to welding and cutting operations.
6.3.5. Protect computers and other electronic control modules during welding procedures.
6.3.6. Clean, prepare, align and secure the metal to be welded.
6.3.7. Determine the joint and weld type.
6.3.8. Perform continuous, stitch, tack, plug, butt and pinch welds with and without backing and fillet welds.
6.3.9. Perform a visual test on each weld type and causes of defects.
6.3.10. Perform cutting processes (e.g., mechanical, electrical, gas) with different materials and body or frame locations.
6.3.11. Attach nonstructural components through riveting and adhesives.

Outcome 6.4. Plastics and Adhesives

Replace or repair plastic components and adhesives.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

6.4.1. Identify types of plastics, determine their repairability and identify repair procedures.
6.4.2. Clean and prepare the surface of plastic parts.
6.4.3. Replace rigid, semi-rigid and flexible plastic panels.
6.4.4. Replace bonded and non-bonded rigid exterior composite body panels and straighten or align panel supports.
6.4.5. Inspect, remove and replace repairable plastics and other components that are recommended for off-vehicle repair.

Outcome 6.5. Surface Preparation

Remove paint and coatings and prepare surfaces for refinishing.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

6.5.1. Remove paint from the damaged area of a body panel.
6.5.2. Locate and reduce surface irregularities on a damaged body panel.
6.5.3. Heat shrink stretched panel areas to proper contour.
6.5.4. Cold shrink stretched panel areas to proper contour.
6.5.5. Mix and apply body filler, apply body and finishing fillers and shape during curing.
6.5.6. Rough sand cured body filler to contour and finish sand.
6.5.7. Inspect, remove, label, store and replace exterior trim and components necessary for proper surface preparation.
6.5.8. Inspect and identify substrate, type of finish, surface condition and film thickness.
6.5.9. Dry sand or wet sand and featheredge damaged areas.
6.5.10. Apply suitable metal treatment or primer.
6.5.11. Mask and protect other areas that will not be refinished.
6.5.12. Select, mix and apply primers and primer surfacers/sealers.
6.5.13. Remove dust and clean areas to be refinished.
6.5.14. Apply stone chip and corrosion-resistant coatings, caulking and seam sealers to repaired areas.

Outcome 6.6. Paint Preparation and Application

Mix, match, apply and identify defects in paint.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
	X

Competencies

6.6.1. Determine the type and color of paint already on the vehicle by the manufacturer's vehicle information label.

6.6.2. Identify and mix paint and tint colors using a formula to achieve a blendable match and identify poor hiding colors.

6.6.3. Shake, stir, reduce, catalyze or activate and strain paint.

6.6.4. Apply selected products on a test and letdown panel to check for color match.

6.6.5. Apply single stage, top coat, base coat and clear coat.

6.6.6. Denib, buff and polish finishes.

6.6.7. Apply multistage coats for panel blending and overall refinishing.

6.6.8. Identify and determine the cause of paint defects (e.g., blistering, blushing, dry spray appearance, fish eyes, lifting, clouding, orange peel, overspray, solvent popping sags, sanding marks, contour mapping, color difference, tape tracking, low gloss, poor adhesion, cracking, corrosion, airborne contaminants, water spotting, die-back, chalking, bleed-though, pin-holing, buffing-related imperfections, pigment flotation) and correct.

6.6.9. Measure mil thickness.

Strand 7. Aviation and Aeronautics

The learner applies principles of aerodynamics environment, meteorology, electricity, schematics, materials and processes to perform ground operations, traffic control functions and communications.

