



ICAO

Doc 10098

Manual on Competency-based Training and Assessment for Aircraft Maintenance Personnel

First Edition, 2021



Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION **Documents**
AVA Document Sharing Hub



| ICAO

Doc 10098

Manual on Competency-based Training and Assessment for Aircraft Maintenance Personnel

First Edition, 2021

Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION



Documents
Document Sharing Hub

Published in separate English, Arabic, Chinese, French, Russian
and Spanish editions by the
INTERNATIONAL CIVIL AVIATION ORGANIZATION
999 Robert-Bourassa Boulevard, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents
and booksellers, please go to the ICAO website at www.icao.int

First edition 2021

**Doc 10098, *Manual on Competency-based
Training and Assessment for Aircraft Maintenance Personnel***
Order Number: 10098
ISBN 978-92-9265-538-0 (print version)
ISBN 978-92-9265-629-4 (electronic version)

© ICAO 2021

All rights reserved. No part of this publication may be reproduced, stored in a
retrieval system or transmitted in any form or by any means, without prior
permission in writing from the International Civil Aviation Organization.

AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

[illegible][illegible]

FOREWORD

Current industry trends indicate a significant increase in the worldwide fleet, while a large number of current aircraft maintenance personnel (AMP) is due to retire from the industry, leading to a shortage of AMP in the coming years. The shortage of AMP would result in a significant increase in demand for training.

In 2020, procedures on a new approach for the implementation of competency-based training and assessment for AMP were included as Part III of the *Procedures for Air Navigation Services — Training* (PANS-TRG, Doc 9868). These procedures provide States, approved maintenance organizations (AMOs) and aviation training organizations (ATOs) with guidance on how to structure their approach to training and assessment of AMP. The procedures provide a flexible framework that stakeholders can adapt to their local operational contexts and requirements.

AMP can have varying degrees of educational background, which can range from the self-taught individual to the holder of a university engineering degree. However, irrespective of educational background, all AMP must demonstrate a high level of technical competency and understanding of regulatory compliance. Often, meeting these high standards requires comprehensive training that provides the necessary knowledge, skills and attitudes for assuming the responsibility for aircraft maintenance.

This manual provides guidance on a new approach of applying competency-based training and assessment to aircraft maintenance personnel in accordance with Part III of the *PANS-TRG* (Doc 9868). This manual was developed by the Competency-Based Training and Assessment Task Force, with contribution from subject matter experts on maintenance personnel.

Throughout this manual, for the phrase “aircraft maintenance (technician/engineer/mechanic),” the terms in brackets are given as acceptable additions to the title of the licence. Each State is expected to use its preferred term. For the purpose of this manual and as a matter of convenience, the acronym AMP is used to refer to aircraft maintenance (technician/engineer/mechanic) personnel.

Comments on this manual, particularly with regard to its application and usefulness, would be appreciated from States and ICAO Technical Co-operation Field Missions. These will be taken into consideration in the preparation of subsequent editions. Comments concerning this manual should be addressed to:

The Secretary General
International Civil Aviation Organization
999 Robert-Bourassa Boulevard
Montréal, Québec H3C 5H7
Canada

TABLE OF CONTENTS

	<i>Page</i>
Glossary	(ix)
Publications	(xv)
Chapter 1. Introduction	1-1
1.1 Background	1-1
1.2 Competency	1-3
1.3 Why competency-based training and assessment?	1-4
1.4 Competency-based approach to training and assessment	1-5
1.5 Intended users	1-5
1.6 Structure of this manual	1-5
1.7 Relationship of this manual to the PANS-TRG (Doc 9868)	1-7
1.8 Regulatory requirements	1-8
1.9 General information	1-9
1.10 Developing a competency-based training and assessment programme for AMP	1-10
1.11 The ICAO competency framework	1-10
1.12 Principles of competency-based training and assessment	1-11
1.13 Assessment of students	1-12
1.14 Evaluation of course	1-12
1.15 Training and assessment materials	1-13
1.16 Steps to develop an AMP CBTA	1-13
Chapter 2. Design of competency-based training and assessment for aircraft maintenance personnel	2-1
2.1 General	2-1
2.2 Components of competency-based training and assessment	2-1
2.3 Overview of competency-based training and assessment workflows	2-2
2.4 Workflow 1 — Analyse training need	2-4
2.5 Workflow 2 — Design competency-based training and assessment	2-7
2.6 Workflow 2, Part 1 — Design the adapted competency model	2-7
2.7 Workflow 2, Part 2 — Design the training and assessment plans	2-10
2.8 Workflow 3 — Develop the training and assessment materials	2-23
2.9 Workflow 4 — Conduct the course in accordance with the training and assessment plans	2-24
2.10 Workflow 5 — Evaluate the course, including the training and assessment plans	2-24
Attachment A to Chapter 2. How to develop a training needs analysis	2-A-1
Attachment B to Chapter 2. Example of a training specification	2-B-1
Attachment C to Chapter 2. How to develop an adapted competency model	2-C-1
Attachment D to Chapter 2. Example of an adapted competency model	2-D-1
Attachment E to Chapter 2. Example of a training plan	2-E-1
Attachment F to Chapter 2. Example of an assessment plan	2-F-1
Attachment G to Chapter 2. Example of a competency checklist	2-G-1
Attachment H to Chapter 2. Example of a competency assessment form	2-H-1

	<i>Page</i>
Attachment I to Chapter 2. Example of a syllabus	2-I-1
Attachment J to Chapter 2. ICAO competency framework for aircraft maintenance personnel	2-J-1
Chapter 3. Guidelines for the implementation of competency-based training and assessment for aircraft maintenance personnel.....	3-1
3.1 General.....	3-1
3.2 Guidelines for civil aviation authorities (CAAs).....	3-1
3.3 Guidelines for approved training organizations (ATOs).....	3-2
3.4 Guidelines for approved maintenance organizations (AMOs)	3-2
3.5 AMP training and licensing path	3-3
3.6 Competency-based training and assessment — basic training and licensing	3-3
3.7 Competency-based training — type-rating training and AMO authorization	3-5
3.8 Competency-based training and assessment — certification authorization of non-licenced AMP.....	3-6
3.9 Competency-based training and assessment — differences training – rating or approval	3-7
3.10 Competency-based training and assessment —training and licensing pathways	3-7
Chapter 4. Competency-based training and assessment – aircraft maintenance personnel refresher training.....	4-1
4.1 General.....	4-1
4.2 Refresher training material	4-1
Chapter 5. Competency-based training and assessment licences and privileges	5-1
5.1 General.....	5-1
5.2 Existing aircraft maintenance licences and training programmes.....	5-1
5.3 Link between competency-based training and assessment and privileges	5-2
5.4 Issuance of licences and certification authorizations	5-2
Chapter 6. Developer, instructor and assessor	6-1
6.1 General.....	6-1
6.2 Instructing and assessing theoretical and practical training.....	6-1
6.3 General requirements for instructors and assessors	6-2
6.4 Responsibilities and qualification of course developers.....	6-2
6.5 Responsibilities and qualification of course instructors.....	6-3
6.6 Responsibilities and qualification of course assessors	6-5

GLOSSARY

DEFINITIONS

When the following terms are used in this document, they have the following meanings:

Adapted competency model. A group of competencies with their associated description and performance criteria adapted from an ICAO competency framework that an organization uses to develop competency-based training and assessment for a given role.

