

WHITE PAPER

COMPETENCY BASED EDUCATION IN PART 147
AVIATION MAINTENANCE TECHNICIAN SCHOOLS

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INTRODUCTION

The purpose of this white paper is to identify recent and impending changes in aviation maintenance training that may require new approaches to technician training and related activities. This paper will identify how competency based education is conducted in current educational models. It will then identify the elements needed to apply these concepts to existing maintenance training programs and Federal Aviation Administration (FAA)/aviation maintenance technician schools (AMTSs). The goal is to show how a competency based education system can be a viable method to maintain or improve maintenance training and newly certificated aviation technician competencies.

This paper is a precursor to major regulatory proposals. It will suggest language and approaches adaptable to aviation maintenance training incorporating a competency based model. The approaches suggested will focus on incorporating competency based education techniques, training and education, and appropriate use of new maintenance training techniques. Methods of incorporating the use of specific competencies as a measure for course completion, rather than “seat time” will be the primary focus.

This paper was prepared by the Aviation Technician Education Council for the Flight Standards Service – Aircraft Maintenance Division Manager – Timothy W. Shaver with limited consultation with the staff of that division. As such I take full responsibility for the paper’s content. Accordingly, this document does NOT represent official FAA policy or proposals for policy change. The purpose is to stimulate responsible discussion within the aviation community regarding the need for improved approaches to maintenance training.

I invite interested parties to comment on this paper. Write to the address on the cover or email dyenf@brcc.edu or atec@atec-amt.org.

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BACKGROUND

The vast majority of initial aviation maintenance training in the United States is conducted by Aviation Maintenance Technician Schools (AMTSs) certificated by the Federal Aviation Administration (FAA) in accordance with 14 Code of Federal Regulations (CFR) Part 147. Unlike pilot training which can be conducted under either 14 CFR Part 61 by an individual flight instructor or flight school or Part 141 by an FAA-approved Flight School, there is no other viable mechanism for an educational entity to conduct aviation maintenance training. Under the existing part 147 regulations, current maintenance training is tied to a rigidly enforced accounting of student attendance with consideration for student competency left to the integrity of the individual AMTS.

The need for aviation maintenance technicians (AMTs) is rapidly increasing and there is a need to provide as many as 609,000 AMTs over the next 20 years. Given the high cost of certification, new aviation maintenance schools are unlikely to be certificated in the near future, and ramping up the existing schools to meet this anticipated demand is unlikely without incorporating attractive cost-effective measures such as competency based education (CBE) and distance education (DE). For years the aviation industry has lamented the perceived poor preparation of AMTS graduates. Additionally, the AMTS have complained about the micromanagement by FAA Principal Maintenance Inspectors (PMIs) and Principal Avionics Inspectors (PAIs) that spend the majority of their surveillance time checking and cross-checking attendance records.

The common denominator in all these changes is the need to have an adaptable aviation maintenance training system that will not only maintain but greatly improve the competency of the initial AMTS graduate. To accomplish this challenging goal, it is necessary to examine maintenance training in the context of both the current time-based philosophy as well as emerging changes in system educational philosophy. Modernized approaches to aviation maintenance training systems, policies, and procedures can then be examined and a mitigation strategy devised.

THE CURRENT REGULATORY AND SYSTEM ENVIRONMENT FOR MAINTENANCE TRAINING

Competency-Based Training: Training delivered and evaluated based upon the amount of training each individual needs to achieve “mastery” of required tasks. Competency may be achieved at different rates for different people and the amount of elapsed time between training events that competency is maintained also varies individually and must be considered. Competency-based training varies from prescriptive training in that it recognizes that one size cannot fit all.

Train to Proficiency: Train to proficiency provides for the variations of individual learning rates. It allows for additional exposure to task until the mechanic is proficient and competency is achieved.

Data Collection and Feedback: Data collection and analysis assesses the skill and knowledge of the individual and crew and monitors the health of the training program. The data element provides a continuous feedback loop allowing for rapid adjustments when performance indicators warrant action and, in conjunction with other factors, helps determine the correct intervals between training events.