Outcome 7.1. Aviation

Describe the air transportation industry.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.1.1. Trace air technology from its inception to the current industry, including future trends.
7.1.2. Describe the major contributors and barriers to air transportation development.
7.1.3. Identify the elements of the industry that contribute to the movement of people and goods.
7.1.4. Describe the major legislative acts that have impacted aviation.
7.1.5. Describe the Federal Aviation Administration (FAA) primary use categories.
7.1.6. Describe the functions of the major categories of aircraft.
7.1.7. Describe the function of the fixed base operator and its role in general aviation.
7.1.8. Distinguish general aviation from commercial aviation.
7.1.9. Describe the military and commercial uses of helicopters.
7.1.10. Describe the space environment including solar and planetary objects, gravity, atmosphere and vacuum.
7.1.11. Describe manned and unmanned space exploration and the contribution to aviation technology.

Outcome 7.2. Basic Electricity Concepts

Assess basic electricity.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.2.1. Calculate and measure capacitance and inductance.
7.2.2. Calculate and measure electrical power.
7.2.3. Measure voltage, current, resistance and continuity.
7.2.4. Determine the relationship between voltage, current and resistance in electrical circuits.
7.2.5. Read and interpret aircraft electrical circuit diagrams (e.g., solid state devices and logic functions).
7.2.6. Inspect and service batteries.

Outcome 7.3. Drawings

Utilize aircraft drawings.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.3.1. Use aircraft drawings, symbols and system schematics.
7.3.2. Draw sketches of repairs and alterations.
7.3.3. Use blueprint information.
7.3.4. Use graphs and charts.

Outcome 7.4. Materials and Processes

Evaluate materials and processes.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.4.1. Identify and select appropriate nondestructive testing methods.
7.4.2. Perform dye penetrant, eddy current, ultrasonic and magnetic particle inspections.
7.4.3. Perform basic heat treating processes.
7.4.4. Identify and select aircraft hardware and materials.
7.4.5. Inspect and check welds.
7.4.6. Perform precision measurements.

Outcome 7.5. Operations and Services

Perform ground operations and services.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.5.1. Weigh aircraft.
7.5.2. Perform a complete weight and balance check and record data.
7.5.3. Start, ground operate, move, service and secure aircraft and identify typical ground operation hazards.
7.5.4. Identify and select fuels.
7.5.5. Identify and select cleaning materials.
7.5.6. Inspect, identify, remove and treat aircraft corrosion and perform aircraft cleaning.

Outcome 7.6. Mathematics and Physical Principles

Apply mathematics concepts and physical principles.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.6.1. Extract roots and raise numbers to a given power.
7.6.2. Determine the area and volume of geometrical shapes.
7.6.3. Solve ratio, proportion and percentage problems.
7.6.4. Perform algebraic operations involving the addition, subtraction, multiplication and division of positive and negative numbers.
7.6.5. Apply the principles of simple machines; sound, fluid and heat dynamics; basic aerodynamics; aircraft structure; and theory of flight.
7.6.6. Employ the principles of simple machines.

Outcome 7.7. Power Plant

Describe power plant and airframe related systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.7.1. Identify the major types of aircraft engines.
7.7.2. Describe the types of fuel and oil systems.
7.7.3. Describe how the cooling system functions.
7.7.4. Describe how the exhaust system functions.
7.7.5. Identify major components of the electrical system.
7.7.6. Describe the function of the aircraft hydraulic system.
7.7.7. Identify the major types of landing gears and explain how they function.

Outcome 7.8. Airport Environments

Identify airport environments.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.8.1. Identify the different types of airports within the United States.
7.8.2. Distinguish between controlled and non-towered airports.
7.8.3. Identify features of airports and directional traffic patterns and interpret runway markings.
7.8.4. Identify lighting systems and explain their function.
7.8.5. Determine wind direction and speed with and without instruments.
7.8.6. Describe noise abatement strategies and procedures.

Outcome 7.9. Air Traffic Control and Communication

Identify, describe and apply concepts of air traffic control and communication.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.9.1. Describe the principles of radar.
7.9.2. Describe the components of secondary radar.
7.9.3. Control airplane departure, arrivals and ground operations from an airport tower.
7.9.4. Sequence airplane approaches and departures with approach control radar.
7.9.5. Interpret weather for departures and arrivals using automatic terminal information system (ATIS) and traffic collision avoidance system (TCAS) equipment.
7.9.6. Define the very high frequency (VHF) and ultra high frequency (UHF) radio bands.
7.9.7. Describe the use of radio phraseology and light signals.
7.9.8. Interpret standard instrument approach procedures (approach plates) and standard instrument departures and arrivals.
7.9.9. Describe the Federal Aviation Administration (FAA) philosophy on the Next Generation Air Transportation System (NextGen).

