ETA® International
Technician in Precision Optics - (TPO)
Competency Requirements

NOTE: Portions of this document have been excerpted from information provided by OP-TEC, the National Center for Optics & Photonics Education, an NSF Advanced Technological Education (ATE) Center of Excellence (www.op-tec.org). A primary reference from OP-TEC is "The National Precision Optics Skill Standards for Technicians (www.op-tec.org/potskillstandards.php).

Precision Optics technicians work in the technical area of optical component fabrication in optical shops for optics manufacturers, and in quality control departments (incoming and/or outgoing inspection) for organizations that incorporate precision optics into various systems. They must understand and be able to examine the properties and uses of a variety of bulk materials, have experience in the use of equipment and procedures for shaping polishing and coating precision optics, and the use optical instruments, procedures and guidelines for verifying optical component dimensions and tolerances. They can also handle, store and ship precision optical components

Technician Level: These technicians have the minimum required hands-on competencies and experience with fabrication and test of fewer types of optics.

Certification requires competence in the following **knowledge** areas:

1) Applied mathematics
2) Safety

The required knowledge competence can be demonstrated via a passing score of 75% or better on each of the Technician in Precision Optics Certification exam sections. These exam sections will be required of all applicants, regardless of formal education training or work experience.

Certification requires competence in the following **hands-on** competency areas:

1) Specific technical skills in
    a) Materials
    b) Measurements and testing
    c) Fabrication
    d) Assembly
2) Basic technical skills

The required hands-on competence can be demonstrated via one or more of the following:

1) If employed currently, or previously employed, a letter from the employer, preferably a supervisor who has been certified, certifying that the person has demonstrated the competencies listed.
2) Transcript showing passing grade of C or better in the subject matter from an accredited college or university or technical school.

<u>Technician-Level Knowledge Competencies</u> – Certification as a "Technician in Precision Optics" requires evidence of understanding and competence in <u>all</u> of the following areas.

I. Applied Mathematics

1) Understand and utilize basic math skills:
   a) Work with fractions, decimals, and percents, exponents, real & imaginary numbers, symbolically and graphically.
   b) Know basic units of measurements for distance/length, weight, and volume in English and Metric units and be able to convert between English and Metric units.
   c) Know the meaning of various unit measurement abbreviations such as micro, nano, pico, atto, and be able to convert one unit to another.
   d) Estimate answers to problems and round off numbers
   e) Understand precision, accuracy, and tolerance in measurements
2) Understand and utilize basic algebra skills:
   a) Perform calculations using powers, roots, scientific and engineering notation, logarithms, decibels
3) Understand and utilize basic geometry and trigonometry skills:
   a) Perform calculations using lines and angles (parallel and perpendicular lines)
   b) Perform calculations on perimeters and areas of rectangles, parallelograms, trapezoids, triangles, and circles (sine, cosine, tangent functions)
   c) Perform calculations on surface areas and volumes of boxes, cones, cylinders, and spheres
   d) Know definition of and how to use basic trig functions: sine, cosine, tangent

II. Safety

1) Basic laser safety as defined in ANSI Z136.1-2007 American National Standard for Safe Use of Lasers
2) Laser safety concepts
   a) Biological effects of laser radiation on the eye and skin with all wavelength from 180nm to 1mm
   b) Understand the significance of specular and diffuse reflections
   c) Understand the non-beam hazards
   d) Understand laser classification
   e) Maximum Permissible Exposure (MPE), Normal Hazard Zone (NHZ)
   f) Control measure for normal laser operation and during service with defeated interlocks.
   g) Familiarity of the US code of federal regulation 1040.10, Federal Laser Product Performance Standard. Be able to identify if a laser or laser system complies with the code.
3) Knowledge of other basic safety procedures that are likely in most photonics applications:
   a) Electrical
   b) Chemical (e.g., optics cleaning using acetone - flammability & explosion potential)
   c) Materials (e.g., MSDS – Material Safety Data Sheets)

<u>Technician-Level Hands-On Competencies</u> – Certification as a "Technician in Precision Optics" requires evidence of training and/or experience and competence in <u>all</u> of the following areas.

I. Specific technical skills

1) Materials identification, inspection, qualification
   a) Determine optical, chemical, thermal, and mechanical properties of selected materials from handbooks, supplier specification sheets, and Internet sources and assess their relevance to specified manufacturing processes.
   b) Review incoming material certification sheets to match print specifications.
   c) Maintain prescribed documentation of bulk materials using a job jacket or its equivalent.
   d) Inspect and evaluate physical properties of materials for hardness and chemical stability, for defects such as cleavage, inclusions, bubbles, striae, scratches, bulk stress, scattering, fractures, and impurities, and assess their relevance to specified manufacturing processes.
   e) Apply chemical and material handling safety procedures, including knowing handling for optical materials that may present a hazard, to ensure personal safety, prevent material damage, avoid contamination, and maintain material identification.
   f) Understand the properties and work with at least one type of material for optics (e.g., glasses, ceramics, metals, plastics)
2) Measurements and testing
   a) Identify the functions and shapes of various optical components.
   b) Use a loupe to identify bulk material bulk defects such as inclusions, bubbles, striae, scratches, and fractures.
   c) Measure optical surface characteristics during fabrication using appropriate equipment (e.g., scratch and dig inspection box, microscope, loupe, magnifiers, calipers, micrometers, depth gauges, spherometers).
   d) Inspect finished products following accepted procedures and quality assurance criteria to ensure compliance with established specifications by measuring physical and optical properties (shape, reflectivity, transmission, surface quality/roughness) using appropriate equipment, including interferometer, autocollimator, profilometer, reflectometer.
   e) Measure conformance and performance via mechanical and/or optical means and record any deviations from specifications and recommend corrective actions.
   f) Comply with specified handling, packaging, & shipping conditions for finished optical components, coordinating with quality assurance personnel to ensure compliance to design specifications and documentation requirements.
3) Optical Component Fabrication
   a) Operate appropriate equipment to shape optical materials to dimensional specifications (e.g., cutoff and wire saws, abrasive grinding machines, and coring machines).
   b) Operate appropriate equipment and perform procedures for tooling, blocking, generating, shaping, beveling, grinding, polishing, and centering.
   c) Select appropriate abrasives including grit size and composition to achieve design tolerances and specifications for surface quality for specific materials.
   d) Understand the interaction between various materials used in high-tolerance optics fabrication such as hot pitch and acetone.
   e) Prepare fixtures for mounting starting material as part of the fabrication process.