Approved training organization. An organization approved by and operating under the supervision of a Contracting State in accordance with the requirements of Annex 1 to perform approved training.

Approved maintenance organization. An organization approved by a Contracting State, in accordance with the requirements of Annex 8, Part II, Chapter 6 — Maintenance Organization Approval, to perform maintenance of aircraft, engine, propeller or parts thereof and operating under supervision approved by that State.

Note.— Nothing in this definition is intended to preclude that the organization and its supervision be approved by more than one State.

Assessment (evidence) guide. A guide that provides detailed information in the form of evidence that an instructor or an evaluator can use to determine whether a candidate meets the requirements of the competency standard.

Note.— For the purpose of this manual, the evaluator as used in the definition of Assessment (evidence) guide should be understood to include assessor. Additionally, “tolerances” used as example in this manual should be considered as knowledge level, skill level, etc.

Assessment plan. The document that details the assessment events, tools (Assessment (evidence) guide, competency checklist, competency assessment form, etc...) and competency standards that will be used to determine if competency has been achieved.

Note.— For the purpose of this manual, this definition is intended for the AMP CBTA Course Development.

Basic training. Training which is generic in nature but essential in the role of particular activities.

Note.— For the purpose of this manual, basic training may be referred to as initial training or fundamental training.

Certification authorization. An authorization that an approved maintenance organization grants to an individual to perform maintenance certifications or issue certificates of release to service or both on behalf of the organization:

Competency. A dimension of human performance that is used to reliably predict successful performance on the job. A competency is manifested and observed through behaviours that mobilize the relevant knowledge, skills and attitudes to carry out activities or tasks under specified conditions.

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.

Competency standard. A level of performance that is defined as acceptable when assessing whether or not competency has been achieved.

Conditions. Anything that may qualify a specific environment in which performance will be demonstrated.

Differences training. The training required to cover the knowledge, skills and or attitude gap between two similar courses or body of learning subjects.

Dispatch deviation procedures guide. Manual to identify any procedure to dispatch an aircraft with allowable systems/components inoperative or missing.

Note.— Large aircraft manufacturers may choose to produce operating and maintenance procedures in documents such as dispatch deviation procedure guides, for use by operators.

Error. An action or inaction by an operational person that leads to deviations from organizational or the operational person's intentions or expectations.

Note — See Chapter 1 of Annex 19 —Safety Management for a description of operational personnel.

Error management. The process of detecting errors and responding to them with countermeasures that reduce or eliminate the consequences of errors and mitigate the probability of further errors or undesired states.

Note.— See Part II, Section 1, Chapter 6 of the Procedures for Air Navigation Services — Training (PANS-TRG, Doc 9868) and Circular 314 — Threat and Error Management (TEM) in Air Traffic Control for a description of undesired states.

Human performance. Human capabilities and limitations which have an impact on the safety and efficiency of aeronautical operations.

ICAO competency framework. A competency framework, developed by ICAO, is a selected group of competencies for a given aviation discipline. Each competency has an associated description and observable behaviours.

Instructions for continuing airworthiness. A set of descriptive data, maintenance planning and accomplishment instructions, developed by a design approval holder in accordance with the certification basis for the aeronautical product. The ICAs provide air operators with the necessary information to develop their own maintenance programme and also for approved maintenance organizations to establish the accomplishment instructions.

Note.— The design approval holder must follow mandatory requirements regarding: the timeliness and completeness of the ICA's development, the changes to ICA as well as the ICA availability to users required to follow any of the terms of those ICA (e.g. aircraft owner, operator etc.).

Instructional systems design. A formal process for designing training which includes analysis, design and production, and evaluation.

Learning management system. A system designed to fulfil the following training processes:

- a) courseware control;
- b) documentation and record keeping;
- c) student and instructor performance monitoring;

- d) course progression tracking;
- e) standardization of delivery; and
- f) data analysis.

Note.— LMS is most frequently known today as a software application for computers which can effectively accomplish all these processes.

Licensing Authority. The Authority designated by a Contracting State as responsible for the licensing of personnel.

Note.— In the provisions of Annex 1 — Personnel Licensing, the Licensing Authority is deemed to have been given the following responsibilities by the Contracting State:

- a) assessment of an applicant's qualifications to hold a licence or rating;*
- b) issue and endorsement of licences and ratings;*
- c) designation and authorization of approved persons;*
- d) approval of training courses;*
- e) approval of the use of flight simulation training devices and authorization for their use in gaining the experience or in demonstrating the skill required for the issue of a licence or rating; and*
- f) validation of licences issued by other Contracting States.*

Maintenance. The performance of tasks on an aircraft, engine, propeller or associated part required to ensure the continuing airworthiness of an aircraft, engine, propeller or associated part including any one or combination of overhaul, inspection, replacement, defect rectification, and the embodiment of a modification or repair

Maintenance organization's procedures manual. A document endorsed by the head of the maintenance organization which details the maintenance organization's structure and management responsibilities, scope of work, description of facilities, maintenance procedures and quality assurance or inspection systems.

Maintenance records. Records that set out the details of the maintenance carried out on an aircraft, engine, propeller or associated part.

Maintenance release. A document which contains a certification confirming that the maintenance work to which it relates has been completed in a satisfactory manner in accordance with appropriate airworthiness requirements.

Major modification. In respect of an aeronautical product for which a type certificate has been issued, a change in the type design that has an appreciable effect, or other than a negligible effect, on the mass and balance limits, structural strength, engine operation, flight characteristics, reliability, operational characteristics, or other characteristics or qualities affecting the airworthiness or environmental characteristics of an aeronautical product.

Major repair. Any repair of an aeronautical product that might appreciably affect the structural strength, performance, engine, operation flight characteristics or other qualities affecting airworthiness or environmental characteristics.

Minimum equipment list. A list which provides for the operation of aircraft, subject to specified conditions, with particular equipment inoperative, prepared by an operator in conformity with, or more restrictive than, the MMEL established for the aircraft type.

Minor modification. A modification other than a major modification.

Minor repair. A repair other than a major repair.

Modification. A change to the type design of an aircraft, engine or propeller.

Note.— A modification may also include the embodiment of the modification which is a maintenance task subject to a maintenance release. Further guidance on aircraft maintenance, modification and repair is contained in the Airworthiness Manual (Doc 9760).

Non-type and non-licences certification authorization training. Maintenance trainings that are non-type-specific or non-licence-specific conducted to permit persons to perform specified maintenance activities.

Observable behaviour. A single role-related behaviour that can be observed and may or may not be measurable.