CHAPTER 10. PERSONNEL TRAINING

(Source: FAA Advisory Circular 120-16F, dated 11/15/2012)

10-3. INITIAL TRAINING. You should provide initial training right after you hire an employee, or when your existing employees begin to work on new equipment or a new assignment. Your initial training program may include subjects such as employee indoctrination or orientation, maintenance department policies and procedures, maintenance recordkeeping and documentation, aircraft systems or ground equipment, specific skills (for example, avionics, composite repair, aircraft run-up and taxi), skills upgrade, human factors, task-specific training, hazmat, or Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA) regulations familiarization. Your initial training should also include a competence-based assessment of employees. This evaluates an employee’s previous training and experience and helps identify his or her specific individual training needs. The objective is to provide training that addresses the gap between required competence and the competence an individual already has.

10-4. RECURRENT TRAINING. Recurrent training is education occurring on a repetitive basis. You must provide maintenance personnel with the information and skills necessary to maintain your standard of competence. This training also accommodates the introduction of new aircraft; aircraft modifications; new or different ground equipment; new procedures, techniques, and methods; or other new information. Your recurrent training, although occurring on a repetitive basis, may not adhere to a defined schedule. You should not provide repetitive information in recurrent training unless it is needed to maintain the desired degree of competence. Your recurrent training may include:

- Continuing competency training designed to maintain regulatory and certificate currency requirements.
- Refresher training on a seldom-accomplished task or seldom-used skill.
- Update training for particular tasks or skills. Update training can include training bulletins, bulletin board items, self-study tasks, and computer-based instruction (CBI).
- Any other continuing education or training that may not be provided on a defined schedule.

10-5. SPECIALIZED TRAINING. Your specialized training should focus on competence in specific tasks or areas of responsibility, such as RII, borescope, nondestructive testing, or flight control rigging. You might provide this training with initial or recurrent training. You do not need to limit it to maintenance subjects, but instead may include management skills training for new supervisors, computer skills, or other training necessary because of a change in an individual's duties and responsibilities.

10-6. MAINTENANCE PROVIDER TRAINING. Your training program must provide appropriate information to each employee of a maintenance provider about your specific program. The training should include function-specific training appropriate to each person's job assignment or area of responsibility. You do not need to provide training to maintenance provider personnel in areas that do not concern them. For example, training on aircraft log procedures and minimum equipment list (MEL) procedures would not be required for aircraft interior cleaners, but would be required for maintenance personnel assigned to on call maintenance for you.

NOTE: If your maintenance provider has specific types of training for its personnel, you do not need to duplicate that training for those individuals. However, you must ensure your maintenance provider actually has provided the training and that the training meets your own needs and training standards. This could be a CASS work-in-progress audit.

10-7. COMPETENCY-BASED TRAINING. Although air carriers historically have provided a specified number of maintenance training hours to ensure employees have the competencies needed for their jobs, studies have shown that it may be better for you to train to a competency-based standard. You do not have to perform this type of training on a defined schedule or for a specific number of hours. Rather, you should test each individual to evaluate what training he or she needs, and then use these evaluations to identify those personnel who retain a high level of subject competence and who may not require a particular block of instruction. Conversely, you also should identify those individuals who require more training. Training to competence permits you to tailor training programs to the specific requirements of your individual maintenance personnel and maintenance providers.

- a. When to Require Competency-Based Training.** You could use competency-based training to raise an employee's level of competence to that level required by the individual's duties and responsibilities. You should have procedures to determine when an individual requires competency-based training. You may determine the need for this type of training through pre- or post-employment testing, or through the

analysis and corrective action functions of your CASS. If you use competency-based training, it should specifically address the lack of competence. In some instances, competency-based training may consist of an appropriately knowledgeable person simply reviewing procedures with an employee through on-the-job training (OJT). You should design competency-based training to fix an immediate knowledge or skill deficiency and training in your initial or recurrent training requirements.

- b. Competency Deficiencies.** For those circumstances where you identify a competency deficiency through investigation of an event, your competency-based training should show an individual what happened, why it happened, and demonstrate, in a positive manner, how to prevent it from happening again.
- c. Competency Improvement Training.** You should orient your competency improvement training toward correcting personnel competence deficiencies that you have identified through your CASS.