f) Operate appropriate grinding and polishing machines to generate planar and spherical surface optics.
g) Prepare appropriate bevels on optics.
h) Maintain and prepare conduits and pumps for cooling and slurry delivery to work surfaces.
i) Clean optics to appropriate specification levels using proper techniques.
j) Store optics in appropriate containers with environmental controls.
k) Comply with specified handling, packaging, & shipping conditions for finished optical components
l) Apply appropriate maintenance instructions from manufacturers' equipment manuals.

4) Optical Component Assembly
   a) Interpret assembly drawings.
   b) Apply proper cleanroom and airflow workbench procedures.
   c) Use proper alignment techniques for assembly processes including aligning physical and optical centers per specifications.
   d) Use appropriate optical adhesives or epoxies (UV, etc.).
   e) Mount optical components in mechanical assemblies.
   f) Align and cement/pot elements in cells.

II. Basic technical skills

1) Read and interpret technical drawings and specifications for dimensions and tolerancing and data reference
2) Read and understand CAD drawings
3) Read a basic optical layout schematic
4) Operate common machine shop equipment such as lathes, band saws, drill presses, and milling machines.
5) Program CNC controllers according to specifications.
6) Collect data and use computer spreadsheet software (e.g., Excel) for data collection, reduction, presentation.
7) Identify and comply with established regulatory electrical, chemical, and laser codes, including laser safety if laser devices are used in testing.
8) Detect malfunctioning equipment, including recognizing operation out of specifications, and notify appropriate personnel for repair.
9) Apply accepted standards to maintain work area cleanliness.
10) Use established instructions for entering and operating in cleanrooms (if cleanroom operation is required)

End of Technician in Precision Optics Competencies Listings:
(with 2 major Knowledge categories and 2 major Hands-On categories)

Find An ETA Approved School Site:
http://www.eta-i.org/eta_schools.html

Find An ETA Test Site:
http://www.eta-i.org/testing.html

Suggested Study Material and Resources:

(also see websites for even more detail information)

LIGHT- Introduction to Optics and Photonics (hardcover); Judith Donnelly, Nicholas Massa; ISBN 978-09815318-09; New England Board of Higher Education; Jan. 2010; pgs.377. Also available in paperback, black & white paperback, and PDF download at http://stores.lulu.com/photon2

Optics for Engineers; Charles DiMarzio; ISBN 978-14398072-5-5; CRC Press; Aug. 2011; pgs.558. http://www.crcpress.com/product/isbn/9781439807255

Optical Communications Essentials; Gerd Keiser; ISBN 978-00717379-99; McGraw-Hill Companies; July 2003; pgs.396.

Understanding Lasers: An Entry-Level, 3E; Jeff Hecht; ISBN 978-04700889-06; Wiley-IEEE Press; June 2008; pgs.496.

Optics, 4E; Eugene Hecht; ISBN 978-0805856-63; Addison Wesley; Aug. 2001; pgs.680.

Basic Electro-Optics for Electrical Engineers; Glenn D. Boreman; ISBN 978-08194280-66; SPIE Publications; March 1998; pgs.97. http://spie.org/x648.html?product_id=294180

NOTE: The following are to be used as a resource, not intended to replace the approved course training in photonics or precision optics, required in order to sit for the certification qualifying exams.

OP-TEC websites: http://www.op-tec.org/; http://www.op-tec.org/index-1.php; http://www.op-tec.org/OPCN.php; http://www.op-tec.org/index-3.php

SPIE open access self-study resources:

Fundamentals of Photonics, 10 tutorial modules written by experts, part of a project funded by the Center for Occupational Research and Development (CORD) and the Scientific and Technological Education in Optics and Photonics (STEP), and supported by SPIE and other organizations. http://spie.org/x17229.xml

Optipedia, a collection of encyclopedic articles on key topics in optics and photonics. Text, equations, and graphs were originally published in SPIE Press books. http://spie.org/x32276.xml

Other **SPIE** publications in their "Field Guides" series, http://spie.org/x647.xml, (mainly aimed at engineers, but could also be useful to technicians):

Field Guide to Infrared Systems, Detectors, and FPAs, Second Edition
Field Guide to Optical Fiber Technology
Field Guide to Geometrical Optics
Field Guide to Lasers
Field Guide to Polarization
Field Guide to Infrared Systems
Field Guide to Laser Pulse Generation
Field Guide to Optical Thin Films
Field Guide to Interferometric Optical Testing