Performance criteria. Statements used to assess whether the required levels of performance have been achieved for a competency. A performance criterion consists of an observable behaviour, condition(s) and a competency standard.

Rating. An authorization entered on or associated with a licence and forming part thereof, stating special conditions, privileges or limitations pertaining to such licence.

Repair. The restoration of an aircraft, engine, propeller or associated part to an airworthy condition in accordance with the appropriate airworthiness requirements, after it has been damaged or subjected to wear.

Standard practices manual. Manual establishing standard practices to be applied by aircraft and component maintenance personnel for the proper handling (identification, application, working procedures, use of tools, and quality standards) of standard aeronautical hardware.

Threat. Events or errors that occur beyond the influence of an operational person, increase operational complexity and must be managed to maintain the margin of safety.

Note.— See Chapter 1 of Annex 19 — Safety Management for a description of operational personnel.

Training for a particular maintenance rating. Training aimed at developing the set of particular competencies required to perform maintenance tasks on a type of equipment and in specific environments.

Note.— Such types of equipment include, but are not limited to:

- a) a specific aircraft or a broad category of aircraft;
- b) an airframe or aircraft structure;
- c) engines;
- d) aircraft systems or components; and
- e) avionic systems or components.

Training gap analysis. The analysis of the difference between KSA (Knowledge, Skills and Attitude) that the student(s) require and KSA the student(s) possess.

Training needs analysis. The analysis of the students against the competency definitions of their job to determine the precise objectives (knowledge, skills, attitudes) to be trained to carry out that job.

Training objective. A clear statement that is comprised of three parts, i.e. the desired performance or what the trainee is expected to be able to do at the end of training (or at the end of particular stages of training), the performance standard that must be attained to confirm the trainee's level of competence, and the conditions under which the trainee will demonstrate competence.

ABBREVIATIONS

ADDIE	Analyse, design, develop, implement and evaluate
AMP	Aircraft maintenance personnel
AMO	Approved maintenance organization
ATO	Approved training organization
CAA	Civil aviation authority
CBTA	Competency-based training and assessment
DDPG	Dispatch deviation procedures guide
ICA	Instructions for continuing airworthiness
ISD	Instructional systems design
KSA	Knowledge, skills and attitudes
LMS	Learning management system
MEL	Minimum equipment list
MOPM	Maintenance organization's procedures manual
OB	Observable behaviour
SARPs	Standards and Recommended Practices
TNA	Training needs analysis

PUBLICATIONS

(referred to in this manual)

Annexes

Annex 1 — Personnel Licensing

Annex 6 — Operation of Aircraft

Part I — International Commercial Air Transport — Aeroplanes

Part II — International General Aviation — Aeroplanes

Part III — International Operations — Helicopters

Annex 8 — Airworthiness of Aircraft

Annex 19 — Safety Management

Procedures for Air Navigation Services (PANS)

Procedures for Air Navigation Services — Training (PANS-TRG) (Doc 9868)

Manuals

Manual of Procedures for Establishment and Management of a State's Personnel Licensing System (Doc 9379)

Airworthiness Manual (Doc 9760)

Safety Management Manual (SMM) (Doc 9859)

Manual of Procedures for Operations Inspection, Certification and Continued Surveillance (Doc 8335)

Safety Oversight Manual (Doc 9734), Part A — The Establishment and Management of a State Safety Oversight System

Manual on the Approval of Training Organizations (Doc 9841)

TRAINAIR PLUS — Training Development Guide — Competency-based Training Methodology (Doc 9941)

Training Instructors Guide – Competency-based course delivery (Doc 10097)

ICAO Training Needs Analysis (TNA) Methodology and Website Tool User Guidance

Others

Competency-Based Education in Aviation: Exploring Alternate Training Pathways by Suzanne K. Kearns, Timothy J. Mavin and Steven Hodge.

Guidelines and Recommendations on Training Needs Analysis (GR1002) by European Aviation Maintenance Training Committee

Guidance Material and Best Practices for the Implementation of Competency-Based Training in Maintenance by International Air Transport Association

Chapter 1

INTRODUCTION

1.1 BACKGROUND

1.1.1 Current industry trends indicate an expected increase in air traffic and a significant increase in worldwide fleet. This projected growth has led to predictions of adequate aircraft maintenance personnel (AMP) support. The exact timing of the projected growth will depend on factors such as economic development. In addition, with a large number of current AMP due to retire from the industry, both issues would lead to a shortage of AMP during the coming years. This shortage would result in a significant increased demand for the training of new AMP.

1.1.2 In addition, the retirement of legacy aircraft and replacement of fleet with aircraft equipped with new technologies will also generate additional or different training requirements for new and existing AMP.

1.1.3 The aviation industry is becoming more globalized and, with the outsourcing of maintenance, there is a need for the AMP competency to be harmonized to enable the global transferability of AMP. To ensure the quality of maintenance and the safe operation of aircraft, the aviation industry has to find solutions to these additional training demands and requirements while ensuring acceptable competency standards for all AMP.

1.1.4 Competency-based training and assessment (CBTA) is a method to provide an acceptable competency standard for AMP.

Historical and contemporary training programmes

1.1.5 Early aircraft were mostly made up of a structure, control mechanism and engines. Therefore, maintenance training programmes primarily focused on mechanical systems. As aircraft become increasingly sophisticated, increased levels of specialization are required, concentrating on airframes, engines, electrical, instruments and avionics. As a result, the training of AMP is a specialized trade with a high demand for practical skills and comprehensive knowledge of complex systems.

1.1.6 Currently, contemporary training of AMP requires instructor-led, classroom-based theory, where students specialize in a particular area of aircraft maintenance engineering (e.g. mechanical stream or avionics stream). The duration of this theory-based training varies depending on the specialization. After completing the theoretical training, a student often begins a traineeship or apprenticeship that includes further technical and practical experience either in a workshop or on the aircraft to gain the required practical experience. In addition, a student's specific practical experience on particular aircraft subsections (generally split into chapters of a manual), such as airframes, structures, hydraulics, engines and avionics, is recorded. To be licensed by a Licensing Authority, an AMP must demonstrate appropriate experience on particular aircraft systems via an experience record or display acceptable competency through successful completion of appropriate assessments, which may include oral, written and practical applications.

1.1.7 However, there are limits with this training approach, as students only need to demonstrate generic skills on different aircraft types, which may be insufficient for more complex aircraft or new technologies that require specific skills.

Training methods available and used today

1.1.8 Some alternative maintenance training methods available today include the use of simulation. Similar to pilots, AMP now uses e-learning, part-task trainers and full fidelity simulation to practice specific training activities that were traditionally done on an operating aircraft. Similar to training environments of other aviation professions, instructional methods and technology are changing professional practice. However, the traditional regulatory structure on training is time-regulated, syllabus and task-oriented, where students must physically demonstrate generic skills on each aircraft type.

1.1.9 Training through simulation and other teaching technologies are recognized for CBTA; however, this approach is not widely used in aviation today.