EMERGING CHANGES IN COMPETENCY BASED EDUCATIONAL PHILOSOPHY

Credit hours are an educational method of quantifying an amount of learning for the purpose of charging a monetary fee. A credit is not only an instructional hour, but an amount of learning within that allotted time frame. If a student does not reach the required amount of learning (competency) within the allotted time frame the student does not earn the credit, regardless of the hours. This holds true in any educational area of study.

Competence based curriculum design demands performance based assessment.

Figure 2.1 Criteria for Describing and Assessing Competency Based Programs

(Source—Burke et al., 1975)

Competency Specifications

1. Competences are based on an analysis of the professional role(s) and/or a theoretical formulation of professional responsibilities.
2. Competency statements describe outcomes expected from the performance of professionally related functions, or those knowledges, skills, and attitudes thought to be essential to the performance of those functions.
3. Competency statements facilitate criterion referenced assessment.
4. Competences are treated as tentative predictors of professional effectiveness, and are subjected to continual validation procedures.
5. Competences are specified and made public prior to instruction.
6. Learners completing the CBE programs demonstrate a wide range of competency profiles.

Instruction

7. The instructional program is derived from and linked to specified competences.
8. Instruction which supports competency development is organized into units of manageable size.
9. Instruction is organized and implemented so as to accommodate learner style, sequence preference, pacing and perceived needs.
10. Learner progress is determined by demonstrated competence.
11. The extent of learner's progress is made known to him/her throughout the program.
12. Instructional specifications are reviewed and revised based on feedback data.

Assessment

13. Competency measures are validly related to competency statements.
14. Competency measures are specific, realistic and sensitive to nuance.
15. Competency measures discriminate on the basis of standards set for competency demonstration.
16. Data provided by competency measures are manageable and useful in decision making.
17. Competency measures and standards are specified and made public prior to instruction.

Governance and Management

18. Policy statements are written to govern, in broad outline, the intended structure, content, operation and resource base of the program.
19. Management functions, responsibilities, procedures and mechanisms are clearly defined and made explicit.

Total Program

20. Program staff attempt to model the attitudes and behaviors desired of students in the program.

21. Provisions are made for staff orientation, assessment, improvement and reward.
22. Research and dissemination activities are an integral part of the total instructional system.
23. Institutional flexibility is sufficient for all aspects of the program.
24. The program is planned and operated as a totally unified, integrated system.

THE IMPACT OF INCORPORATING COMPETENCY BASED EDUCATION ON AVIATION MAINTENANCE TRAINING

Competency based training and assessment. Training and assessment that are characterized by a performance orientation, emphasis on standards of performance and their measurement, and the development of training to the specified performance standards.

Practical Test Standards. The Federal Aviation Administration (FAA) aircraft mechanic's oral and practical test(s) are outcome-based examinations. Before being issued any airframe and/or powerplant certificate, all applicants must demonstrate the minimum level of knowledge and skills for the certificate or rating sought. Skill tests are significant as they measure the applicant's ability to logically think and objectively apply their knowledge, while demonstrating the physical skills that enable them to carry out aircraft maintenance in a professional and safe manner. Satisfactory demonstration of each skill test is evidence the applicant meets the acceptable degree of competency for the certificate or rating sought.

Compliance with these procedures makes certain that airman applicants meet a satisfactory level of competency and workmanship required for certification. Every applicant is required to demonstrate a minimum satisfactory competency level, regardless of their previous education background.

The adoption of competency based training by an AMTS would allow the training and the practical test standards to align.

References:

- http://www.faa.gov/training_testing/testing/test_standards/#me
- [Aviation Mechanic General Practical Test Standards \(FAA-S-8081-26A\)](#)
- [Aviation Mechanic Airframe Practical Test Standards \(FAA-S-8081-27A with Change 2\)](#)
- [Aviation Mechanic Powerplant Practical Test Standards \(FAA-S-8081-28A\)](#)

A MODERNIZED APPROACH TO AVIATION MAINTENANCE TRAINING

Comparative Study of Personnel Qualifications and Training at Aviation Maintenance Facilities

(Source—Goldsby & Watson, 1998)

The folks who do the work seem to know and understand what they need in order to be sufficiently trained and properly qualified to perform any and all maintenance tasks. The major focus of their comments seems to point toward a need not only for more training, but more of the type of training they can best apply. This does not necessarily mean more time in training. It is also recognized that effective recurrent training is necessary. What most are asking for, in simple terms, is the right stuff at the right time. While not overly critical of the FAA, many feel that the regulator needs to do more toward providing rules and guidance for the industry - rules and guidance that ensure both the appropriate quantity and quality of training, with competence-based qualification requirements (see list 6).