Outcome 7.10. Meteorology

Identify and describe concepts of meteorology.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.10.1. Identify the atmospheric elements and regions.
7.10.2. Describe how atmospheric properties of pressure, condensation, evaporation, precipitation and humidity affect atmospheric conditions.
7.10.3. Describe how heat transfer and balance affect weather.
7.10.4. Describe the effects of gravity, friction and centripetal force on wind.
7.10.5. Explain the causes of atmospheric circulation.
7.10.6. Identify wind patterns based on weather systems.
7.10.7. Describe factors related to stability (e.g., clouds, fronts, air masses, precipitation).
7.10.8. Describe the causes and effects of temperature inversions.
7.10.9. Describe cycles of moisture.
7.10.10. Describe the types, conditions and factors of turbulence.
7.10.11. Describe the types and impact of thunderstorms, tornados and hurricanes.
7.10.12. Define wind shear.
7.10.13. Describe the types of icing and their effect on aviation.
7.10.14. Locate, interpret and use preflight and inflight weather and hazard information.

Outcome 7.11. Flight Environment

Define, determine and navigate aspects of the flight environment.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.11.1. Define and differentiate visual flight rules (VFR) and instrument flight rules (IFR).
7.11.2. Determine right of way and describe minimum safe altitude rules.
7.11.3. Locate positions using latitude, longitude and prime meridian.
7.11.4. Interpret sectional, terminal and world aeronautical charts for navigational aids, elevations and topographical information.
7.11.5. Navigate from point A to point B using the very high frequency (VHF) omnidirectional range (VOR) navigation system.
7.11.6. Navigate from point A to point B using range navigation (RNAV) systems.
7.11.7. Navigate from point A to point B using global positioning systems (GPS).
7.11.8. Read flight instruments and describe their functions.
7.11.9. Describe variation, deviation and magnetic dip.
7.11.10. Describe the classes of airspace and the respective airspeed limitations for airspace.
7.11.11. Distinguish federal and special use from other airways.

Outcome 7.12. Aerodynamics

Describe and define aerodynamics based on scientific concepts.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.12.1. Compare and contrast aeronautics and aerodynamics.
7.12.2. Describe the forces of flight and the three axes of motion.
7.12.3. Define Newton's Laws of Motion and Bernoulli's Principle.
7.12.4. Identify the parts of an airfoil and describe how an airfoil works.
7.12.5. Identify wing designs and their properties and how they affect flight performance.
7.12.6. Discuss the role of thrust and the relationship between lift and drag.
7.12.7. Describe lateral and directional stability and the parts of the aircraft that control the airplane.
7.12.8. Describe how the distribution of weight affects center of gravity (CG).
7.12.9. Demonstrate how to load and balance an aircraft.
7.12.10. Describe the design and power features that affect aircraft stability.
7.12.11. Describe the purpose of the vertical and horizontal stabilizers and demonstrate how they affect the path of an airplane.
7.12.12. Identify the effects of torque (P-factor).
7.12.13. Describe the effects of gyroscopic precession.
7.12.14. Describe the effects of asymmetrical thrust on flight.
7.12.15. Describe the effect of drag and lift on glide.
7.12.16. Define load factor and G-forces.

Outcome 7.13. Performance

Compare and contrast spin and stall, takeoff and landing and climb and cruise.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.13.1. Describe the types and phases of spins and stalls and recovery.
7.13.2. Identify the factors of takeoff and landing performance.
7.13.3. Describe the factors of climb and cruise performance.
7.13.4. Identify the features of the mechanical flight computer and their functions.
7.13.5. Identify hazardous attitudes of flight.