The goal of competency-based training and assessment

1.1.10 CBTA for aircraft maintenance professionals stems from pilot training. The objective of this training method is to move away from time-regulated training towards competency-regulated training to focus on students achieving competency rather than on the completion of a prescribed number of hours of training.

1.1.11 Aircraft manufacturers issue standard practices manuals to describe methods, tools, equipment and standards for maintenance tasks. In a recent study, it was determined that, regardless of aircraft type, maintenance practice on modern aircraft requires a set of generic competencies. The goal of the CBTA process is to align maintenance training with predetermined standards, identified through task analysis. Additionally, it is to provide a competent workforce for personnel working in aircraft maintenance, including those with certification privileges.

1.1.12 CBTA is an option and an alternative to traditional training and does not affect existing licensing and approval processes prescribed in Annex 1 — *Personnel Licensing*. While each approach is different, a course may adopt either approach or a blended approach.

Competencies needed for aircraft and component maintenance

1.1.13 As aircraft and component maintenance significantly impact flight safety and airworthiness, the competencies of the personnel involved should be properly defined, established, assessed, maintained and subjected to regulation and surveillance by the civil aviation authority (CAA).

1.1.14 While aircraft and component maintenance are diverse, maintenance organizations may either cover a broad scope of maintenance activities or be specialized. In either case, the maintenance organizations need to be approved by the CAA for the scope of maintenance performed. As the scope of maintenance varies between organizations, competency requirements for the personnel employed differ accordingly. Part of the approval process conducted by CAAs for maintenance organizations assures that the competency of the AMP meets the requirements of the scope of that area of maintenance for which the approval is sought.

1.1.15 Despite the variation in competency requirements between maintenance organizations, workplaces and tasks, some competencies remain common to a wide range of activities. These competencies are standard competencies related to standard practices that AMP have to acquire, regardless of where they are employed. In addition to these standard practices, personnel will need to demonstrate competencies that are tailored to the equipment and types of aircraft being maintained to fulfil their maintenance tasks.

1.1.16 While a subset of standard practices, defined by many CAAs as “special practices”, may have a significant impact on the airworthiness of a product, the personnel who execute the proper performance of these special practices need to be holders of special qualifications. These qualifications could be obtained when the related competencies have been demonstrated successfully in a standard examination and assessment.

1.2 COMPETENCY

1.2.1 The CBTA is a concept and methodology that was developed during the 1950s and became a mainstream concept in the 1980s. Since then, CBTA has been applied in many different contexts and professions and, therefore, it is understandable that there are many different definitions for competency and CBTA. This section elaborates on the competency concepts as they are used in this manual.

1.2.2 Competency is a consistent dimension of human performance that is used to reliably predict successful performance on the job. Competency can be observed through behaviours that require the use of relevant knowledge, skills and attitudes (KSA) to carry out activities or tasks under specified conditions. Competency is successfully achieved by meeting its associated standard.

1.2.3 Competencies allow for the formulation of solutions for complex and difficult situations, including those situations experienced for the first time. AMP need to be able to deal with these situations effectively while ensuring that the tasks are performed safely. For the use of this document, we define the term “competency” as the sum of KSA.

1.2.4 Knowledge is the set of facts, information acquired through experience, instruction or education. It includes:

- a) specific information required for the students to develop and apply the skills and attitudes to recall facts;
- b) identification of concepts and application of rules or principles; and
- c) problem solving and creative thinking in the context of work.

1.2.5 There are different types of knowledge:

- a) declarative (facts, raw data);
- b) procedural (categorized or contextualized, application of conditional “if-then” rules);
- c) strategic (synthesis, inference to guide resource allocation for decision-making, problem-solving behavioural action); and
- d) adaptive (generalization, innovation, invention).

1.2.6 Skills are the abilities to perform an activity or action effectively. These are developed over time and with practice. While new complex tasks are initially seen as cognitively demanding, some of these cognitive processes become automated, requiring less skill to perform. They are often divided into three types: motor, cognitive and metacognitive skills.

- a) Motor skills are an intentional movement involving a motor or muscular component, which must be learned and voluntarily produced to proficiently perform a goal-oriented task.
- b) Cognitive skills are mental skills that are used in the process of acquiring knowledge. These include reasoning, perception and intuition.

- c) Metacognitive skills relate to the ability of students to monitor and direct their learning processes (“thinking about thinking”); for example, planning how to approach a learning task, monitoring comprehension, and evaluating progress toward the completion of a task are metacognitive.

1.2.7 Attitude is a persistent internal mental state or disposition of a person that influences behaviour, choices and expressed opinions that can be learned. Attitudes have affective components, cognitive aspects and behavioural consequences. To demonstrate the “right” attitude, a student needs to know how to act in a context. For AMP, attitudes towards issues such as safety, adherence to regulations and standards, and working with others is a significant factor in the achievement of competency and the safety of aircraft maintenance.

1.2.8 Competency can only be observed through performance. As it is not possible to directly observe all the different skills, especially cognitive skills, which contribute to competency, they can only be inferred from observations of the AMP’s performance of the task.

1.3 WHY COMPETENCY-BASED TRAINING AND ASSESSMENT?

1.3.1 In a traditional training system, the training is instructor-dependent and centred on subject contents delivered by an instructor in a specific time frame. In a CBTA system, training is student-centred and guides the performance of defined tasks.

1.3.2 The safety, quality and operational performance of approved maintenance organizations (AMOs) depends to a large degree on the competency of its personnel. Maintenance personnel are responsible for the performance and inspection of the maintenance work, as well as certification of maintenance associated with the privileges granted by their licence and or authorizations. Competency standards, therefore, play a key role in ensuring task performance, thereby upholding and potentially improving safety standards in aircraft maintenance. Poorly performed maintenance is associated with the risk of impacting airworthiness of aircraft and flight safety. Therefore, personnel involved in aircraft maintenance must be adequately trained and assessed against the established competency standards. The CBTA-focused approach would ensure training effectiveness by providing a tailored approach to an individual’s training needs and therefore, positively impact AMP competency and maintenance outcomes.

1.3.3 The aviation industry is at the forefront of new technological developments, requiring personnel involved in aircraft maintenance to adapt to new methods, processes, knowledge and skills to build up the necessary competencies. Training programmes need to be updated to include new content and training methodologies. These depend on new developments in training and information dissemination and should be constantly updated to the latest technology. The CBTA approach may improve training by better capturing the changing technology requirements.

1.3.4 Currently, airworthiness regulations stipulate the licences and certification authorizations that AMP have to acquire to perform specified aircraft maintenance tasks. These regulations vary substantially from one country to another in the scope of the privileges, training, experience and examination requirements. This wide variance hampers the aircraft maintenance industry because it limits the exchange of personnel between States and the possibility to outsource maintenance work from one State to another. The CBTA programmes result in AMP that are trained and evaluated against competency standards, with records as evidence. Such records may make it easier for maintenance organizations to employ personnel from other States and organizations and facilitate harmonization.

