



*Certifying Technical Employee Competence*<sup>™</sup>

# Basic Composites Technician Study Guide



## DESCRIPTION

This Basic Composite Technician Study Guide is designed to be used in preparing for the CertTEC Basic Composite Certification examination. The study guide addresses each CertTEC knowledge and characteristics standard and the required level of understanding necessary for passing the examination. The Basic Composites examination will ask one or more questions from the following standards areas:

1. Basic composite materials knowledge
2. Composite fabrication methods
3. Composite inspection techniques
4. Composite health and safety

Use of this study guide coupled with a serious review of the references and study materials that are provided on the CertTEC website (<https://spacetec.us/certtec/>) will ensure the individual is adequately prepared to join the ranks of Certified Basic Composite Technicians.

## Proficiency Code Key

	Level	Definition
<b>Subject Knowledge Levels (SK)</b>	1	Can identify basic facts and terms about the subject. (FACTS)
	2	Can identify relationship of basic facts and state general principles about the subject. (PRINCIPLES)
	3	Can analyze facts and principles and draw conclusions about the subject. (ANALYSIS)
	4	Can evaluate conditions and make proper decisions about the subject (EVALUATION)
<b>Task Knowledge Levels (TK)</b>	1	Can name parts, tools, and simple facts about the task. (NOMENCLATURE)
	2	Can determine step by step procedures for doing the task. (PROCEDURES)
	3	Can identify why and when the task must be done and why each step is needed. (OPERATING PROCEDURES)
	4	Can predict, isolate, and resolve problems about the task. (ADVANCED THEORY)

<b>Task Performance Levels (TP)</b>	1	Can do parts of the task. Needs to be supervised doing most of the task. (LIMITED)
	2	Can do most of the task. Needs help only on hardest parts. (PARTIALLY PROFICIENT)
	3	Can do all parts of task. Needs only a spot check of completed work. (COMPETENT)
	4	Can do the complete task quickly and accurately. Can tell or show others how to do the task. (HIGHLY PROFICIENT)

## REFERENCES

The primary reference for this study guide is *Essentials of Advanced Composite Fabrication and Repair* (2<sup>nd</sup> Ed.) Dorworth, Gardiner, and Mellema, 2018 augmented by numerous relevant articles from Composites World magazine (CW), one of the preeminent periodicals in the composites industry. References also contain many videos of different processes to help technicians visualize complex processes. While these are excellent references chosen specifically for this study guide, prospective composite technicians are urged to seek out relevant information from any viable source available to them.

### I. DEMONSTRATE KNOWLEDGE AND CHARACTERISTICS OF COMPOSITE MATERIALS

#### 1. Demonstrate Knowledge of the Characteristics of Composite Materials

##### Proficiency: SK2, TK2

- Composite advantages vs. metals
- Composite disadvantages vs. metals
- Different composite applications
- Strength and stiffness concepts
- Composite history

##### Resources:

- Essentials of Advanced Composite Fabrication and Repair (2<sup>nd</sup> Ed.), Chapter 1
- Composite Basics: <https://tinyurl.com/Strings-and-Glue>
- Fiber and Resin Primer: <https://tinyurl.com/Fiber-and-Resin-Primer>
- Composites History: <https://tinyurl.com/Composites-History>
- NASA 360 – Composites: <https://tinyurl.com/NASA360-Composites>

## 2. Demonstrate Knowledge of Fibers and Applications

### Proficiency: SK2, TK2

- Fiber types & brand names of fiber reinforcements
- Fibers versus fillers
- Weave Styles and Unidirectional materials
- Woven material basics such as warp and fill directions, selvage edges, etc.
- Fiber density, tensile strength, stiffness (modulus)
- Fiber-dominated properties
- Yarn and tow construction and terminology
- Strength to weight ratios