Outcome 7.14. Human Factors

Describe the impact of aviation and flight environment.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

7.14.1. Identify flight problems associated with aviation physiology.
7.14.2. Describe the effects of hypoxia and carbon monoxide.
7.14.3. Identify the rules of supplemental oxygen.
7.14.4. Describe the decision making process in flight.
7.14.5. Break the chain of poor judgment.
7.14.6. Describe the extent of human factors in aircraft accidents.
7.14.7. Describe the impact of cockpit standardization on accident prevention.
7.14.8. Describe the impact of cockpit automation on human error.
7.14.9. Describe the role of the National Transportation Safety Board (NTSB) in accident investigations.

Strand 8. Aircraft Systems

Learners apply physical principles and mathematics concepts to the inspection and repair of aircraft systems.

Outcome 8.1. Mechanics

Exercise and explain privileges and limitations.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.1.1. Exercise mechanics' privileges within the limitations prescribed by Part 65 of Federal Aviation Regulations (FAR) 148 (3).

8.1.2. Explain the knowledge, skill, experience and requirements to exercise the privileges of the aviation mechanic.

Outcome 8.2. Airframe

Maintain airframe structures.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.2.1. Service and repair wood structures.
8.2.2. Identify wood defects.
8.2.3. Inspect wood structures.
8.2.4. Select and apply fabric.
8.2.5. Inspect, test and repair fabric and fiberglass.
8.2.6. Demonstrate proper surface preparation.
8.2.7. Apply trim, letters and touch up paint.
8.2.8. Identify and select aircraft finishing materials.
8.2.9. Apply finishing materials.
8.2.10. Inspect finishes and identify defects.
8.2.11. Perform airframe conformity and airworthiness inspections.

Outcome 8.3. Sheet Metal and Non-Metallic Structures

Evaluate and repair sheet metal and non-metallic structures.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.3.1. Select, install and remove special fasteners for metallic bonded and composite structures.
8.3.2. Inspect bonded structures.
8.3.3. Inspect, test and repair fiberglass, plastics, honeycomb, composite and laminated primary and secondary structures.
8.3.4. Inspect, check, service and repair windows, doors and interior furnishings.
8.3.5. Inspect and repair sheet metal structures.
8.3.6. Install conventional rivets.
8.3.7. Form, lay out and bend sheet metals.

Outcome 8.4. Metal Components

Join airframe metal components.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.4.1. Weld magnesium and titanium.
8.4.2. Solder stainless steel.
8.4.3. Fabricate tubular structures.
8.4.4. Solder, braze, gas weld and arc weld steel.
8.4.5. Weld aluminum and stainless steel.

Outcome 8.5. Assembly and Rigging Operations

Demonstrate assembly and rigging operations.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.5.1. Rig rotary wing aircraft.
8.5.2. Rig fixed wing aircraft.
8.5.3. Check alignment of structures.
8.5.4. Assemble aircraft components (e.g., flight control surfaces).
8.5.5. Balance, rig and inspect movable primary and secondary flight control surfaces.
8.5.6. Jack aircraft.

Outcome 8.6. Landing Gear Systems

Evaluate and repair aircraft landing gear systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.6.1. Inspect and check landing gear, retraction systems, shock struts, brakes, wheels, tires and steering systems.
8.6.2. Service and repair landing gear, retraction systems, shock struts, brakes, wheels, tires and steering systems.

Outcome 8.7. Power Systems

Evaluate and repair hydraulic and pneumatic power systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.7.1. Fabricate and install rigid and flexible fluid lines and fittings.
8.7.2. Repair hydraulic and pneumatic power systems components.
8.7.3. Identify and select hydraulic fluids.
8.7.4. Inspect, check, service, troubleshoot and repair hydraulic and pneumatic power systems.