1.3.5 Currently, the competencies and knowledge that a particular student brings into a training programme are not considered for training, planning or preparation. As a result, the course content may be a repetition of previously attended training or may be above their level of comprehension. To increase the effectiveness and efficiency of the training programmes, their current competency status must be evaluated against the competencies to be achieved. During this process, a student’s training need should be identified with a focus on filling these gaps using the appropriate methodologies. Clear training objectives stating the competencies to be achieved through examination and assessment are another key element of efficient training programmes that may result in the reduction or extension in training time.

1.3.6 The CAAs require AMOs to ensure that their personnel are competent to perform their duties. Maintenance organizations need to prove how the competency of their personnel are established and assessed. In this regard, the CBTA may assist AMOs in effectively complying with these regulatory requirements. This method may also result in harmonized performance standards and improved safety standards.

1.3.7 The assessment and identification of the student's or organization's training needs are the bases of the implementation of a CBTA programme. This approach would reduce unnecessary training to save time and cost, thereby increasing training efficiency. Moreover, the continuing assessment of students may facilitate the management of the training progress, resulting in better use of training resources.

1.4 COMPETENCY-BASED APPROACH TO TRAINING AND ASSESSMENT

This manual proposes a CBTA approach by providing AMP, approved training organization (ATOs), AMOs and CAAs with guidance identifying the AMP competencies necessary for the AMP work environment. In addition, included is guidance on the assessment that is needed for the stages of AMP development. The manual also contains detailed guidance material on the design and development of an AMP training programme, and provides examples of training objectives based on the *Procedures for Air Navigations Services – Training* (PANS-TRG, Doc 9868), Part III, Appendix 2 to Chapter 1 (Guidelines for the Implementation of Competency-based Training and Assessment for AMP).

Note.— Implementation of CBTA programmes for AMP is optional.

1.5 INTENDED USERS

This manual is intended for:

- a) AMOs and ATOs who are developing an entirely new training system;
- b) AMOs and ATOs who already have an established training system and intend to evolve their system towards a competency-based approach; and
- c) CAAs to ensure that a CBTA programme for a particular licence and certification authorization demonstrates the required set of competencies with the privileges granted.

1.6 STRUCTURE OF THIS MANUAL

1.6.1 The manual contains six chapters that elaborate on the components as they relate to particular types of training. The chapters also provide detailed examples to help the user understand the particulars of each training.

1.6.2 Chapter 1 provides an overview of the structure of the manual, regulatory requirements, and how to use the manual. It also contains general information on the principles and development of CBTA, the ICAO competency framework for AMP as well as the description of the steps to be taken to develop an AMP CBTA.

1.6.3 Chapter 2 guides the design of CBTA for organizations intending to implement a CBTA approach that is specific to their environment and requirements. It makes use of the ICAO competency framework for the AMP and the “analyse, design, develop, implement and evaluate” (ADDIE) instructional systems design (ISD) model. A few examples are provided in the attachments to enable a better understanding of the application of the guidelines for AMP contained in this manual.

1.6.4 Chapter 3 provides the guidelines for the implementation of CBTA and assessment for AMP. It describes the role of CAAs and AMOs in a CBTA environment. Attachment J to Chapter 2 includes an ICAO competency framework for AMP which is to be used by AMOs or ATOs to develop adapted competency models to suit their organizational context.

1.6.5 Chapter 4 provides guidelines to AMOs or ATOs in the preparation and provision of refresher training for AMP. The objective of refresher training is to ensure that AMP maintain competency.

1.6.6 Chapter 5 provides material on the implementation of a competency-based approach to training and assessment for personnel working in aircraft maintenance, including those with certification authorization privileges. This material is complimentary to those provided in Chapter 2. Furthermore, the content will be useful to CAAs responsible for approving the AMOs or ATOs training programmes for AMP.

1.6.7 Chapter 6 describes the responsibilities and qualification that apply to the developers, instructors and assessors in a CBTA environment and the competencies to be demonstrated in a competency-based training programme. All developers, instructors and assessors in a CBTA environment should have an understanding of the overall CBTA approach throughout the training process and the knowledge of the subject matter and training course content.