### Resources:

- Essentials of Advanced Composite Fabrication and Repair (2<sup>nd</sup> Ed.), Chapters 3 & 6
- Fiber Basics: <https://tinyurl.com/Fiber-Basics>
- Fiber reinforcements: <https://tinyurl.com/Woven-Composite-Fabrics>
- Fiber Forms: <https://tinyurl.com/Fiber-Forms>
- Ply Orientation (video): <https://tinyurl.com/Ply-Orientation>
- Glass Manufacturing: <https://tinyurl.com/Glass-Fiber-Manuf>
- Carbon Fiber Manufacturing (video): <https://tinyurl.com/Carbon-Fiber-Manufacturing>
- Kevlar Basics: <https://tinyurl.com/Kevlar-Basics>
- Basalt Fiber: <https://tinyurl.com/Basalt-Fiber>
- Boron Fiber: <https://tinyurl.com/Boron-Fiber>
- Fillers: <https://tinyurl.com/Filler-Materials>

## 3. Demonstrate Knowledge of Matrices

### Proficiency: SK2, TK2

- Thermoset vs. Thermoplastic matrices
- Differences between polyesters, vinyl esters, epoxies, and other thermoset resin systems
- Initiators vs. Hardeners
- Mix ratios
- Cross-linking
- Cure cycles, Exotherms
- Matrix-dominated properties

- Glass Transition temperature ( $T_g$ )
- Storage: Shelf life vs. Out time
- Bonding strength
- Out life versus work time
- Moisture contamination

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2<sup>nd</sup> Ed.), Chapters 2 and 6
- Resin Matrices: <https://tinyurl.com/Resin-Matrices>
- Prepregs: <https://tinyurl.com/Prepreg-Benefits>
- Thermoplastic Matrices: <https://tinyurl.com/Thermoplastic-Matrices>
- Thermoset Matrices: <https://tinyurl.com/Thermoset-Matrices>

**4. Identify the Characteristics of Fiber/Matrix Interfaces**

**Proficiency: SK2, TK2**

- Distinguish between sizing, coupling agents, and fiber finishes
- Voids and porosity's effect on the fiber/matrix bond
- Water intrusion (moisture wicking) of fibers effects on the fiber/matrix bond
- Sizing, finishes, and coupling agents

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapters 2 and 3
- Fiber sizing: <https://tinyurl.com/Sizing-001> , <https://tinyurl.com/Sizing-002>

**5. Demonstrate knowledge of core materials**

**Proficiency: SK2, TK2**

- Understand primary benefits of using sandwich construction
- Sandwich construction issues
- Honeycomb cores
- Foam cores

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 5
- Core Material Basics: <https://tinyurl.com/Core-Materials-001>
- Sandwich Structure Application: <https://tinyurl.com/Applications-001>

- DarkAero Core Video: <https://tinyurl.com/Cores-DarkAero-Video>

## II. DEMONSTRATE KNOWLEDGE AND CHARACTERISTICS OF FABRICATION METHODS

### 1. Demonstrate Knowledge of the Methods of Vacuum Bagging

**Proficiency: SK3, TK3, TP3**

- Benefits of vacuum bag processing
- Relationship between vacuum and atmospheric pressure
- Understand the function of release layers; solid release film, perforated release film, and peel ply
- Understand the function of bleeder layer(s)
- Understand the function of breather layer(s)

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 7
- Fabrication Methods: <https://tinyurl.com/Fabrication-Methods-001>
- Fabrication Methods (2): <https://www.compositesworld.com/articles/fabrication-methods-2015>
- Basic Vacuum Bagging: <https://tinyurl.com/Vacuum-Bagging-Basics>
- Defects: <https://tinyurl.com/Manufacturing-Defects>

### 2. Demonstrate Knowledge of Resin Transfer Molding (RTM)

**Proficiency: SK3, TK3, TP3**

- Distinguish between resin transfer molding (RTM), resin infusion molding (RIM), and vacuum-assisted resin transfer molding (VARTM)

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 8
- RTM/VARTM: <https://tinyurl.com/RTM-VARTM>
- Resin Infusion Process: <https://tinyurl.com/Resin-Infusion-Basics>

### 3. Demonstrate knowledge of sheet molding compound (SMC) and bulk molding compound (BMC)

**Proficiency: SK3, TK3, TP3**

- Sheet molding compound (SMC)
- Bulk molding compound (BMC)
- Tooling and temperature requirements