Outcome 8.8. Control Systems

Evaluate and service cabin atmosphere.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.8.1. Inspect, check, troubleshoot, service and repair heating, cooling, air conditioning and pressurization systems and air cycle machines.

8.8.2. Inspect, check, troubleshoot, service and repair heating, cooling, air conditioning and pressurization systems.

8.8.3. Inspect, check, troubleshoot, service and repair oxygen systems.

8.8.4. Identify the basic cabin atmosphere principles and components.

Outcome 8.9. Instrument, Communication and Navigation Systems

Evaluate and service instrument, communication and navigation systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.9.1. Inspect, check, service, troubleshoot and repair electronic flight instrument systems and both mechanical and electrical heading, speed, altitude, temperature, pressure and position indicating systems and built-in test equipment.

8.9.2. Install instruments and perform a static pressure system leak test.

8.9.3. Explain mechanics' privileges and limitations associated with aircraft instrument systems.

8.9.4. Inspect, check and troubleshoot autopilot, servos and approach coupling systems.

8.9.5. Inspect, check and service aircraft electronic communication and navigation systems (e.g., very high frequency [VHF] passenger address interphones and static discharge devices, aircraft VHF omnidirectional range navigation system [VOR], instrument landing system [ILS], long-range aid to navigation [LORAN], radar beacon transponders, flight management computers, ground proximity warning systems [GPWS], global positioning systems [GPS]).

8.9.6. Inspect and repair antenna and electronic equipment installations.

Outcome 8.10. Fuel Systems

Evaluate and service airframe fuel systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.10.1. Check and service fuel dump systems.
8.10.2. Perform fuel management transfer and defueling.
8.10.3. Inspect, check and repair pressure fueling systems.
8.10.4. Repair aircraft fuel system components.
8.10.5. Inspect and repair fluid quantity indicating systems.
8.10.6. Troubleshoot, service and repair fluid pressure and temperature warning system.
8.10.7. Inspect, check, service, troubleshoot and repair aircraft fuel systems.

Outcome 8.11. Electrical Systems

Evaluate and service airframe electrical systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.11.1. Repair and inspect aircraft electrical system components, crimp and splice wiring to manufacturer's specifications and repair pins and sockets of aircraft connectors.
8.11.2. Install, check and service airframe electrical wiring, controls, switches, indicators and protective devices.
8.11.3. Inspect, check, troubleshoot, service and repair alternating current (AC) and direct current (DC) electrical systems.
8.11.4. Inspect, check and troubleshoot constant speed and integrated speed drive generators.

Outcome 8.12. Position, Warning and Hazard Control Systems

Evaluate and service position, warning and hazard control systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.12.1. Inspect, check and service speed and configuration warning systems, electrical brake controls and antiskid systems.
8.12.2. Inspect, check, troubleshoot and service landing gear position indicator and warning systems.
8.12.3. Inspect, check and troubleshoot airframe ice and rain control systems.
8.12.4. Service and repair airframe ice and rain control systems.
8.12.5. Describe operations of typical anti-icing and de-icing systems.
8.12.6. Demonstrate preventive maintenance for typical anti-icing and de-icing systems.
8.12.7. Inspect, check and service smoke and carbon monoxide detection systems.
8.12.8. Inspect, check, service, troubleshoot and repair aircraft fire detection and extinguishing systems.

Outcome 8.13. Engines

Evaluate and service reciprocating, radial and turbine engines.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.13.1. Inspect and repair radial engines.
8.13.2. Overhaul reciprocating engines.
8.13.3. Inspect, check, service and repair reciprocating engines and engine installations.
8.13.4. Install, troubleshoot and remove reciprocating engines.
8.13.5. Explain turbine engine theory (e.g., propulsion, turbo prop, turbo jet, turbo fan).
8.13.6. Overhaul a turbine engine.
8.13.7. Inspect, check, service and repair turbine engines and turbine engine installations.
8.13.8. Install, troubleshoot and remove turbine engines.
8.13.9. Perform power plant conformity and airworthiness inspections.