1.7 RELATIONSHIP OF THIS MANUAL TO THE PANS-TRG (DOC 9868)

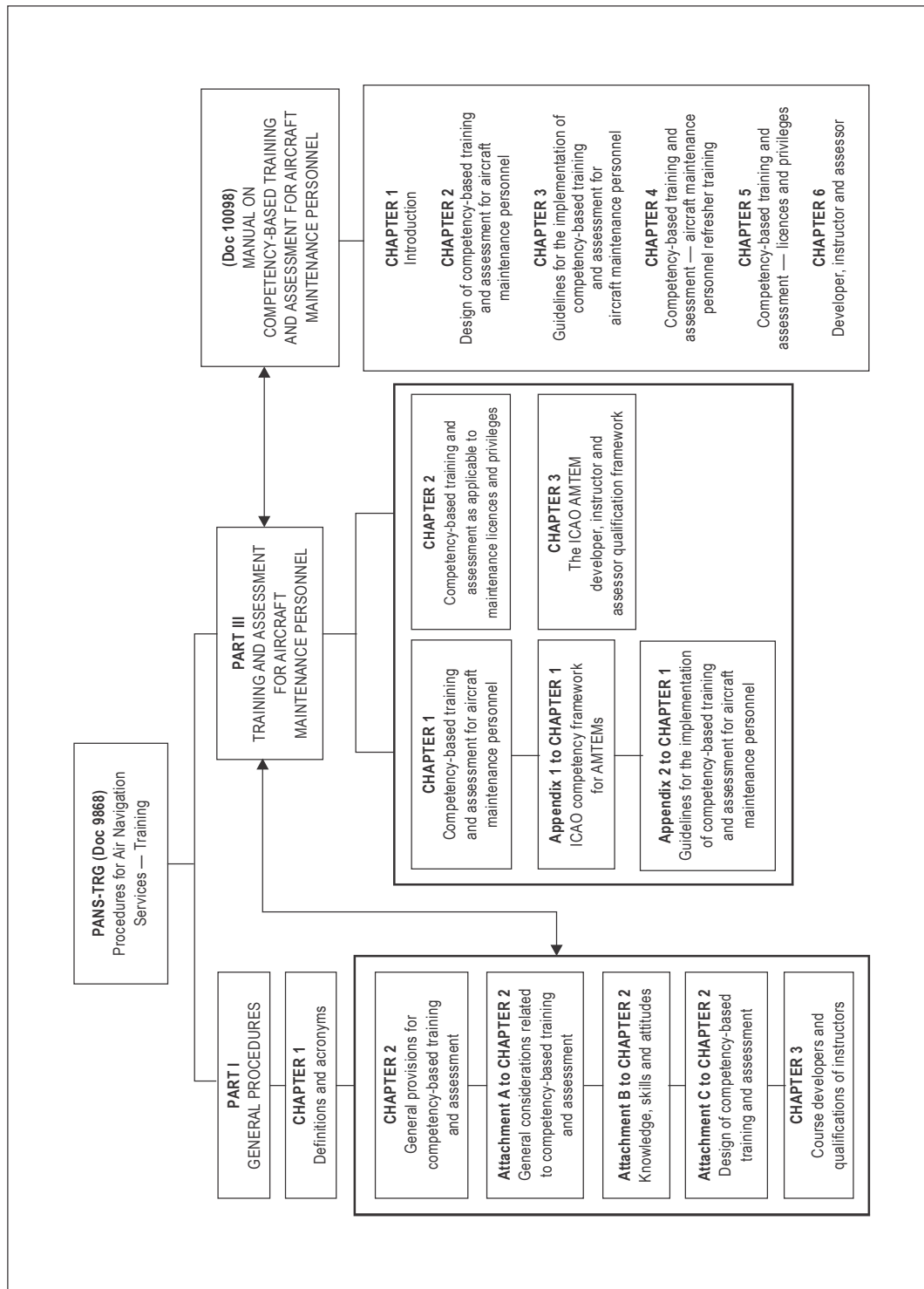


Figure 1-1. Relationship of this manual to the PANS-TRG (Doc 9868)

1.8 REGULATORY REQUIREMENTS

Note.— AMP should meet the final competency standards approved by the CAA in accordance with Annex 1 requirements.

1.8.1 The successful application of regulations and the achievement of regulatory objectives regarding the safety and efficiency of aircraft operations depend greatly on all persons involved having a full understanding of the risks and the regulations. This can only be achieved by a well-planned and well-maintained initial and recurrent training programme. As AMP play a significant role in the safe operation of an aircraft, the Annexes to the Convention on International Civil Aviation require that they be appropriately trained.

1.8.2 In Annex 1, AMP privileges that may be endorsed on an AMP licence or recorded are:

- a) aircraft as entered on the licence in their entirety either specifically or under broad categories; or
- b) airframes and engines and aircraft systems or components as entered on the licence either specifically or under broad categories; and/or
- c) aircraft avionic systems or components as entered on the licence either specifically or under broad categories.

1.8.3 Annex 1 states that before a person can be issued with an AMP licence, there are several criteria that need to be met. These include age, knowledge, skills and experience requirements for all AMP and the specific requirements for each of the privileges. Annex 1 also provides requirements for the certification authorization of AMOs to appoint non-licensed personnel.

1.8.4 States use Annex 1 as a basis for their national regulations that are related to the licensing of AMP and Annex 6 — *Operation of Aircraft* as a basis for their national regulations that are related to the approval of operators' maintenance control arrangements for the issuance and extension of an Air Operator's Certificate.

1.8.5 The general requirement is for all AMP to demonstrate knowledge of the following subjects¹:

Table 1-1. AMP knowledge requirements by subject

<i>Subject</i>	<i>Description</i>
Air law and airworthiness requirements	rules and regulations relevant to the AMP licence holder including applicable airworthiness requirements governing certification and continuing airworthiness of aircraft and approved aircraft maintenance organization and procedures.
Natural science and aircraft general knowledge	basic mathematics; units of measurement; fundamental principles and theory of physics and chemistry applicable to aircraft maintenance.

1. Annex 1, Chapter 4.

<i>Subject</i>	<i>Description</i>
Aircraft engineering	characteristics and applications of the materials of aircraft construction including principles of construction and functioning of aircraft structures and fastening techniques; engines and their associated systems; mechanical, fluid, electrical and electronic power sources; aircraft instrument and display systems; aircraft control systems; and airborne navigation and communication systems.
Human performance	human performance, including principles of threat and error management relevant to aircraft maintenance.
Aircraft maintenance	tasks required to ensure the continuing airworthiness of an aircraft, including methods and procedures for the overhaul, repair, inspection, replacement, modification or defect rectification of aircraft structures, components and systems following the methods prescribed in the relevant maintenance manuals and the applicable Standards of airworthiness.

1.8.6 In addition, Annex 1 states that the applicant should have completed a course of training appropriate to the privileges to be granted. Furthermore, the applicant should have experience in the inspection, servicing and maintenance of aircraft or its components as specified in Annex 1 Chapter 4.

1.8.7 Annex 1 also requires that the applicant shall have demonstrated the ability to perform those functions applicable to the privileges to be granted. Before 1998, Annex 1 categorized licences as Type 1 or Type 2, making a clear distinction between overhaul and release to service. Today, Annex 1 no longer specifies these two levels of licence, and so States are now able to define the scope of licences in a way that best suits their local needs.

1.8.8 The Standards and Recommended Practices (SARPs) concerning aeroplane maintenance are included in Annex 6, Part I — *International Commercial Air Transport — Aeroplanes*, Chapter 8 and Part III — *International Operations — Helicopters*, Chapter 6, Section II. In addition, Annex 6, Part II — *International General Aviation — Aeroplanes*. Chapter 2.6 requires that for general aviation, the person signing the maintenance release shall be qualified in accordance with Annex 1.

1.9 GENERAL INFORMATION

CBTA may be implemented by an AMO or ATO, or a combination of both. If implemented, CBTA should address as a minimum, the following:

- a) conduct of a Training Needs Analysis (TNA);
- b) derivation of training objectives from the TNA and their formulation in an observable and measurable fashion;
- c) development of a curriculum to achieve an optimal path to the required competencies;
- d) development of criterion-referenced, valid, reliable and performance-oriented assessments;
- e) performance criteria to be considered by the assessor when assessing each competency and the use of an assessment (evidence) guide applicable to all competency-based assessments;
- f) selection and description of the training for competency-based developers, instructors and assessors;

Note.— In addition to the above, consider the development of material-dependent training (as opposed to instructor-delivered training).

- g) identification of indicators to be used to evaluate the effectiveness of training on the AMP's performance; and
- h) use of a continuous evaluation process to ensure the effectiveness of training and its relevance to real-time operations.

Note.— For additional information, refer to the PANS-TRG (Doc 9868), Part I, Chapter 2.

1.10 DEVELOPING A COMPETENCY-BASED TRAINING AND ASSESSMENT PROGRAMME FOR AMP

1.10.1 The development of CBTA should be based on a systematic approach whereby AMP competencies and performance criteria are defined, training is based on the competencies identified, and assessments developed to determine whether these competencies have been achieved. It makes use of the ICAO competency framework for AMP and the ADDIE ISD model. The *PANS-TRG* (Doc 9868) describes procedures for the design of a CBTA programme including those for AMP. This manual builds on these procedures and provides guidance to AMOs and ATOs in the development of an AMP CBTA programme.

1.10.2 CBTA for AMP is generally delivered in several stages, as follows:

- a) "basic training" that is usually undertaken only once;
- b) "rating training" that is undertaken as required per rating;
- c) aircraft difference training as required per rating;
- d) non-type and non-licences certification authorization training (i.e. AMO); and
- e) refresher training and assessment, which is undertaken multiple times to ensure that competencies are maintained.