List 6. Comments by Workers

- "We need more recurrent training; use it or lose it."
- "More OJT is needed -- the right way, with check lists and task sign off."
- "There should be less time in the classroom, more practical/hands on."
- "There's not enough training -- period. Management needs to realize that it pays off."
- "Training needs to be based on what we do on the job."
- "Learning how to troubleshoot better would save a lot of money for the company."
- "There are too many push-back, tire and brake, mechanics on the line."
- "We must have special training on the new technology in all the new aircraft."
- "The culture that allows us to change the same good part over and over again needs to change."
- "Our training should be on what really happens on the line. It should not be too deep and spend lots of time on internals. Tell us, show us, and let us practice what we need for our jobs."
- "In the old days, we had OJT instructors who could teach two or three others and fix an airplane at the same time. There is very little hands-on training nowadays."
- "Don't bore us with stuff that is too basic, we've seen too much of the same stuff."
- "Too much training happens by accident, where 'x' hours of training is given to solve a situation. There is little thought given to the content of such training, or what the mechanic can actually do when the training is over. Some us call this feel-good training, it makes management feel good."
- "Training at the aircraft factories is too long, too boring, too engineering oriented, and doesn't give a mechanic what is needed. They could give us what we need in less than half the time."
- "Education is everything in our business."
- "Don't get the wrong idea. A lot of our training is what we need and right on."
- "A&P schools are the weakest link. They have no current methods or techniques."
- "A new A&P only has a learner's permit."
- "There are some great new A&Ps, others who can hardly read and barely write."
- "The A&P schools don't teach enough about transport aircraft."

- “Anyone seems to be able to buy an A&P license.”
- “Is the FAA going to bring schools up to date? They are way behind the power curve.”

OBSTACLES TO IMPROVED MAINTENANCE TRAINING POLICIES AND PROCEDURES

The debate on aviation maintenance education and training between the FAA, industry, and AMTSs has too often been concerned with structures and delivery and too little concerned with content and outcomes.

A NEW APPROACH TO TRAINING STANDARDS DEVELOPMENT AND APPLICATION

(Source—Preamble Language from Part 147 NPRM, 2015)

The FAA also proposes to include an option for competency-based training utilizing minimum credit hours based on typical higher education accreditation criteria. The minimum number of credit hours (equivalent to 1,900 training hours) would total 43 credit hours. This would be the combined credit hours for Airframe and Powerplant requirements, which include a minimum of 10 credit hours for the General curriculum, 18 credit hours for the Airframe curriculum, and 15 credit hours for the Powerplant curriculum. Each school would have the option to be approved for either an instructional hours curriculum or a credit hours curriculum, but not both.

A credit hour is a unit of measure that gives value to the level of instruction, academic rigor, and time requirements for a course taken at an educational institution. At its most basic, a credit hour is a proxy measure of a quantity of student learning. The higher education community has long used the credit hour, as defined by the “Carnegie unit,” as part of a process to establish a standard measure of faculty workloads, costs of instruction, and rates of educational efficiencies, as well as a measure of student work for transfer students. A credit hour for purposes of part 147 is an institutionally established equivalency that reasonably approximates some minimum amount of student work reflective of the amount of work expected in a Carnegie unit. A school that chooses to use a credit hour curriculum would be required to determine the clock-to-credit-hour conversion requirements and credit hours to be awarded for coursework under that option.

Aviation Technician Education Council response

The antiquated hour/credit requirement puts too much emphasis on the time a student spends in a classroom seat at the expense of the skills he or she actually gains. Industry is in desperate need of a competency-based standard, free of specific hour/credit requirements, which will allow industry to transition away from seat time in favor of a structure that creates flexibility, and allows students to progress as they demonstrate mastery of subject matter, regardless of time, place, or pace of learning.