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 7
- SMC: <https://tinyurl.com/SMC-Basics>
- Compression Molding: <https://tinyurl.com/Composite-Compression-Molding> ,  
<https://tinyurl.com/Compression-Molding-002>

**4. Demonstrate knowledge of release films**

**Proficiency: SK3, TK3, TP3**

- Distinguish between solid release films, perforated release films, porous Teflon® (TFP), non-porous Teflon® (NTPF), and peel-ply fabrics

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 7

**5. Demonstrate principles of operation of a platen press**

**Proficiency: SK3, TK2**

- Advantages of a platen press/compression molding
- Tooling and temperature considerations
- “Charge” materials, e.g. BMC, SMC, etc.

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 7
- Compression Molding: <https://tinyurl.com/Composite-Compression-Molding> ,  
<https://tinyurl.com/Compression-Molding-002>

**6. Identify the characteristics of filament winding**

**Proficiency: SK2, TK2**

- Applications for filament-wound structures
- Distinguish between filament winding and automated fiber placement

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 7 - 8
- Filament Winding (videos): <https://tinyurl.com/Filament-Winding> ,  
<https://tinyurl.com/Filament-Winding-002>
- Fiber Placement and Tape Laying: <https://tinyurl.com/Fiber-Placement---Tape-Laying>

**7. Demonstrate knowledge of pultrusion methods**

**Proficiency: SK2, TK2**

- Describe the pultrusion process
- Applications for pultruded composite structures

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 8
- Pultrusion Process: <https://tinyurl.com/Pultrusion-001>
- Pultrusion (video): <https://tinyurl.com/Pultrusion-002>

**8. Demonstrate knowledge of the use and characteristics of the autoclave process**

**Proficiency: SK2, TK2**

- Advantages of autoclave processing
- Ply consolidation
- Reduced void content

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 7
- Autoclave Operation (video): <https://tinyurl.com/Huntsman-Autoclave>
- Autoclave Principle of Operation (video): <https://tinyurl.com/Autoclave-Principles>
- Improving Autoclave Performance: <https://tinyurl.com/Autoclave-CW>

**9. Differentiate characteristics of joining and bonding**

**Proficiency: SK3, TK2, TP2**

- Fastener design & material considerations
- Material thickness considerations
- Adhesive bonding limitations

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapters 8, 11, and 12
- Kraden's Adhesives vs. Riveting: <https://tinyurl.com/Adhesive-vs-Riveting>

**10. Demonstrate knowledge and characteristics of adhesive bonding**

**Proficiency: SK2, TK2**

- Differentiate between co-curing, co-bonding, and secondary bonding
- Identify different types of adhesives, e.g. liquid vs. paste vs. film
- Understand bond-line thickness control

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 11



- SAMPE Adhesive Bonding (video): <https://tinyurl.com/SAMPE-Adhesive-Bonding>
- Structural Adhesives: Part 1: <https://tinyurl.com/Structural-Adhesives-Pt-1>

## 11. Identify proper methods of surface treatment for adhesive bonding

### Proficiency: SK3, TK2, TP2

- Distinguish between surface treatments for metals vs. composites
- Understand the concept and importance of “surface energy”
- Abrasion materials and methods
- Solvent cleaning

### Resources:

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 11
- BTG Labs surface prep: <https://tinyurl.com/BTG-Labs>
- Peel ply surface prep: <https://tinyurl.com/Peel-Ply-Surface-Prep>

## 12. Identify and demonstrate knowledge of the types of fasteners

### Proficiency: SK3, TK2, TP2

- Demonstrate knowledge of the types of fasteners
- Demonstrate knowledge of proper hole sizing
- Identify the correct methods for drilling holes in composite materials
- Identify the proper equipment required for fastener installation

### Resources:

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 12
- F-35 Skins: <https://tinyurl.com/F-35-Skins>
- Boeing video: <https://tinyurl.com/Boeing-Fasteners>
- Monogram video: <https://tinyurl.com/ComposiLokII>