Outcome 8.14. Instrument Systems

Evaluate and service engine instrument systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.14.1. Troubleshoot, service and repair electrical and mechanical fluid rate-of-flow indicating systems.

8.14.2. Inspect, check, service, troubleshoot and repair electrical and mechanical engine temperature, pressure and revolutions per minute (rpm) indicating systems.

8.14.3. Explain mechanics' privileges and limitations associated with engine instrument systems.

Outcome 8.15. Fire Protection Systems

Evaluate and service engine fire protection systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.15.1. Inspect and check engine fire detection and extinguishing systems.

8.15.2. Service, troubleshoot and repair engine fire detection and extinguishing systems.

Outcome 8.16. Electrical, Ignition and Starting Systems

Evaluate and service engine electrical, ignition and starting systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.16.1. Repair engine electrical system components.

8.16.2. Install, check and service engine electrical wiring, controls, switches, indicators and protective devices.

8.16.3. Explain ignition and starting systems theory.

8.16.4. Overhaul a magneto and ignition harness.

8.16.5. Inspect, service, troubleshoot and repair reciprocating and turbine engine ignition systems and components.

8.16.6. Inspect, service, troubleshoot and repair turbine engine electrical starting systems.

8.16.7. Inspect, service and troubleshoot turbine engine pneumatic starting systems.

Outcome 8.17. Lubrication and Cooling Systems

Evaluate and service lubrication and cooling systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.17.1. Identify and select lubricants.
8.17.2. Repair engine lubrication system components.
8.17.3. Inspect, check, service, troubleshoot and repair engine lubrication systems.
8.17.4. Repair engine cooling system components.
8.17.5. Inspect, check, troubleshoot, service and repair engine cooling systems.

Outcome 8.18. Fuel Systems

Evaluate and service fuel metering and engine fuel systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.18.1. Describe fuel metering system theory.
8.18.2. Troubleshoot and adjust turbine engine fuel metering systems and electronic engine fuel controls.
8.18.3. Overhaul carburetors.
8.18.4. Repair engine fuel metering system components.
8.18.5. Inspect, check, service, troubleshoot and repair reciprocating and turbine engine fuel metering systems.
8.18.6. Describe engine fuel system theory.
8.18.7. Repair engine fuel system components.
8.18.8. Inspect, check, service, troubleshoot and repair engine fuel systems.

Outcome 8.19. Induction and Exhaust Systems

Evaluate and service induction and exhaust systems.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.19.1. Describe induction and engine airflow system theory.
8.19.2. Inspect, check, troubleshoot, service and repair engine ice and rain control systems.
8.19.3. Inspect, check, service, troubleshoot and repair heat exchangers, superchargers and turbine engine airflow and temperature control systems.
8.19.4. Inspect, check, service and repair carburetor air intake and induction manifolds.
8.19.5. Inspect, check, troubleshoot, service and repair engine exhaust systems.
8.19.6. Troubleshoot and repair engine thrust reverser systems and related components.

Outcome 8.20. Propellers

Evaluate and service propellers.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.20.1. Describe propeller theory and operation.
8.20.2. Inspect, check, service and repair propeller synchronizing and ice control systems.
8.20.3. Identify and select propeller lubricants.
8.20.4. Balance propellers.
8.20.5. Repair propeller control system components.
8.20.6. Inspect, check, service and repair fixed-pitch, constant-speed feathering propellers and propeller governing systems.
8.20.7. Install, troubleshoot and remove propellers.
8.20.8. Repair aluminum alloy propeller blades.

Outcome 8.21. Unducted Fans and Auxiliary Power Units

Evaluate and service unducted fans and auxiliary power units.

An "X" indicates that the pathway applies to the outcome.

Air Transportation	Ground Transportation
X	

Competencies

8.21.1. Inspect and troubleshoot unducted fan systems and components.
8.21.2. Inspect, check, service and troubleshoot turbine-driven auxiliary power units.