A STRATEGY FOR EVOLUTIONARY BUT RESPONSIVE CHANGE

Essentially, competency-based or personalized learning in aviation maintenance training would realize a transition away from seat time, in favor of a structure that creates flexibility, allows students to progress as they demonstrate mastery of academic content and manipulative skills, regardless of time, place, or pace of learning. Competency-based strategies provide flexibility in the way that credit can be earned or awarded, and provide students with personalized learning opportunities. These strategies include online and blended learning, dual enrollment and early college high schools, project-based and community-based learning, and credit recovery, among others. This type of learning leads to better student engagement because the content is relevant to each student and tailored to their unique needs. It also leads to better student outcomes because the pace of learning is customized to each student.

By enabling students to master skills at their own pace, competency-based learning systems help to save both time and money. Depending on the strategy pursued, competency-based systems also create multiple pathways to certification, make better use of technology, support new staffing patterns that utilize teacher skills and interests differently, take advantage of learning opportunities outside of school hours and walls, and help identify opportunities to target interventions to meet the specific learning needs of students. Each of these presents an opportunity to achieve greater efficiency and increase productivity.

FAA APPROVAL CONSIDERATIONS

COMPETENCY-BASED TRAINING. Although 14 CFR Part 147 AMTS curriculums historically have provided a specified number of maintenance training hours to ensure students have the competencies needed for their jobs, studies have shown that it may be better to train to a competency-based standard. Competency based training this type of training does not depend on a defined schedule or for a specific number of hours. Rather, each individual is evaluated on what training he or she needs based on approved curriculum content and FAA PTS requirements. These evaluations standards are then used to identify those personnel who retain a high level of subject competence and who may not require a particular block of instruction. Conversely, those individuals who require more training can also be identified using the same criteria. Training to competence permits you to tailor training programs to the specific requirements of the individual student and curriculum requirements.

WHEN TO USE COMPETENCY-BASED TRAINING. The AMTS should use competency-based training to raise a student's level of competence to that level required by the FAA curriculum and applicable FAA Practical Test Standard (PTS).

The AMTS must have documented procedures to determine when an individual is enrolled in competency based training and the AMTS must determine the need for this type of training through pre- or post-student testing evaluation.

If an AMTS elects to utilize competency-based training, it should specifically address any lack of competence by an enrolled student and provide for additional training in those area of demonstrated deficiencies.. In some instances, competency-based training may consist of an appropriately authorized instructor reviewing individual student's performance (PTS) and knowledge test in the specific areas of the FAA required curricula content.

Competency based training may focus on one individual or a small group. An AMTS may use competency based training in all areas of the FAA approved curriculum requirements based on an individual, or groups mastery of the specific FAA Practical Test Standard (PTS) as aligned to the 147 approved corresponding curriculum requirement.

COMPETENCY DEFICIENCIES. For those circumstances where an AMTS identifies a competency deficiency through the competency based training evaluation of the students or group of students PTS mastery requirements, the AMTS must show how a student or group of students will be reintroduced to the FAA approved curriculum and PTS standards.

COMPETENCY IMPROVEMENT TRAINING. The AMTS should orient competency improvement training toward correcting personnel competence deficiencies that have been identified through the approved curriculum testing process and PTS standard evaluations.

SAMPLE PART 147 AMTS COMPETENCY BASED POLICY AND PROCEDURES

Course: Engine and Starting Systems

Description: Introduces the overhaul, inspection, and troubleshooting of reciprocating and gas turbine ignition and starting systems, including the repair and bench testing of components. Lecture 1 hour per week, Laboratory 3 hours per week.

Lecture hours	25
Laboratory Hours	50
Credits	3.0

Evaluation and Requirements:

Grade Determination: Student evaluation based on performance on Letter Grades (A,B,C,D,F) This system cannot be altered after the first class meeting. In determining the final grade, The student's performance will be evaluated in the following areas: *

- 25% Quizzes (4)
- 10% Participation
- 25% Projects (13)
- 40% Final Exams (3)

94-100%	A
86-93%	B
75-85%	C
70-74%	D
Below 70%	F

Quizzes will be averaged together for 25% of the final class average.

Projects will be averaged together for 25% of the final class average.

All projects must be completed to receive a passing grade.