1.10.3 Each phase of a CBTA programme, including theoretical and practical training, is to integrate the CBTA approach as necessary to ensure the required level of competency is achieved.

1.11 THE ICAO COMPETENCY FRAMEWORK

1.11.1 The ICAO competency framework supports the establishment of a systematic approach as outlined in the *PANS-TRG* (Doc 9868), Part I, Chapter 2, by providing a model that should be adapted to suit the variety of situations that exist worldwide in the AMP environment.

1.11.2 The ICAO competency framework for AMP is a generic, high-level structure that has been designed to apply to all ratings and during any phase of training and assessment. The ICAO competency framework for AMP in Attachment J to Chapter 2 consists of a select group of competencies with their associated description and observable behaviours (OBs). Organizations electing to implement CBTA for AMP should use this competency framework to develop an adapted competency model that forms the basis for the development of CBTA for AMP. The development of the adapted

competency model and the associated training and assessment must take into account the regulatory, operational, technical and organizational environment within which the AMP will perform their tasks. The assessment (evidence) guide is to be developed by AMOs or ATOs as part of the local adaptation process.

Note.— The elements of an adapted competency model are outlined in the PANS-TRG (Doc 9868), Part I, Chapter 2, and include performance criteria for each competency.

1.11.3 The competencies with their associated description and OBs are to be used to develop performance criteria. The definition of performance criteria is provided in the Definitions Section.

1.11.4 To develop an adapted competency model, the ICAO competency framework is used in combination with regional and national task analysis of AMP functions for each rating and a clear understanding of the local environment.

Note.— An adapted competency model is developed based on the ICAO competency framework for AMP contained in Attachment J to Chapter 2, which describes the process for developing an ICAO competency framework.

1.12 PRINCIPLES OF COMPETENCY-BASED TRAINING AND ASSESSMENT

The principles and procedures for the development and implementation of a competency-based training programme focus on training and assessing how an AMP is expected to competently perform on the job. The principles for CBTA apply to all phases of the CBTA process:

- a) relevant competencies should be clearly defined for a particular role within an aviation discipline;
- b) there should be a link between competencies and training, required performance on the job, and assessment;
- c) competencies should be formulated in a way to ensure that they can be trained for, observed and assessed consistently in a wide variety of tasks for an aviation profession or role;
- d) students should successfully demonstrate competency by meeting the required competency standard;
- e) each stakeholder (student, instructor, training organization, operator, service provider and regulator) should have a common understanding of the competency standards;
- f) clear performance criteria should be established for assessing competency;
- g) evidence of competent performance should be valid and reliable;
- h) instructors and assessors' judgements should be calibrated to achieve a high degree of reliability;
- i) assessment of competencies should be based on multiple observations across multiple tasks; and
- j) to be considered competent, a student should demonstrate an integrated performance of all the required competencies to a specified standard.

1.13 ASSESSMENT OF STUDENTS

1.13.1 Assessment is an integral part of the CBTA process; its purpose is to measure whether the student has achieved the training objectives and the relevant competencies. AMP assessments should provide incentive and motivation and confirm that learning and competency have been achieved. The instructor should assess if the training objectives have been met. Performance during assessments should indicate whether the instruction methods used are effective or should be improved.

1.13.2 AMP should be informed of how they will be assessed. The information should include the assessment conditions, expected performance and the required standards. AMOs, ATOs and CAAs should have processes to deal with assessment failures. AMP should be informed of the result of their assessments, and instructors should offer feedback on how to correct a mistake or unsatisfactory practical performance.

1.13.3 The assessment plan should describe the process and tools that will be used to determine how an AMP's performance compares with the performance criteria in order for the AMP to demonstrate the required competencies and to receive feedback for process improvement. Tools such as periodic training reports or checklists on achievements of performance and competencies may be useful to document this process.

1.13.4 Once an AMP has demonstrated the required performance, it is necessary to maintain this level of performance and therefore maintain competency. A refresher training plan is required to ensure that the refresher training maintains competencies. The plan may be influenced by many factors, e.g. activity exposure, technical developments and new procedures. Chapter 4 contains more information about refresher training.

1.14 EVALUATION OF COURSE

1.14.1 As part of a safety and a quality management system, a process to benchmark, maintain and improve the efficiency and quality of training is required. A continuous feedback system of gathering data from students, instructors, assessors and organizations should be implemented. The feedback system may use different methods (e.g. handwritten, electronic), and all feedback should be documented.

1.14.2 Training objectives should indicate the conditions under which AMP performance will be performed and assessed and the standard to be attained. Only the training objectives are required for basic and qualification training. For CBTA, students should meet the competency standards associated with their job description.

1.14.3 The training provider can use a variety of assessment methods. Each assessment method should be selected according to the training objective, the competency to be achieved, and its impact on safety and quality. Possible assessment methods could be:

- a) open and/or multiple-choice questionnaire;
- b) written and oral examination; or
- c) practical assessment.

1.14.4 Where possible, CAAs, AMOs or ATOs should build an examination question repository or at least a comprehensive written list of all questions, and performance exercises should be kept updated to ensure the currency of the AMPs' knowledge and skills, in light of the rapid evolution of technology and systems.

- 1.14.5 The evaluation process should be acceptable to the CAA. This evaluation ensures that training:
- a) and related assessment plans are relevant to the task;
 - b) leads students to acquire the necessary competencies in a progressive and satisfactory manner; and
 - c) achieves the training objectives as derived from the TNA.
- 1.14.6 Corrective action is to be taken if a need is indicated by the training or post-training evaluation.

Note.— Workflow 5 “Evaluate the course, including the training and assessment plans” in Section 2.10 illustrates the process that should be considered for evaluating a CBTA course.

1.15 TRAINING AND ASSESSMENT MATERIALS

1.15.1 CAAs responsible for approving AMO and ATO training programmes should ensure that the training and assessment materials meet the provisions in the *PANS-TRG* (Doc 9868), Part I, Chapter 2. This manual contains additional guidance for the development of training and assessment materials.

1.15.2 CBTA programmes for AMP are to be based on the ICAO competency framework as per Attachment J to Chapter 2, as applicable to the aircraft maintenance domain, and are to be created using the ADDIE ISD model or equivalent.

Note.— A detailed systematic guide on the design of CBTA using the ADDIE ISD model is found in the PANS-TRG (Doc 9868), Part I, Chapter 2, Attachment C.

1.16 STEPS TO DEVELOP AN AMP CBTA

1.16.1 There are six steps to develop an AMP CBTA which can be described by five workflows.

1.16.1.1 Step one: The development of a training specification would require a training needs analysis based on reviewing inputs such as training requests, task list, and operational, technical, regulatory and organizational documents. The review process should include the identification of the purpose of the training required and the associated operational, technical, regulatory and organizational tasks, and any other requirements. See Workflow 1 in Section 2.4 for more information.