## 13. Demonstrate knowledge of tooling (molds)

### Proficiency:

- Tool and part design
- Metal vs. composite tooling
- Elastomeric mandrels, bladders, and cauls

### Resources:

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 9
- Tooling Basics: <https://tinyurl.com/Composite-Tooling>

- Bladder and caul tooling: <https://tinyurl.com/Bladder-and-Caul-Tooling>

### III. DEMONSTRATE KNOWLEDGE AND CHARACTERISTICS OF INSPECTION AND REPAIR TECHNIQUES

#### 1. Demonstrate knowledge and characteristics of non-destructive inspection techniques

##### Proficiency: SK3, TK2

- Understand basic inspection techniques, e.g., visual and tap testing
- Identify more advanced techniques, e.g., Ultrasonic (A and C scan), radiographic, and thermographic techniques

##### Resources:

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 10
- Ultrasonic Inspection: <https://tinyurl.com/Ultrasonic-Inspection> ,  
<https://tinyurl.com/UT-Basics>
- Thermal Wave Imaging: <https://www.thermalwave.com/technology/>
- X-Ray Inspection: <https://tinyurl.com/Radiographic-Inspection>

#### 2. Demonstrate knowledge and characteristics of destructive testing techniques

##### Proficiency: SK3, TK2

- Tensile and compressive testing
- Shear and flexure testing
- Fracture toughness and fatigue testing

##### Resources:

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 10
- Destructive testing (video): <https://tinyurl.com/Mechanical-Testing> ,  
<https://tinyurl.com/Mechanical-Testing-002>
- Instron testing (video): <https://tinyurl.com/Instron-Testing>

#### 3. Demonstrate knowledge and characteristics of composite repair techniques

##### Proficiency: SK3, TK2

- Types of damage
- Damage detection
- Paint removal
- Damage removal
- Types of repair, e.g., tapered, stepped, scab patch

- Vacuum bagging and curing methods

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 13
- Composite Repair: <https://tinyurl.com/Composite-Repair>

#### **IV. DEMONSTRATE KNOWLEDGE AND UNDERSTANDING OF HEALTH AND SAFETY**

##### **1. Demonstrate knowledge and understanding of SDS forms**

**Proficiency: SK3, TK3, TP3**

- Understand the purpose of the safety data sheet (SDS)
- Recognize the 16 required sections of an SDS

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 14
- OSHA Hazcom Standard: <https://tinyurl.com/OSHA-HAZCOM-Standard>
- HIS Video: <https://tinyurl.com/9ukt5c6x>

##### **2. Demonstrate knowledge and understanding of personal safety and composites**

**Proficiency: SK3, TK3, TP3**

- Recognize the four routes of exposure for hazardous materials
- Understand permissible exposure limits (PEL)
- Understand the hazards associated with matrices (resins)
- Understand the hazards associated with fiber reinforcements (airborne fibers)
- Understand the regulatory hierarchy for controlling worker's exposure

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 14
- OSHA Website: <https://www.osha.gov/hazcom>
- OSHA HAZCOM Standard: <https://tinyurl.com/OSHA-HAZCOM-Standard>

##### **3. Identify various personal safety equipment**

**Proficiency: SK3, TK3, TP3**

- Demonstrate knowledge of appropriate personal protective equipment (PPE) for composites work, e.g., proper respirator and/or glove selection

**Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapter 14
- Safety in Composites: <https://tinyurl.com/Safety-in-Composites>

- OSHA Composites: <https://www.osha.gov/composites>

#### **4. Demonstrate knowledge of the proper disposal of materials**

##### **Proficiency: SK3, TK3, TP3**

- Understand general composite-related HAZMAT disposal concepts
- Understand current composite recycling efforts

##### **Resources:**

- Essentials of Advanced Composite Fabrication and Repair (2nd Ed.), Chapters 14
- Carbon fiber recycling: <https://tinyurl.com/Carbon-Recycling>
- Hazmat disposal: <https://tinyurl.com/HAZMAT-Disposal>
- NESHAP: <https://tinyurl.com/EPA-Compliance>