Professionalism & Participation computed for 10% of the final class average:

- o 1/2 - attendance
- o 1/2 – instructor's evaluation of professionalism

Final exam – written, oral, and practical averaged together for 40% of class grade

FAA Objectives (from Operational Specifications):

	Levels
1. Overhaul magnetos	2
2. Overhaul ignition harness	2
3. Inspect reciprocating engine ignition systems/components	2
4. Service reciprocating engine ignition systems/components	2
5. Troubleshoot reciprocating engine ignition systems/components	2
6. Repair reciprocating engine ignition systems/components	2
7. Inspect turbine engine ignition systems/components	2
8. Service turbine engine ignition systems/components	2

9. Troubleshoot turbine engine ignition systems/components	2
10. Repair turbine engine ignition systems/components	2
11. Inspect turbine engine electrical starting systems	3
12. Service turbine engine electrical starting systems	3
13. Troubleshoot turbine engine electrical starting systems	3
14. Repair turbine engine electrical starting systems	3
15. Inspect turbine engine pneumatic starting systems	1
16. Service turbine engine pneumatic starting systems	1
17. Troubleshoot turbine engine pneumatic starting systems	1

AMTS Performance Objectives:

1. Assigned Reading:

- Aviation Maintenance Technician Handbook-Powerplant, Volume 1, Chapter 4, Engine Ignition and Electrical Systems, pp. 4-1/4-43 and Chapter 5, Engine Starting Systems, pp. 5-1/5-17.
- Best of AMT Magazine: Recip Technology, Turbine Technology, Magneto Maintenance, pp. 3-7; *The 500-hour slick Magneto Inspection*, pp. 30-33; *Get the Lead Out*, pp. 100-101; *Operating Suggestions That Eliminate Lead Buildup*, p. 102; *Removal and Installation Tips from Champion*, p. 103; *Inspecting Turbine Ignition Leads*, pp. 202-203; *Turbine Ignition Fault Isolation*”, pp. 238-239; and *A Few Simple Igniter Inspection Tips*, p. 240.

2. Review External Links:

- **Aircraft Ignition:**
<http://www.nleindex.com/index.php?PID=HTDI&SID=BrowseIndex&tID=E/2269>
- **Unison:**
<http://www.unisonindustries.com/index.html>
- **Aerosance:**
<http://tcmlink.com/aerosance/index.cfm>
- **The Magneto Ignition Systems:**
<http://www.sacskyranch.com/pubsmag.htm>
- **Light Speed Engineering:**
<http://www.lsecorp.com/Products/IgnitionBasics.htm>
- **Aircraft Magneto Troubleshooting:**
http://www.sacskyranch.com/aircraft_magneto_troubleshooting.htm
- **Aircraft Magneto Systems:**
<http://selair.selkirk.bc.ca/systems1/Engines/Aircraft%20Magneto%20systems.html>
- **Champion Aerospace:**
<http://www.championaerospace.com/magnetos.htm>

3. Watch the Lecture Presentations:

- Ignition System Overview
- Reciprocating Engine Ignition Systems
- Magneto Servicing
- Turbine Engine Ignition Systems
- Ignitors
- Starting Systems
- Starter Generator

4. Review the Following Video Series:

- Magneto Videos
- Impulse Coupling Videos
- Engine Timing Videos
- Spark Plug Videos
- Rotax Ignition Videos
- Turbine Engine Ignition Videos

5. Successfully Complete the following written assessments with a score of 75% or higher:

- Quiz #1 Reciprocating Engine Ignition Systems
- Quiz #2 Spark Plugs and Leads
- Quiz #3 Turbine Engine Ignition Systems
- Quiz #4 Starting Systems

6. Complete the following practical projects with a score of 75% or higher:

- Bendix S20-series Magneto
- Bendix High Altitude Magneto
- Bendix Low Tension Magneto
- Bendix Dual Magneto
- Slick Magneto
- Magneto to Engine Timing
- Impulse Coupling
- Spark Plug Servicing
- Ignition Lead
- Reciprocating Engine Starting System
- Turbine Engine Ignition System
- Turbine Engine Electrical Starting System
- Turbine Engine Pneumatic Starting System

7. Complete the final class assessments with a score of 75% or higher

- Written final exam
- Oral final exam
- Practical final exam

Flowchart