1.16.1.2 Step two: An adapted competency model needs to be designed to include competencies, descriptions and performance criteria (comprising of OB, final competency standard and conditions) based on a review of the training specification and the ICAO competency framework for AMP. The review process should include a selection of relevant competencies, OB, determination of relevant competency standards and the conditions under which the competencies must be observed. See Workflow 2, Part 1 in Section 2.6 for more information.

1.16.1.3 Step three: An assessment plan (including interim and final competency standards, assessment list, assessment tools) and a training plan (comprising of syllabus, composition and structure, milestones, modules/training needs and course schedule) need to be designed based on a review of training specification, adapted competency model and task analysis. The review process should include determination of sub-tasks and KSA from the task list and other relevant data in the training specification and performance of a training gap analysis. It should also include developing a syllabus, milestones, interim competency standards, and the list of assessments used to collect evidence that the interim

and final competency standards have been achieved. Furthermore, it should incorporate the development of assessment tools and design of remaining elements of the training plan. See Workflow 2, Part 2 in Section 2.7 for more information.

1.16.1.4 Step four: Training and assessment materials (comprising of course schedule, training event materials, examinations, practical and other assessments) need to be developed based on a review of the adapted competency model, assessment plan, training plan. The review process should include the development of educational materials, examinations and assessments. See Workflow 3 in Section 2.8 for more information.

1.16.1.5 Step five: The course needs to be conducted according to the training and assessment plan using the adapted competency model, assessment plan, training plan, course materials, facilities and equipment, and training and assessment personnel. The course is to be delivered according to the training plan, and students' progress needs to be monitored against interim and final competency standards. Students should be provided timely and continuous feedback on performance so that deficiencies can be diagnosed and remedied promptly. Assessments need to be carried out according to the assessment plan to determine students' competency. See Workflow 4 in Section 2.9 for more information.

1.16.1.6 Step six: The course (including the training and assessment plans) needs to be evaluated based on a review of course results, students, instructors, assessors' feedback and audit reports. The review process should include analysis of results, reports and feedback so that improvement actions can be formulated. All these should be captured in the course report. See Workflow 5 in Section 2.10 for more information.

Chapter 2

DESIGN OF COMPETENCY-BASED TRAINING AND ASSESSMENT FOR AIRCRAFT MAINTENANCE PERSONNEL

2.1 GENERAL

This chapter provides guidance on the design of CBTA for organizations intending to implement the CBTA approach. It makes use of the ICAO competency framework for AMP and the ADDIE ISD model or equivalent. Some examples are provided in the appendices to enable better understanding of the application of the guidelines for AMP contained in this manual.

Note.— This chapter expands on the information contained in the PANS-TRG (Doc 9868), Part III, Chapter 1, and should be read with Doc 9868.

2.2 COMPONENTS OF COMPETENCY-BASED TRAINING AND ASSESSMENT

The CBTA framework consists of five components depicted in Figure 2-1 and defined in Table 2-1 providing guidelines on their development.

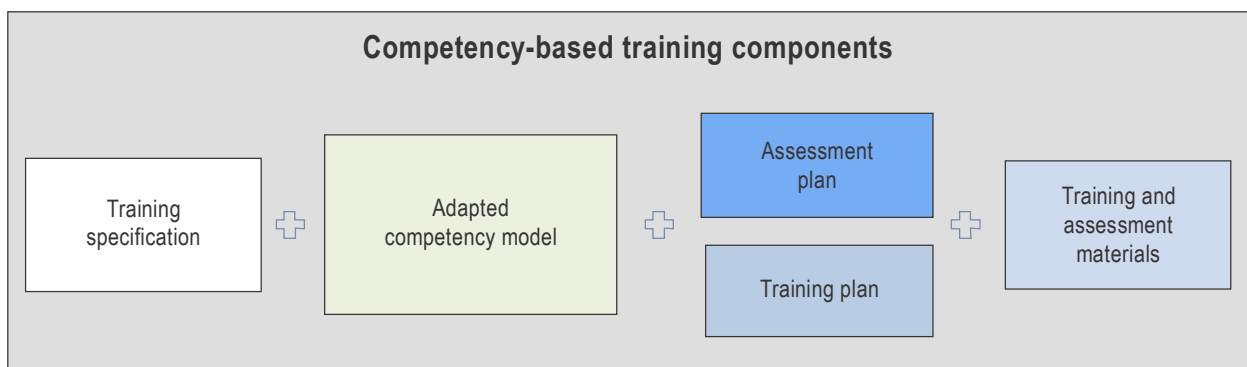


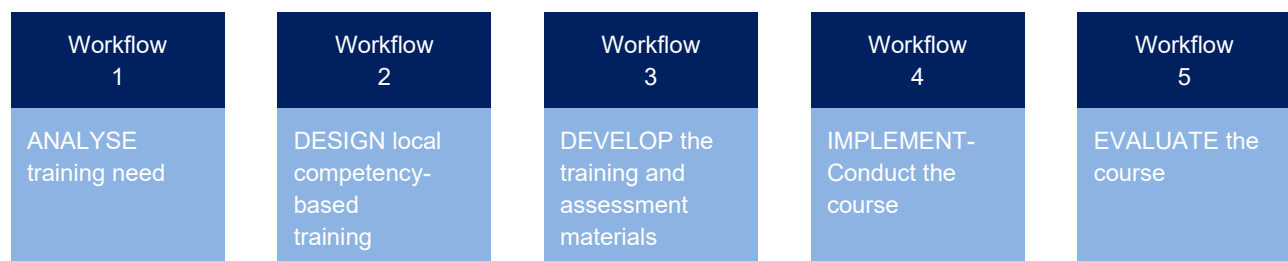
Figure 2-1. CBTA components

Table 2-1. CBTA components

<i>CBTA components</i>	
Training specification	The document that describes the purpose of the training, list of tasks and requirements that should be fulfilled when designing the training. The training specification is the output of the TNA.
Adapted competency model	A group of competencies with associated description and performance criteria adapted from the ICAO competency framework that an organization may use to develop CBTA for a role. The components of an adapted competency model are:
	1. <i>Competency</i> A dimension of human performance that is used to reliably predict successful performance on the job. A competency is manifested and observed through behaviours that mobilize the relevant KSA to carry out activities or tasks under specified conditions. 2. <i>Performance Criteria</i> Statements used to assess whether the required levels of performance have been achieved for a competency. A performance criterion consists of an OB, condition(s) and a competency standard.
Assessment plan	The document that details the assessment events and tools (Assessment (evidence) guide, competency checklist, competency assessment form) to be used in the determination of competency achieved.
Training plan	The document used for structuring, developing and delivering the training.
Training and assessment materials	All the materials used in the training and assessment following the training plan, including course programme, training notes, manuals, presentations, simulated exercises, etc.

2.3 OVERVIEW OF COMPETENCY-BASED TRAINING AND ASSESSMENT WORKFLOWS

2.3.1 The structured ADDIE ISD model or equivalent is used to design and deliver the components of CBTA. The approach consists of five workflows depicted in Figure 2-2 and further detailed in this section.

**Figure 2-2. CBTA workflows**